

Proceedings of the



Virginia Junior Academy of Science

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The Virginia Academy of Science (VAS) is the fifth largest state, region, or city academy of science in the U.S.; it was founded in 1923 to promote the civic, academic, agricultural, industrial, and commercial welfare of the people of Virginia. Exemplary programs have included *Flora of Richmond and Vicinity*, Published, 1930, the first comprehensive multidisciplinary studies of the James River Basin and the Great Dismal Swamp, volunteer research assistance to Virginia in the instance of the kepone pollution disaster, and leadership in establishing the Science Museum of Virginia.

Fall Undergraduate Research Meeting:

The focus of this meeting is support of undergraduate student research. Specific details about the 2021 Fall Undergraduate Research Meeting, including the location and date will be made available on the VAS website (www.vacadsci.org) during the summer.

The Virginia Junior Academy of Science

VJAS is a national model for the new and renewing state junior academies and has been ranked among the top three in the nation for over two decades. Through VJAS and other programs, VAS annually reaches over 40,000 Virginia middle and high school students. Hundreds of volunteers make it possible for Virginia secondary students to experience these activities.

VJAS General Session

Ecology of Migratory Birds: Using Behavior to Inform Conservation. **Leslie P. Bulluck**,
Virginia Commonwealth University.

George W. Jeffers Memorial Lecture

Computer Games for CEOs: Preventing the Next Big Oil Spill. **Jason R. W. Merrick**,
Virginia Commonwealth University.

Contributors and Supporters

The Virginia Academy of Science notes with appreciation the contribution and support of hundreds of individuals and dozens of organizations to the success of its 90th Annual Meeting and of the 73rd Research Symposium and Annual Meeting of the Virginia Junior Academy of Science.

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Animal and Human Sciences A

First Place

The Effect of Different Humidity Levels on the Number of Dust Mites

Ankit Kumar, George H. Moody Middle School

Dust mites are microscopic, eight-legged creatures that live in similar association with humans. These mites need certain environmental factors to live and develop. The growth and development of dust mites highly depends on the humidity levels. Humidity is the most significant environmental factor that can affect the growth of house dust mites. Dust mites need a certain amount of moisture in the air to survive. The purpose of this experiment was to examine the effect of different humidity levels on the number of dust mites. The hypothesis that was made by the experimenter was if different levels of humidity are tested, then the 40% humidity level will collect the least number of dust mites. For this project, a bedroom with carpet flooring was selected and the experimenter marked five areas with duct tape which had measurements of 50 cm by 50 cm each. A Sunbeam Cool Mist Humidifier was used to regulate the humidity levels in the room. After the humidifier was maintained for six days, the five areas of carpet were vacuumed by the Shark Cordless 18 Volts hand vacuum cleaner. Quickly after, the dust from the five separate areas was placed in five separate Ziploc plastic bags. These plastic bags were placed in a freezer for twenty-four hours to kill the dust mites and a microscope with a magnification of 150X was used to examine the dust mites. The hypothesis was supported by the data found from the experiment. The results indicated that the 40% humidity level collected the least amount of dust mites, when compared to other levels of independent variable, with a mean of 2 dust mites. The findings agreed with similar research, in that the growth and development of dust mites will reduce, when the humidity level is below 50%. This happens because of the lack of moisture in the air for the dust mites to absorb.

Second Place

The Effect of Flash Angle on Red-eye in Flash Photography

Alexis Long, George H. Moody Middle School

Red-eye is the dreaded and unwanted appearance of red irises in flash photography. The on-camera flashbulb gained popularity in the 1960s and ever since then scientists have been trying to solve the problem of red-eye. Since red-eye occurs when the light from a flash reflects off the blood vessels in the pupil, the purpose of this project was to change the angle of a detachable flash so that the light from the flash would hit the pupil and would not be reflected back into the lens. The angle between the flash and the camera was tested at zero, ten, twenty, and thirty degrees horizontal to the camera. Five photographs were taken for each level. The results indicated that red-eye does not occur when the flash is at a zero degree angle to the camera. The data partially supported the hypothesis that if a flash was placed at different angles, then the thirty degree angle would least frequently result in red-eye. Since the other trials with a 20 degree angle and a 30 degree angle still got red-eye, the hypothesis was not completely supported. There was no red-eye occurrence at all when the flash angle was wider than zero degrees because the light reflected off the back of the retina at an angle opposite of the angle in which the light contacted the eye. Therefore, the light did not reflect back at the lens. To improve this experiment, different lighting could be tested or having the camera on a different setting. Further research on this specific experiment would be to have smaller angles between 10 degrees and zero to see if angles smaller than 10 degrees result in red-eye.

Third Place

The Effect of the Music of Ellington and Tchalkovsky on Spatial-temporal Reasoning in Roborovski Dwarf Hamsters

Michael Lenzi, Oak Knoll Middle School

Spatial-temporal reasoning is a cognitive ability where someone, or something, has the ability to visualize putting together pieces of a puzzle or solving problems, like running through a maze. It's a type of reasoning about shape, measurement, depiction, and navigation. The "Mozart effect" is a previous study of this, and is the end result of what happens after listening to Mozart's music. The purpose of this experiment was to test spatial-temporal reasoning, in hamsters, by using different means, which was music from different composers. It was also to investigate the short-term memory of the test subjects. For this experiment, the subjects were tested in three parts. After regulating their feeding time, the first step was to test them, in the maze, without any music played and using this as a base. The next step was to play Ellington's music for them, for a week, and retest them not changing any constants. The final step was to play Tchaikovsky's music for them, for a week, and retest them exactly the same way. The hypothesis was supported because the data reflected that of the six subjects, four increased their speed after listening to different composer's music. The hamsters strengthened their cognitive abilities, including spatial-temporal reasoning and short-term memory recall.

Honorable Mention

Mosquito Attraction

Matthew Jaffe, Thomas Jefferson Middle School

Mosquitoes have proven to be a global health hazard, transmitting diseases from Malaria to West Nile Virus. To control the mosquito population, scientists developed mosquito dunks; a system of chemicals that kill mosquito larvae in water. However, it has proven impossible to put mosquito dunks in all potential mosquito breeding sites. The question posed here was, "Could mosquito dunks be made more effective with a mosquito attractant to lure mosquitoes to specific breeding sites?" Research revealed three substances effective in attracting mosquitoes: carbon dioxide, (CO₂, represented by dry ice), ethanol and sugar. It was hypothesized that if mosquitoes were exposed to these three substances, sugar would attract the most mosquitoes, because sugar was identified as a source of food for mosquitoes. For the experiment, 5 ml each of sugar, dry ice, ethanol and a control of 5 ml of water were placed in the four corners of a terrarium containing mosquitoes, and the number of mosquitoes attracted to within a 5 centimeter radius of each substance was recorded. The results of the experiment showed that sugar attracted the most mosquitoes with a mean of 0.9 mosquitoes per trial. CO₂ attracted the second greatest number of mosquitoes, with a mean of 0.7; ethanol was third with a mean of 0.6 mosquitoes, while the control attracted the least number, with a mean of 0.3 mosquitoes per trial. The hypothesis was accepted: sugar attracted three times as many mosquitoes as the control. These results support the idea that mosquitoes could be more effectively exterminated by adding sugar to mosquito dunks.

Honorable Mention

The Effect of Different Types of Antacids on the pH of an Acidic Solution at Different Time Intervals

Andrew Jordan, George H. Moody Middle School

Antacids are medicines commonly purchased over-the-counter to treat heartburn, acid indigestion, and related ailments. The purpose of this experiment was to test the effectiveness of different antacids in neutralizing acid, including two available over-the-counter (Tums and Alka-Seltzer) and two natural substances (Magnesium Hydroxide and Baking Soda). The experimenter's hypothesis was that magnesium hydroxide would neutralize the acid the best, due to the fact that it has the highest pH level out of the four antacids. Before conducting the experiment, the over-the-counter antacids that weren't already in powder form were crushed with a mortar and pestle. Ten trials of each antacid were used in the experiment. Ten milliliters of lemon juice (acid) and 10 ml of cabbage juice (a pH indicator) were poured into a beaker for each trial. A ¼ teaspoon of the antacid was added to each beaker and stirred for 20 seconds to mix with the acid solution. At various intervals (immediate and 3, 5, and 15 minutes), the resulting pH of the solution was recorded for each trial using the color of the solution. These steps were

repeated for all of the different types of antacids. Magnesium hydroxide was most effective in neutralizing the acid with an average pH for all of the time intervals of 10.69. Baking soda raised the pH to an average across the trials of 6.21. Tums raised the solution pH to 5.25 on average and Alka-Seltzer 4.91 on average. The data supported the hypothesis that magnesium hydroxide would be most effective in raising the pH of the solution. Based on the resulting pH values in this experiment, it appears that a natural remedy like magnesium hydroxide or baking soda may be more effective, and far less costly, than over-the-counter remedies that are popular with consumers.

Honorable Mention

The Effect of Vitamin C (Ascorbic Acid) on the Removal of Calcium Apatite (Hydroxyapatite)

Rujul Kaul, George H. Moody Middle School

According to Linus Pauling's Unified Theory of Cardiovascular disease published in 1992 ascorbate deficiency is the common cause of human cardiovascular disease and taking ascorbates can be an effective treatment for the disease. This led to several studies and trials to understand the effect of vitamin C (ascorbic acid) on the cardiovascular diseases. It has been established that ascorbic acid can help with arterial damage due to its antioxidant capabilities. The purpose of this study was to test the effect of ascorbic acid on the removal of calcium apatite, compound found in calcified arteries, using 60%, 50%, 40%, 30%, and 20% (w/v) concentration of ascorbic acid. 0.6 grams of chicken bones (vertebrate bones contain calcium apatite) were placed in ten 23 ml test tubes containing 20 ml of ascorbic acid for each level of concentration of ascorbic acid. The mixture in the test tubes was left undisturbed for 36 hours. The loss in bone mass and the mass of crystals was recorded for each test tube. The crystals formed during the reaction of ascorbic acid and calcium apatite were tested for an ascorbate salt. The results indicated that the 60% concentration of ascorbic acid produced the most crystals with a mean mass of 1.5 g and mean bone loss of 0.2 g. No reaction or loss in bone mass occurred for ascorbic acid concentrations of 50%, 40%, 30%, and 20%. The data supported the research hypothesis that if high concentration of vitamin C was used then it can remove calcium apatite. Based on the values of bone loss and mass of the crystals, it appears that there is a relationship between higher concentration of ascorbic acid and the removal of calcium apatite. Before a clear trend can be established further experimentation with ascorbic acid concentration higher than 60% should be performed. For real world application, double-blind trials need to be conducted to test the effectiveness of ascorbic acid in removing arterial calcium in humans.

The Effect of Sports Performance Drinks on the Teeth of an Athlete during a Simulated Baseball Season

Robert Beran, George H. Moody Middle School

Athletes are bombarded with ways to boost performance. What marketers do not explain is that their product may cause irreversible teeth damage. The human tooth is comprised of enamel-covered crown, cementum covered root, and a neck. Tooth enamel can be eroded by plaque, and sugars and fermentable carbohydrates are acidogenic in dental plaque. Accordingly, it was desired to determine what, if any, impact is there on an athlete's tooth after consuming sports performance drinks in a simulated baseball season. In the experiment, teeth substitutes were exposed to water (control) and Gatorade, G2, PowerAde and PowerAde Zero (independent variables) for the approximate amount of time during a middle school baseball game or practice that teeth are exposed to liquid. The teeth substitutes were not rinsed until the approximate amount of time lapsing between exposure and teeth brushing during evening bedtime ritual. This process was repeated for 28 days. Tooth substitutes contained more mean discoloration (98%, 89%, 98%, 88%) than the control group (0%). Those exposed to sugar enriched varieties contained more mean discoloration (98%, 98%) than low sugar variables (89%, 88%). The data supported the research hypothesis that if a tooth of an athlete is exposed to sugar enriched performance drinks, then it will have the most decay during a simulated baseball season as

visually evident by discoloration. Before a precise correlation may be determined, one would need to be able to measure the amount of tooth decay independent of stain by dyes and pigments.

Are You Defined by your BMI?

Jacob Cirrincione, Gildersleeve Middle School

Obesity has become a growing concern in the United States and especially among the pediatric population. The purpose of the experiment was to determine if BMI is an adequate measure of obesity in children aged 8-14 years old, and to determine if there is a relationship between percent body fat and body mass index (BMI). Materials were gathered. Height in inches and weight in pounds were measured using the scales. BMI was calculated from the formula. Skin fold measurements were obtained using folds in the right abdomen, right tricep, and left subscapular area using Lange calipers. Percent body fat was calculated using a standard formula. A regression analysis and analysis of variance (ANOVA) were performed on the data using a computer program. The R^2 (or line of best fit) for all data was 0.3496. The Pearson R (correlation coefficient) was 0.5, suggesting a moderate correlation. The ANOVA analysis demonstrated significance for percent body fat relative to all independent variables (age, gender, disease) and interactions of the variables. BMI only showed significance relative to disease. Percent BMI and percent body fat were determined to be indirectly proportional and not correlated. The percent BMI measure is completely independent of the percent body fat measure. Lastly, percent body fat is a more reliable and a better measure of obesity risk than percent BMI. At each variable and interaction among the variables, the relationship between them and percent body fat is significant and not occurring by chance alone.

The Effect of Water Temperature on Goldfish Breathing Rates

Hannah Collier, George H. Moody Middle School

Oxygen dissolves in water because of the atmosphere and the plants in the water. The colder the water is, the higher the dissolved oxygen level is. That doesn't always mean it is better for the fish. Goldfish tend to live in fresh water that is 20-23.9 degrees Celsius. They breathe using their gills to pull out oxygen from the water. The purpose of this experiment was to determine the effects of water temperature on goldfish breathing rates. Thirty goldfish were bought and placed into three different tanks. One tank had colder water (17.5 degrees Celsius). The second tank had room temperature water (21 degrees Celsius). The third tank had the warmest water of all (23.6 degrees Celsius). Once all the fish were in the appropriate water temperature, their breathing rates were calculated. The results supported the hypothesis that if the temperature of the water were to be changed, then the goldfish receiving the warm water would have higher breathing rates than the goldfish receiving the room temperature and cold water. The results agreed with the hypothesis that if you place fish in three different temperatures of water, then the fish in the warmest water will have the highest breathing rates. The experiment could have been more accurate if there was an easier way to keep track of each individual fish and if achieving and maintaining the desired temperature was easier.

The Effect of Starting Distance on Jump Length

Greta Engel, Thomas Jefferson Middle School

The purpose of this experiment was to study the effects of starting distance on jump length. The hypothesis was that the farther the starting distance, the longer the jump. The first step in this experiment was to gather all needed materials (a long jump pit, rake, 5 test subjects, a measuring tape, and something to mark each starting distance). Next, mark starting distances (7, 10, 13, and 16 running strides) away from the board. After that, stand on the runway, and then sprint down the runway. When you reach the board, jump over the pit. Next, measure the jump using the measuring tape. Finally, repeat steps 3-7 for each trial, taking 5 minute breaks between each trial. From the data gathered, although the difference was insignificant, 16 steps had the longest jump. Because of the results, it is now thought that the best starting distance depends on the person jumping. 16 steps away from the board averaged to 11 ft 2.6 in, 13 steps away averaged to 10 ft 6.9in, 10 steps away averaged to 11 ft 1.5 in, and 7 steps away averaged to 10 ft 4.8 in. Even though the hypothesis was correct, it shouldn't be approved or disapproved because the difference was insignificant.

The Effect of Light Intensity on Fish Activity

Casey Fenster, Tuckahoe Middle School

The fishing industry is rapidly changing due to overfishing and other environmental issues such as urbanization. Urbanization can reduce the quality of stream habitat. For example, previous research has suggested that changes in light intensity can affect fish spawning and fry hatching. All of these factors could influence the sport fishing industry. This experiment was conducted to determine how varying light intensities influence fish movement patterns and therefore, play a role in saving the declining fishing industry and affect the sport in a positive way. This experiment allowed individual *Notemigonus crysoleucas* (Golden Shiner) minnows to choose light or dark conditions in an experimental aquarium to determine the fish's preference. A variety of pre-trial experiments was used to determine the most effective equipment setup. The results from a one sample t-test at the 95% confidence level showed that the minnows preferred the dark side over the light side.

The Effect of Different Game Difficulties on Mood

Andrew Frank, Tuckahoe Middle School

Playing video games can cause all different types of reactions, like causing a person to become mad, angry, or even happy. Video games were chosen to see if higher difficulty levels have a greater effect on mood. It was hypothesized that if different difficulty levels were tested, then the highest difficulty level (all-madden) would cause the angriest mood. The testing was done with Madden 25 since it is a common game and it had the amount of difficulty levels needed. The experiment had one trial with two repeated trials. There were eight test groups and one person in each test group. The experiment took two days and was done in a residence. The data was quantitative and qualitative. The data was recorded using a mood log that recorded their mood and the result of the game. The hypothesis was supported, because it was discovered that the highest difficulty level caused the angriest reaction. Based on the findings, consumers should play lower difficulty levels when looking for a fun and easy game that will cause a happier reaction than a high difficulty level.

Comparing the Efficiency of Learning between Cats and Dogs

Anna Homer, Sabot at Stony Point

The purpose of this study was to find the more efficient learner: *Felis catus* or *Canis lupus familiaris*. The more efficient learner could be more easily trained as certain types of service animals. The hypothesis was that *F. catus* would be the more efficient learners, based on their cerebral cortex having much higher neuron counts as compared to that of *C. lupus familiaris*. The testing procedure was based on Ivan Pavlov's classical conditioning findings. The results disproved the hypothesis, when five out of five *C. lupus familiaris* made an association and only one out of five *F. catus* did so. The conclusion, that *C. lupus familiaris* are the more efficient learners, especially around humans, confirms that *C. lupus familiaris* are better candidates for most types of service animals than *F. catus*. The limitations built into the design of this experiment probably led to its conclusion. As the field of animals acting as service and companion animals expands to include not only *F. catus* but also birds, monkeys and others, scientists need to find more effective experimental designs to measure and tap the intelligence and potential for service of domesticated animals less reliant on sociality than *C. lupus familiaris*.

The Effect of Acid on Bone Density

Camden Hunt, Gildersleeve Middle School

In this experiment, the experimenter soaked chicken bones in vinegar to show how much harm acid can cause. To start, the experimenter gathered 25 chicken bones, 25 mason jars, a triple-beam-balance, a beaker, 3 graduated cylinders, 3750 ml of vinegar, and 3750 ml of water. The experimenter then filled the first 5 mason jars with 300 ml of vinegar, the next 5 with 300 ml of water, the next with 150 ml of water and 150 ml of vinegar, the next with 75 ml of water and 225 ml of vinegar and the last with 225 ml of water and 75 ml of vinegar. After 1 day, the experimenter measured the density of each of the bones. The same way done after the second and third days, then recorded. After 3 days, the trials of 300 ml of vinegar went down in density by about 0.3 g/ml, going from a density of 1.1 to about 0.8, while water

stayed at 1.1 g/ml. These results show that vinegar lowers bone density. In conclusion, too much acid is bad for our bodies.

The Effect of Gender on Size of Home Ranges in Harbor Porpoises

Io Kovach, Thomas Jefferson Middle School

The movements of harbor porpoises (*Phocoenaphocoena*) in the Bay of Fundy and near Cape Cod were tracked using satellite telemetry. Archived satellite data from a database was used. Tracking periods ranged from 22 to 30 days. Female porpoises traveled further than males because females are larger than males and they travel further. This supports the ecological theory that home range size is correlated with body size.

The Effect of Different Types of Antacids on Solubility of Proteins in the Stomach

Corina Kowalski, George H. Moody Middle School

Gastric juice is an acidic digestive fluid secreted by glands in the stomach lining, and is crucial to breaking down food. At the entrance to the stomach, there is a small valve called the lower esophageal sphincter (LES) which only opens to allow food to pass through and closes immediately after. However, if the valve stays open too long or does not close completely, stomach acids will leak into the esophagus and cause heartburn. This is a disease known as Gastroesophageal Reflux Disease (GERD), or more commonly as acid reflux disease. Antacid pills are basic over-the-counter drugs that can be taken to neutralize the pH of gastric juice, and thereby relieve the symptoms. Based on research, the hypothesis stated that the stomach acid itself (control) would break down chicken the most due to its low pH. The purpose of this experiment was to determine the effect of different antacid types on solubility of proteins in the stomach. One half liter of simulated stomach acid was created (1 half liter water, 2.80 grams hydrochloric acid, and 2.50 grams table salt) and divided into five of the same containers, each containing 100 ml. Different types of antacids were collected: aluminum compound, calcium carbonate, magnesium compound, and sodium bicarbonate. Chicken pieces were measured (20 grams in each container, cut into 2 grams pieces) and added into each of the five containers. Antacids were added to four of the containers and left to sit at a constant temperature for six hours. Chicken pieces were extracted, air-dried for eight hours, and weighed in grams. Data was collected. The chicken soaked in the control group (simulated stomach acid) gained 8 grams on average, totaling 28 grams. The chicken soaked in sodium bicarbonate (Alka-Seltzer) gained 7 grams on average, totaling 27 grams. The chicken soaked in calcium carbonate (Tums) gained 2 grams on average, totaling 22 grams. The chicken soaked in aluminum compound (Rolaids), gained 7 grams on average, totaling 27 grams. The magnesium compound (Maalox) decreased by 2 grams on average, totaling 18 grams. The hypothesis was proven wrong and the opposite had taken place; the control had gained the most mass. In conclusion, this experiment determined that while stomach acid by itself softened the proteins and allowed more acid to enter and begin to break them down (increasing the mass), both the magnesium compound and calcium carbonate toughened the proteins and made it harder for acids to enter and begin the process of breaking them down.

The Effect of Dominance on Hands to Cold Temperatures

Alan Lai, Tuckahoe Middle School

There are many times when people's hands are freezing, hot, or in pain. The sensitivity of people's hands determines these feelings. The experimenter wanted to know whether or not sensitivity is greater on the dominant hand or not. The real world value of this experiment is so that if someone is doing hard work with their hands, this would tell them which hand they should use. This feeling or sensation was tested by putting people's hands into a bowl filled with 1000 ml of 12 degree Celsius water, and seeing which hand would pull out first, the non-dominant or the dominant. The independent variable in this experiment was hand dominance and the dependent variable was which hand pulled out first. It was hypothesized that if the dominant and non-dominant hands are immersed into a bowl of cold water, then the dominant hand will pull out first. The experiment was conducted with 3 trials with 2 test groups: a group with 5 left handed people and a group with 10 right handed people, meaning that there were a total of 15 people tested. The bowl containing the water was set onto a flat marble table, where the subject would place their hands into

the water for 10 seconds before pulling out the hand that felt colder. The experimenter recorded which hand pulled out first on a data log which was on the computer. The hypothesis for this experiment was supported, the results of the experiment show that the dominant hand was pulled out the most in all 3 trials, whereas the non-dominant was barely pulled out in those 3 trials. It shows that the dominant hand is more sensitive than the non-dominant hand.

The Effect of Caffeine on Heart Rate

Caroline Lash, Gildersleeve Middle School

The purpose of this experiment was to find out the effect of caffeine on heart rate. The procedures used were checking the subject's resting heart rate, and then, having the subject's consume the caffeine. Next, wait fifteen minutes and check heart rate again, and lastly, record the data. Some of the major results that were found are that the soda with the most caffeine did not make the heart rate raise more than a soda with less caffeine. Also, when drinking water the heart rate did not rise, it actually dropped by 0.25 beats per minute (BPM). Lastly, the lowest heart rate average after drinking the drinks was 62.5 (water), and the highest was 79.75 (root beer) In conclusion, the soda with the most caffeine did not raise heart rate the most. The soda with less caffeine raised heart rate the most. Water made the heart rate slightly drop.

Animal and Human Sciences B

First Place

The Effect of Different Tea Extracts on Growth of Glioma Cells

Farheen Zaman, George H. Moody Middle School

Malignant Glioma is a brain tumor, which has a lot of resistance against traditional treatments, such as chemotherapies. Currently surgery, radiation, and chemotherapy with temozolomide are the standards of care, although there are limitations. Tea, both green and black, has many polyphenols and flavonoids. Studies have shown an inverse relationship between consumption of tea and development of cancers. The purpose of this experiment was to compare the effect of green tea extract to black tea extract on growth of glioma cells, as well as the amount of tea extract on growth. Based on research, the hypothesis was if 320 µg/ml of the green tea extract is added to the cells, the growth of the cells would dramatically decrease. Seven groups of cells were grown in media, and then after 24 hours were given different types and different concentrations of tea extract. The cells were then put into an incubator for 72 hours. Cell viability was measured after 72 hours incubation with a cellometer after staining with Trypan blue dye. The results indicated that at the lower concentrations of 80 µg/ml and 160 µg/ml, green tea was more effective (at 80 µg/ml, green tea had a mean 57.8% viability, and black tea had a 82.7% viability); however, black tea was more effective at concentrations of 320 µg/ml (green tea had a viability of 19.4%; black tea had a viability of 9.5%). The data suggested that both the tea extracts had some harmful effects on glioma cells' growth.

Second Place

The Effect of an Added Dog Dental Hygiene Bone on Bacteria Growth in a Dog's Mouth

Lauren Murtha, George H. Moody Middle School

Dental hygiene is extremely important for a dog's overall health. Bad dental hygiene can lead to periodontal disease which can lead to serious illness or even death if not treated properly. Periodontal disease is caused by an excess of plaque on the teeth and gums. Plaque is made when saliva mixes with bacteria and the mixture hardens on the tooth. This led to an experiment designed to see if adding a dental hygiene bone for dogs has any effect on the bacteria growth. The hypothesis in the experiment was: If a dental hygiene bone is added to regular teeth brushing, then the bacteria growth will decrease more than brushing alone. The study was done by collecting three samples from a dog's mouth. One was taken before any method of cleaning was used on the teeth; one was taken after the dog's teeth were brushed, and one was taken after the dog was given a bone. Once all samples were taken, they were streaked onto three separate agar plates and the lids were taped shut. The agar plates were then placed in the homemade incubator and left for two days. The results showed that the bone created the highest decrease in bacteria, except for in the third trial where the bacteria significantly increased after the dog was given the bone. The bone also had the lowest mean number of colonies which was 979. The culture that was taken before the dog had any method of teeth cleaning done had the highest mean at 1,235. It was then concluded that the bone had a positive effect on the bacteria growth, even with the increase in the third trial.

Third Place

The Effect of Dosage and Exposure Time of Palmitic Acid on Prostate Cancer Cells

Shaandro Sarkar, George H. Moody Middle School

Prostate cancer, the most commonly diagnosed form of cancer in the United States in men, is a cancer that develops in the prostate and spreads to other parts of the body. A high-fat diet can increase the risk

of prostate cancer. A major component of a high-fat diet is palmitic acid, a saturated fatty-acid. The purpose of the experiment was to determine the effect of dosage and exposure time of palmitic acid on prostate cancer cells. To perform the experiment, prostate cancer cells were added to 60 wells in a 96-well plate. Cells were either left untreated, tested with methanol, or treated with 10 μM , 25 μM , 50 μM , or 100 μM of palmitic acid. A plate with this setup was used for four different periods of time: one day, two days, four days, and six days. An MTT assay was performed to determine the absorbance level of each well under a multiplate reader, which allowed for determination of percentages of cells living. Results indicated that both methanol and palmitic acid killed the cells dramatically. This did not support the hypothesis, as palmitic acid did not increase the proliferation of cells. Thus, there seems to be a correlation in which palmitic acid kills prostate cancer cells at high dosages. To verify this, further studies must be made with lower amounts of methanol to account for its effect on the experiment. Also, concentrations of palmitic acid should be changed to reflect human intake to determine the true effect of palmitic acid on prostate cancer cells.

Honorable Mention

The Effect of Sugar, High Fructose Corn Syrup, Acetic Acid and Water on Teeth

Sarah Purrington, Sabot at Stony Point

Tooth decay is a problem in third world countries for people without money to buy treatment for their teeth and who are choosing to drink soda instead of water. The two components that make tooth decay happen are bacteria and food. In this experiment, human saliva and different drink ingredients were used to trigger decay to test which ingredient would cause the most change in the teeth and which ingredient would cause the greatest decrease of enamel and Dentine measured by mass. The drinks used were Sprite (containing high fructose corn syrup), Spanish 7-UP (containing sugar), lemon juice (containing acetic acid) and water. The experiment lasted five weeks and there were 12 teeth (three for each ingredient) which were tested six times each (including a test before the experiment). The hypothesis was that the high fructose corn syrup in Sprite would create the most decay. The data showed that the acetic acid, in lemon juice, caused the most decay on the teeth. Along with causing the most decay, the acetic acid also caused the teeth's mass to decrease with an average of 0.5 g and the teeth in the water increased in mass with an average of 0.33 g. Research suggests that since the bacteria in the saliva fed off of the acetic acid, the bacteria (from the saliva) fed off of the tooth causing the teeth in the acetic acid to dissolve over time. Therefore, based on experimentation, drinking a substance containing acetic acid on a regular basis, without proper treatment, causes human teeth to brown, to dissolve and can cause a white substance to form.

Honorable Mention

The Effect of Face Type on Dog's Sense of Smell

Leila Shepard, Tuckahoe Middle School

Canis familiaris, domestic dogs, are very interesting animals, and scientists are finding out more about them and their amazing noses every day. Research proves that dogs actually have more human-like qualities than a person may think. However, their sense of smell is beyond what a human could ever do without the help of high-tech machinery. The experimenter wanted to find out if the length of a dog's nose affects sense of smell. The experimenter tested six dogs, three of each face type. Three cups were placed in front of the dog, one cup with a treat under it. The dog did not know which cup contained the treat. A timer was set and stopped when the dog found the treat. This was repeated two more times with each dog to have more accurate results. Many programs involving the usage of dogs use mesocephalic dogs because it is believed that they have the better sense of smell. What if they don't? What if brachycephalic dogs really have the better sense of smell? The experimenter hypothesized that the mesocephalic dogs would have the better sense of smell. The test results concluded that mesocephalic, or long snouted dogs, had the better sense of smell than brachycephalic, or short-nosed dogs. My hypothesis was fully supported by my results.

The Effect of Living Space on the Weight of Fish

Aidan Lowe, Gunston Middle School

Did you know that comet goldfish or scientifically, *Carassius auratus* can grow up to 60 centimeters and weigh up to 3 kilograms? Well the four *Carassius auratus* in this project didn't get to be that big, but they were fat. The project was conducted to find out if *Carassius auratus* or comet goldfish would grow in a big container or grow big in a smaller container. The comet goldfish were fed small goldfish pellets and some flakes. They were all given the same amount of food to eat at all the same time. The results were that the fish in the bigger container grew the best because it had more space to grow. But the fish in the smallest container also thrived. The hypothesis was supported; goldfish grow best in big containers if the fish can find the food. This project was interesting because it involved observing the growth of the goldfish in different conditions. The time spent observing and caring for the *Carassius auratus* was well spent. The scientist that conducted this experiment learned how to take care of a pet and it was very fun to complete.

The Effect of Different Types of Moisturizers on Dryness of Skin

Juliana McKean, George H. Moody Middle School

Moisturizers, when used on skin, are meant to strengthen skin barrier function, and lower transepidermal water loss. In other words, they are meant to strengthen the skin's permeability and help it contain water. 20 milliliters of moisturizer with glycerin, 100% petroleum jelly moisturizer, moisturizer containing mineral oil, and water (control) were tested on Jell-O as a human skin equivalent. The hypothesis for the experiment was, if moisturizer with glycerin as the second ingredient after water, moisturizer with mineral oil in it, and a 100% petroleum jelly moisturizer are tested on a human skin equivalent, the moisturizer with glycerin as the second ingredient after water would leave the skin the heaviest and with the most moisture. However, the hypothesis did not compare to the results. Based on the results, 100% petroleum jelly moisturizer provided the skin with the best care. It had the lowest variance between the mean of the ten trials on the first day tested and the mean of the ten trials the last day tested compared to the other results. The purpose of the experiment was to see which moisturizer worked the best. Dry skin is a common problem that lots of people suffer from everyday around the globe. Many moisturizers make claims that they are the best, when in reality there is another moisturizer that is much better. Overall, 100% petroleum jelly is the best moisturizer based off the results of this experiment.

The Effect of Handedness on Color Perception

Emmarose Price, Kenmore Middle School

Hand dominance is the use of one particular hand during most tasks. Left-handed people's corpus callosum, the group of nerve fibers that connect the two cerebral hemispheres of the brain, is larger than that of righties. Because of this the two sides may work together better in lefties. The purpose of this experiment was to find out whether a person's hand dominance affects how the brain processes color and shares the color information across the corpus callosum. The hypothesis was that left-handed subjects would be more likely to see both colors than right-handed subjects, because the two sides of the brain may communicate better in lefties. The subject was asked what color they saw most after putting on a pair of colored swimming goggles. The goggles were colored in a way that each side of the brain perceived a different color. A greater percentage of lefties saw both colors than righties. Most people saw the color that was processed by the side of the brain that controls the subjects' dominant hand. Therefore the hypothesis that it would be more likely for left-handed subjects to see both colors was accepted.

Crickets Attraction to Genetically Modified Seeds

Seneca Randolph, Thomas Jefferson Middle School

The purpose of this experiment was to find the effect of Genetically Modified (GMO) seeds on crickets' attraction. People should care about this experiment because some farmers have trouble with pests eating or killing their crops. So this experiment tested Genetically Modified seeds to see if they attracted

more pests (or in this experiment crickets) than non-GMO seeds. If farmers use the results of this experiment they might change the type of seed they use, which will allow them to produce more food and make higher profits from their crops. In addition, the world's hungry population would have more food so the results can help improve food security for vulnerable people.

The Effect of Temperature on Cricket Growth

Phillip Reeves, Thomas Jefferson Middle School

Many different perfect temperatures had been found to grow crickets, but which was best? The purpose of this experiment was to determine the effect of heating on the rate at which crickets grow. This science fair project contributed information to the care of crickets. This, if published, would have benefited cricket keepers very much, and would have made it easier for reptile breeders to grow feeder crickets. Crickets were raised at room temperature, and in containers heated by 40, 60, and 75 watt bulbs. All cricket containers were equipped with egg cartons, food and water dishes, and an appropriate light bulb (40, 60, 75, none). The light bulbs were controlled using a light timer to switch 12 hours on and 12 hours off. The crickets were taken out of their containers and photographed each week. The pictures were then uploaded to the computer and analyzed using ImageJ. The data were recorded in spreadsheets, and box and whisker plots were then made using RStudio. Lastly, the individual cricket data in the spreadsheets were averaged for each group and plotted in RStudio to create bar charts. After three weeks, it was determined that the crickets heated with 40 and 60 watt bulbs were the largest and had grown about the same amount as each other. They grew nearly twice as much as the crickets heated by the 75 watt bulbs. The 75 watt-heated crickets grew about 1.5 times as much as the control group.

The Effect of Different Concentration of Vinegar on the Number of Melanogaster Fruit Flies Caught in Vinegar

Abigail Ringberg, George H. Moody Middle School

Vinegar is often referred to as one of the world's oldest cooking ingredients and method of preserving food, but it has many other purposes. Chemist Stahl in the first half of the eighteenth century discovered the sour principle of vinegar was acetic acid. Due to this acetic acid vinegar maintains a pungent odor. Pomace flies, on another note, also known as fruit flies or vinegar flies can be classified as a yellow, brown, or black color and have light or red eyes. The scientific name is *Drosophila melanogaster*. The purpose of this experiment was to determine the effect on the concentration of vinegar on the number of melanogaster flies attracted to the vinegar. Fruit flies were spread evenly into ten plastic bins each containing five bowls holding the different vinegar (apple cider vinegar at 5% acidity) concentrations. The first bowl held 100%, the second held 75%, the third held 50%, the fourth held 25% and the last bowl, the held, held 100% water. After two hours, the amount of melanogaster flies found trapped in each bowl was calculated. The results corresponded with the hypothesis that if vinegar occupies 100%, vinegar occupies 75%, vinegar occupies 50%, vinegar occupies 25%, and vinegar occupies none of the bowl then the bowl with 100% vinegar will attract the most flies. The bowl with 100% vinegar had a mean of 32 flies, while the bowl with all water had a mean of 10 flies. The results show that as the concentration of vinegar increased the number of flies found in the trap accumulated. Though the results could have been made more accurate if more professional techniques were used to measure and count flies, and a more sealed, test proof environment was used for the experiment.

The Effect of Emotion on Heart Rate Increase

Matthew Scherer, Tuckahoe Middle School

The importance of this experiment was to help keep patients with heart diseases in a safe environment. The hypothesis was if emotions were tested to see which would increase the heart rate most, then fear would increase it most. Doctors and scientist over the past few years have learned more and more about heart rate changes due to the amount of deaths caused by heart attacks and stroke. Common heart diseases are as follow: Angina, Congenital Heart Disease, Congestive Heart Failure, Coronary Heart Disease, Coronary Microvascular Heart Disease, Cyanotic Heart Disease, and Hypertensive Heart Disease. The results supported the hypothesis by saying that fear increased the heart rate from the average 75 bpm (beats per minute) to the result average of 102.13 bpm. Anger's result average was

84.83 bpm, while sadness had a stunning result average of 41.18 bpm. As shown in the results, fear increased the heart rate the most, but what the experimenter thought was astonishing was how much sadness decreased the heart rate. The results show high risks when people with heart diseases are in a scary or frightful situation and therefore should avoid being exposed to that emotion.

Epigenetic Effects of Herbicide Exposure and Subjection to Microgravity Environment on *Drosophila melanogaster* Fruit Fly

Marissa Sumathipala, Farmwell Station Middle School

Epigenetic changes, changes to the structure of DNA that affects gene expression, are influenced by environment and over multiple generations may be inherited. While the DNA sequences are unchanged, epigenome modifications are observed as epigenetic effects. Environmental stressors can alter not only the behavior of the exposed adult, but affect its offspring via epigenetic changes. The goal of this research was to investigate the epigenetic effects of two environmental factors, herbicide exposure and subjection to a simulated microgravity environment, as evidenced by behavioral changes and development anomalies of first generation offspring. The fruit fly *Drosophila melanogaster* was used as the model. In the first experiment, virgin flies were exposed to herbicide. In the second experiment, the virgin flies stayed in a micro gravity (rotating) environment. Both experiments contained control groups that were either not exposed to herbicide or was not subjected to rotation. Locomotor behavior of first generation offspring of the virgin flies were assessed. Locomotor behavior of the herbicide-exposed flies were different to the control with jerky, erratic, aggressive behavior. They were larger in body size than the controls. Locomotor behavior of the flies in the microgravity environment were significantly different from the control, showing instability and seizure-like behavior with violent movement and periods of stillness. From the experimentally observed results, it is concluded that the two independent variables of herbicide exposure and microgravity influenced epigenetic changes in the first generation offspring.

The Effect of Workout Intensity on Horses' Cool Down Rate

Catherine Vidunas, Tuckahoe Middle School

The experimenter enjoys working and riding *Equus ferus caballus*. She wants to give them plenty of time to cool down after they have worked so hard for her. This experiment has real world value because it can help prevent an E. f. caballus from getting sick and in severe cases dying after being ridden. The main way you can tell if an E. f. caballus is cooled down is to check their heart rate to determine how fast or slow it is beating. The purpose of this experiment was to determine how long it takes to get the E. f. caballus heart rate back to normal. Once the heart rate returns to normal, the E. f. caballus would then be cooled down. A heart rate monitor designed for E. f. caballus was placed on the E. f. caballus, and then ridden for a certain amount of time at three gaits. The results concluded that the hypothesis was supported. The hypothesis stated if the workout intensity was increased, then the cool down time would be longer. The results showed that by cooling the E. f. caballus out for about 5 min and 20 sec after the trot and 6 min and 30 sec after the canter it cooled down. By cooling down and walking for this amount of time it would decrease the risk of the E. f. caballus getting sick. It would still be possible, but it decreases the risk. In conclusion the experimenter has proved that if you cool an E. f. caballus down for the given times there is a decreases risk of sickness in the E. f. caballus.

The Effect of Video Game Difficulty on Blood Pressure

Elias Wolman, Tuckahoe Middle School

A tough game is frustrating, and losing a tough game is even more frustrating. This experiment attempted to determine if the difficulty level of a video game affects the player's blood pressure. The game used for this experiment was NCAA Football 13, and it was played on an Xbox 360. It was hypothesized that if the game was played on the highest difficulty, then the player's blood pressure would be the highest out of the four difficulties. The difficulties were Freshman, Varsity, All-American, and Heisman. The subjects played three four minute games on each difficulty and their blood pressure was taken after each game. The difficulty with the highest average blood pressure was All-American. The conclusion reached was that the subjects became more confident after winning their first two games and expected to win on the All-American difficulty because of their prior success. They were frustrated when they lost and that is why

their blood pressure went up. All but one game was won on Freshman difficulty, and 8 out of 15 games were won on Varsity. That totaled a winning percentage of 73.33%, which is almost three out of four games won. Only 33.33% of the games were won on All-American. Heisman had the second highest blood pressure.

The Canine Communication Conundrum

Anne Zetkalic, Thomas Jefferson Middle School

The purpose of this experiment was to examine how much dogs understand cues from their owners, and what the most effective type of beckoning was to help dogs understand these cues. The goal of the experiment was to find the effect of the owner's beckoning towards one treat over another on whether the dog goes to the treat the owner wanted it to. The hypothesis was that dogs would go to the treats the most when the owners pointed and kneeled. The procedure included having a dog sit, placing two treats in front of it at equal distances, having the owner either point and kneel, point and stand, stand and look at a treat, (or not be present, which was the control), and then record whether the dog went to the "owner's" treat. The results showed that dogs went to the owner's treats 3/3 times when their owners were pointing and kneeling, and $\frac{2}{3}$ times in the standing and pointing, as well as the standing and looking groups. In the control, $\frac{1}{3}$ dogs went to the owner's treat. The hypothesis, therefore, was proven correct. The results proved that dogs do understand cues sent from humans, even slight ones, yet showed that larger, more obvious gestures are more effective. This research will help dog owners understand the best way to communicate with their canine companions.

The Effect of Backpack Weight on Bone Trauma

Carolyn Zhang, Tuckahoe Middle School

Students in middle school often break bones and need help to carry their backpacks around. Students with bigger backpacks tend to be shorter and they break their bones often. These students that fracture or break parts of the body don't have to do gym class and leave class early. Those students also require help from one other student to help them carry their backpack to those classes. The objective of this experiment is to find out where and how the bones break in the spine. Another object of this experiment is to see if the backpack weight does have something to do with students or if it's genetic. Using a spine model, the backpack was placed on an iron railing attached to the wood. The angle of the wood was measured using a protractor. The woods' angles did increase but all the angles were acute. This can show people that a human's spine can take more weight without breaking the bone or muscle. The mean of the data was 23.1667 degrees. The range was 47 degrees. There was no mode. The median was 18 degrees. There was also uneven trauma as the weights increased. This shows how the spine can break in different ways.

Botany

First Place

Be Wise, Mycorrhize!

Gloria Wyszynski, Chesapeake Bay Governor's School for Marine & Environmental Science

Mycorrhizae fungus is a symbiotic fungus that is naturally found in healthy soil. It attaches itself to a plant and grows within it and it is hypothesized that the fungus helps the plant access more water, increase plant growth, and excrete substances that break down elements such as phosphorus and nitrogen, making it easier for the plant to absorb. It is also hypothesized that the fungus is capable of creating webs of hyphae which help to stabilize the soil and prevent soil and nutrient runoff. This study compared the effects of basil, string bean, and kohlrabi plants that were treated with an arbuscular mycorrhizal fungus versus basil, string bean, and kohlrabi plants that were grown without the fungus. The plants were tested for plant height, water drainage, and dried root mass to determine whether or not the mycorrhizae helped the plant grow taller and whether it stabilized the soil. What was found was that the mycorrhizae increased the basil and string bean's height significantly but not the kohlrabi's height when compared with the non-mycorrhizal plants. The fungus increased the soil's capability of draining water without any puddles or runoff in all three mycorrhizal plant tubs. As far as root mass, the fungus significantly increased the basil and kohlrabi's root mass but not the string bean's root mass.

Second Place

Effect of Alternative Forms of Agriculture on Plant Growth

John White, Southwest Virginia Governor's School

With our planet's rapidly growing population, it is becoming difficult to find enough arable land to grow the necessary amount of crops. Two possible alternatives to traditional soil farming, or geaponics, are hydroponics and aeroponics. Both of these systems are able to grow more plants, in a smaller area than geaponics, and can be put in places where you could not put soil-based growing systems. In this experiment, *Phaseolus vulgaris*, *Cucurbita pepo*, and *Zea mays* were all grown in aeroponics, hydroponics, and geaponics systems. The hypotheses were as follows: H0: If *Phaseolus vulgaris*, *Cucurbita pepo*, and *Zea mays* are grown in three different systems, then there will be no change in the length or mass of each species from system to system. HA: If *Phaseolus vulgaris*, *Cucurbita pepo*, and *Zea mays* are grown in three different systems, then there will be a significant change in the length and mass of each species from system to system. To begin, 216 seeds of each species were planted into miniature green houses to ensure that 36 would be able to be put into each system. These seeds were allowed to grow for two weeks, and during this time three versions of each system were constructed. After these two weeks, the plants were randomly assigned a system so that there were twelve of each species in each system, and transferred to their systems. Over a three week period, the plants were measured every two days, and weighed on the first and last day. When all the data were recorded, they were compared using an ANOVA test, and a follow up Tukey test if necessary. These tests showed that there was significance in all of the data except for the mean lengths for the squash ($p = 0.1368$), with one or both alternatives having significantly higher data. This rejects the null hypothesis, and accepts the alternative that there would be significance in the mass or length differences. These results show that alternative agricultural methods would be suitable ways to alleviate the need for arable farmland for a variety of crops. Further research could be conducted to see if similar results are found if this project is completed in a less controlled environment, such as a field.

Third Place

The Effect of Microwave Radiation on Seed Germination

Anna Polise, Washington-Lee High School

This experiment was designed to observe the effect of microwave radiation on seed germination. The number of seeds to germinate was measured, as well as the number of days until germination. The hypothesis stated that if seeds receive no microwave radiation, then they will germinate the fastest and more of them will germinate. The independent variable for this experiment was the time in the microwave, and the levels were 0, 15, 30, and 45 seconds. The 0 second group was the control group. The dependent variables were the number of seeds that germinated within each group, and the number of days until germination. Each group of 30 seeds was microwaved for the given amount of time, and then stored between two moist paper towels in a warm, dark cabinet where they could be observed for the duration of the experiment. All the seeds in the control group germinated, and did so in an average of 3.26 days. All of the seeds of the fifteen second group germinated, and did so in an average of 2.6 days. In the 30 seconds group, six seeds germinated in an average of 8.36 days. No seeds germinated in the 45 second group during the 10 day experiment. The results show that microwave radiation can have harmful effects on seed germination, especially in large amounts.

Honorable Mention

The Effects of Crop Pairing on Total Fruit Yield

Caroline Lancaster, Chesapeake Bay Governor's School for Marine & Environmental Science

The method of crop pairing was tested to see its effects on overall fruit yield. Ratios of different seed combinations of corn and beans were planted in a quarter of an acre growing plot in King William, Virginia. The ratios used were 100% corn, 66% corn, 33% beans, 50% corn, 50% beans, 33% corn, 66% beans and 100% beans. After planting, all crops received the same care and the fruit was picked and weighed as it matured. Only the edible fruits were considered in this experiment due to the fact that these are marketed to the public. After data were collected, it was seen that the ratio with the highest total fruit yield was the 50% corn, 50% beans with a total combined weight of approximately 16,047 grams. The pairing that had the lowest total fruit yield was the 33% corn, 66% bean ratio with a weight of approximately 6,945 grams. The ratio that had the highest total corn yield was the 100% corn ratio with a weight of approximately 13,522 grams, and the pairing with the highest total bean yield was the 66% corn, 33% beans ratio with a weight of approximately 5,868 grams. A trend was seen given that for every one percentage increase in corn there would be a 21 gram increase in weight overall. This trend also suggests that for every one percentage increase in beans there would be a 6 gram increase in overall weight. A linear regression was run and provided a p-value of 0.0012 which suggests that crop pairing does have an effect on total fruit yield. The study shows that when crop pairing is done correctly it has positive effects on total fruit yield, and in this experiment the ratio that had the highest total fruit yield was 50% corn, 50% beans.

Honorable Mention

How Close is Too Close? The Struggles of the Native Pepper: Chiltepin

Hannah Rennolds, Chesapeake Bay Governor's School for Marine & Environmental Science

Throughout the last few decades the presence of unwanted, non-indigenous plant and animal species has caused a detrimental drop in the native populations of both plants and animals. The most prevalent of such effects in the plant communities is often the theft of available nutrients. Non-indigenous plant species disrupt the growth patterns of the pre-existing plants, causing habitat destruction for other types of organisms that call them home. The comparison of two separate pepper species, the Chilean Habanero and the American Chiltepin, will hope to prove the dangerous effects that non-indigenous plants have on their surroundings. The two plants were planted both in monoculture and in juxtaposition. The interaction between them was tested by determining the effect that physical proximity has on the growth rates and available nutrients of each pepper species when grown in monocultures and when grown together. This study did not produce any significant p-values from the ANOVAs that were run determining the effect that the closeness of the Habanero had on the growth of the Chiltepin. The big

picture of how close is too close was affected by such natural, environmental factors as the interspecific competition between the two as well as potential allelopathy can add to the adverse effects that non-native species can have on the environment.

The Effect of Different Environments on the Growth of Mold in Bottled Water

Nomin Baatarkhuu, Washington-Lee High School

The purpose of this experiment was to test the effect of different conditions on the rate of the growth of mold in bottled water. The different independent variables that were tested were water bottles placed in room temperature capped (control) and uncapped, in the refrigerator capped and uncapped, and in direct sunlight capped and uncapped. The original hypothesis was if the water bottle was placed in direct sunlight uncapped, then it would grow mold the fastest. This experiment was done by placing 200 ml Deer Park water bottles in each independent variable. Every day the bottles were checked, and were analyzed for any signs of mold. As soon as there was mold in the water, the number of days that it took for the mold to grow was recorded. This experiment was tested to see if bottled water actually went bad. The different conditions were used to decide what the prime environment for water should be. The results matched the hypothesis in the end. Direct sunlight while the bottle is uncapped caused the rate of mold to accelerate. The control did not grow mold at all. These results show that if bottled water is left in room temperature conditions capped, then it will go bad more slowly. Overall, this project is a sample of what a person can do with water and the length of time that it takes for it to grow mold.

The Effect of Different Types of Radiation on Germinating Seeds

Shreoshee Barua, Washington-Lee High School

Any type of radiation can cause serious damage to the human body, and usually the first signs of radiation passing through a human are not noticed, only in extreme cases like cancer. Even for solar radiation, such as skin cancer for example. The purpose of this experiment was to determine whether or not cell phone radiation really does have any negative impact on germinating lima beans. Since it is not proven but in rare cases have shown quite a handful amount of people are being diagnosed with brain cancer, particularly the ones who are on their phones constantly, it made the experimenter curious to approach an experiment to find answer to this logic. Even if the phone isn't active and is left by the head of the person while they are sleeping, it's been known to cause headache or nausea symptoms for that same exact person the next morning. Speaking from the experimenter's past experiences. The information throughout the research is enough to support the research that cell phone radiation would cause the lima beans to die as oppose to the other types of radiation. Other types of radiation which involve physical contact with the plants can cause just as much damage as well. It was hypothesized that if a group of lima bean plants receive the iPhone 5C's radiation, then it will eradicate or stop the plant growth faster than the other groups (H.P. laptop radiation, LED light bulb radiation, control group - the sun) being applied to the plants. For two weeks all the types of radiation were given to each of the groups in separated isolated rooms accompanied with solar radiation. Consistency of the independent variable remained intact throughout the treatment for each corresponding group. Observations on how many plants survived and the weight of each plant was also recorded. Indeed cell phone radiation turned out to be the most harmful out of all. But HP laptop and iPhone 5C were very close to eradicating the plants than the LED light bulb and solar radiation.

The Effect of Microradiation on Different Levels of Maturity on Plant Growth

Samantha Morley, Washington-Lee High School

With a more common use of radiation in modern life, it is important to have an idea how radiation can affect the growth of living things. This project was done to study whether microwaves could improve or impede the growth of *Raphanus sativus*, more commonly known as Cherry Belle Radishes, which naturally grow very quickly in comparison to most plants. The hypothesis made before executing the

experiment was if a *Raphanus sativus* sprout was exposed to microwave radiation, then it would grow taller. This was tested through having three groups of plants. Group A was the control group, so those plants did not receive any radiation. Group B was made up of the plants that were not radiated until after germination when they were sprouts. Finally, Group C was the group of plants that was radiated in seed form (before germination). This hypothesis was not supported, because the group of plants that was radiated in sprout form had the lowest height average, and was shown to be significantly affected negatively from the radiation, through statistical analysis. While the group of plants that was radiated as seeds had a slightly lower average height than the control, that data was statistically insignificant as there was too much data overlap between those two groups. Hence, while there was not a statistically significant difference between plants radiated as seeds and the control group, there was statistical significance between plants radiated after germination and plants not radiated.

Effects of Gamma Rays on the Germination and Growth of Radishes (*Raphanus sativus*)

Pooja Patel, Shenandoah Valley Governor's School

The purpose of this project was to determine the effect of gamma rays on the growth and germination of plants. In this experiment, four groups of seeds that had been exposed to different levels of gamma radiation (50,000, 150,000, 500,000, 4,000,000) and a control group that had not been irradiated were tested. The hypothesis was the control seeds would have the longest stem and root length as well as the most germinated seeds, because it had not been affected by the radiation. Fifty seeds from each group were planted in 1 cm deep in wells that were 3 cm apart and were filled with Miracle-Gro Seed Starter® soil. Seeds germinated and plants were grown for three weeks. Stem length and the root length were measured after the first week and the last week. The stem lengths of the plants had similar means. The longest average stem length was the control plants ($M = 7.49$, $S.D. = 2.07$), while the second longest was the 50,000-rad plants ($M = 6.31$, $S.D. = 1.53$). The third longest average stem length was the 150,000-rad plants ($M = 5.26$, $S.D. = 1.91$) and the shortest average stem length was the 500,000-rad plants ($M = 2.09$, $S.D. = 0.90$). A single factor ANOVA and a post hoc analysis was done to compare the means of the groups. In the analysis the results were $F(3,149) = 82.27$, $p = 1.9 \times 10^{-31}$. My post hoc analysis showed there was a significant difference among the means of all the groups.

The Effect of Electrical Stimulation on *Raphanus sativus*

Anirudh Sreekumar, Washington-Lee High School

Electroculture is a practice that is used in agriculture, and it is defined as the practice of applying electric fields or other sources of small air ions to growing plants. The purpose of this practice is to increase the speed or production of crops. The purpose of this experiment was to determine the effect of electrical stimulation via a battery on the growth of radish plants (*Raphanus sativus*). It was hypothesized that the treatment group that was given the greatest amount of electrical stimulation would grow the tallest and be the healthiest. Thirty-two radish plants were grown and treatment groups included a control with no electricity, 6 volts, 9 volts, and 12 volts. Eight plants were assigned to each treatment group. All the plants were placed next to each other and were given the same amount of water each day. For 5 minutes each day, the plants that needed electricity were given it using a battery and crocodile clips. The measurement of each plant's height was taken each day. At the end of the experiment, each plant was given a qualitative health rating on a scale of 1 to 5. The hypothesis was not supported, as the 12-volt treatment group was actually the worst performing group. The best performing groups in terms of height are listed in order as follows: 6 volt, 9 volt, control, and 12 volt. Although the hypothesis was not supported, the experiment still suggests that electrical stimulation is beneficial for plant growth to an extent. An ANOVA test showed that the data was statistically significant. Further testing ideas could be using a different source of electricity, or changing the amount of time the plants were exposed to the electricity.

The Effect of Electricity on Plant Growth

Gabriella Velazquez, Mathematics & Science High School at Clover Hill

The experiment, "The Effect of Electricity on Plant Growth", tested four levels of electricity and determined the effect of electricity on plant growth. The independent variable (IV) was the electricity, and the levels of IV were the following: No Electricity, 1.5 volts, 6 volts, and 9 volts. The experimental hypothesis for the

experiment was that the electricity would result in increased plant growth, as there is growing evidence towards the field of electroculture. The purpose of the experiment was to determine the effect of electricity on plant growth, and at which level of electricity plant growth is optimum. This project would be beneficial in agriculture, as it may lead to a revolution in the way plants are cultivated and grown. To conduct the experiment, six radish seeds were placed in each of twelve pots. Each level of IV had three pots and, accordingly, eighteen trials. Electricity was applied five minutes to the plants daily for a week, the voltage of electricity applied being based on the level of IV. Every other day, observations were made, including plant height measurements in millimeters, and photographs. The dependent variable (DV), the plant growth, was determined by plant height and measured in millimeters. The experiment revealed that electricity does increase plant growth; the 6 volts level was most effective in optimizing plant growth, while the No Electricity was least effective. This may have been the result of a current of electrons triggering some chemical or biological reactions in the plant that cause rapid growth.

The Effect of Lithium Chloride on Mung Bean Plant Growth

Priya Verma, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine if lithium chloride has an effect on the growth of Mung bean plants. Recently, water contaminated with lithium chloride was absorbed by maize plants, resulting in stunted growth, and lithium chloride may have similar effects on Mung bean plants. Two lithium chloride solutions were made: one with 10 mg/L, and another with 25 mg/L. Seventy-five Mung bean seeds were planted with 25 seeds watered with the 10 mg/L solution, another 25 watered with the 25 mg/L solution, and the remaining 25 watered with tap water. The plants were grown for 15 days, and their heights were measured three times throughout this time period. The control that was used in the experiment was distilled water. It was hypothesized that a 25 mg/L solution of Lithium chloride would result in smaller and shorter Mung bean plants. The results revealed that plants grown in distilled water grew 0.3 cm shorter than the plants grown in the lithium chloride solutions. A t-test was done on the data and it revealed that the data was not significant. The results did not support the research hypothesis. It is believed that the results are due to the fact that plants exposed to lithium concentrations of 20 mg/L or lower are known to thrive. This research could lead to further studies that investigate the effects of different amounts of lithium chloride on the growth rates of different species of plants.

Chemistry A

First Place

An Alternative Method for the Measurement of Capillarity and Potential Magnitude of Capillary Forces

Christopher Bolton, Atlee High School

The following experiment was conducted in order to develop an alternative method for the measurement of capillary forces in terms of the maximum electrostatic force that can be achieved between the particles in a single medium, as well as the particles of a different medium. These forces, collectively known as capillary forces, or adhesion and cohesion, give rise to fluids in thin cylindrical tubes, and were measured by the following proposed method and equation. By increasing the concentration of salt molecules to water molecules in a solution with increment molarity from 0.0 M to 0.6 M, it was established that water would dissociate salt (NaCl) into its component ions and surround these in hydration shells. This process, known as solvation, prevented the further binding of water molecules to other H₂O in the form of Hydrogen bonds, and to the glass (SiO₂) molecules. The increased salt concentrations resulted in a statistically significant difference between mean heights, which decreased linearly. The mean heights recorded progressed negatively from 17.8 mm to 9.25 mm for 0.0 M and 0.6 M, respectively. In addition to the mean height of the meniscus in a capillary tube, the theoretical values for bulk intermolecular forces were calculated using the procedure outlined in Methods and Materials, which was verified by several trial runs. The movement of electrons in the orbitals of glass molecules and water molecules was highly random, but for at an instantaneously small unit of time, the electrons of a molecule were concentrated on one side of a molecules, creating a momentary dipole attraction, especially that between water and silicon dioxide molecules. This interaction, in this experiment, was theoretically magnified to show a direct correlation between the addition of salt molecules and the weakening of intermolecular capillary forces, and thusly supported the proposed method for the measurement of the sum of these forces. This experiment provides background research and yielded significant results with analysis to support the method.

Second Place

The Effect of Different Concentration Levels of Perborate Mixture on the Luminol Mixture

Emnet Atlabachew, Washington-Lee High School

An experiment was conducted to see the effect of different concentrations of perborate mixture on the chemical luminol. The experiment was conducted for further research on its forensic background. Luminol, a chemical, is used to detect blood that isn't visible to the naked eye. This project obtained the information that the higher concentration level of the perborate mixture (or whichever oxidizer is being used) the longer the glow of the luminol mixture would last (also brighter), thus letting the investigators easily see the blood, and for a longer period of time. In this experiment the independent variable is the different levels of concentration of the perborate mixture. The dependent variable is the duration of the glow. The hypothesis that was obtained was that if the concentration of the perborate mixture was increased then the luminol mixture would glow longer. For the experiment 5 cups were used for each trial. Each cup had a different concentration level of the perborate mixture. A total of 5 trials were conducted. After the experiment was conducted it was evident that the higher concentration level of the perborate mixture the longer the luminol mixture glowed. In this experiment the highest concentration level was 0.014 g/ml, which were 5 scoops of the perborate mixture. This project supported the hypothesis and supported that the increase in the oxidizer (the perborate mixture) increased the rate of reaction thus making it last longer.

Third Place

A Study of the Sensitivity of the ALCO-SCREEN™ Alcohol Test Strips

Caitlin Cain, Gloucester High School

The United States has experienced decreased worker productivity due to alcohol misuse. Thus, the federal government has enacted laws permitting the use of zero tolerance policies in the workplace and the use of alcohol testing on employees. An inexpensive, quick way of testing employees for alcohol consumption as compared to the traditional Breathalyzer test or blood test is to use ALCO-SCREEN™ test strips. These tests detect flavoenzymes, specifically, alcohol oxidase, and give a relative blood alcohol concentration in an employee's saliva. The purpose of this study was to determine the sensitivity of these saliva dipsticks to ethanol and to determine how long a false positive result will be attained after using an alcohol containing mouthwash. The hypothesis was if a person swishes with a mouthwash containing alcohol, then they will register a false positive for fifteen minutes. This time was selected because the directions for the test strips state that one should wait fifteen minutes after placing a substance in the mouth before testing. A dilution of ethanol was performed and it was determined that the test strips were highly sensitive to ethanol as it took a $1.5259 \times 10^{-4}\%$ solution to no longer register positive. Additionally, human participants were asked to swish with an alcohol containing mouthwash and were subsequently tested every three minutes to determine the length of time a positive alcohol test would be obtained. All fourteen human trials with the mouthwash registered a positive reading at fifteen minutes and stopped registering positive after an average thirty minutes. Therefore, the results of this study does not uphold the hypothesis due to the ALCO-SCREEN™ saliva test strips being highly sensitive to the presence of ethanol even after a fifteen minute waiting period.

Honorable Mention

The Effect of Different Concentrations of Cadmium Chloride and Sodium Tellurite on the Quality of Quantum Dots Produced in *Lumbricus rubellus*

Amirah Anderson, Mills E. Godwin Specialty Center for Science, Math & Technology

Quantum dots are nanoparticles often used to detect anomalies and disease in human tissue. While quantum dots are most often produced synthetically, this method is very expensive. *Lumbricus rubellus* (earthworms) are also capable of producing quantum dots in their bodies when they ingest certain chemicals. The purpose of this experiment was to determine the effect on quality of quantum dots produced when worms are exposed to varying concentrations of potassium tellurite and cadmium chloride. Eighty *Lumbricus rubellus* were exposed to different concentrations of cadmium chloride and potassium tellurite for eleven days in a normal environment at room temperature. Tissue from their digestive tracts showed that samples where worms ingested higher levels of chemical concentration indeed gave off more light suggesting high quality quantum dots. Four of the six comparative t-tests proved to be statistically significant indicating that the null hypothesis can be rejected and outcomes are most likely due to the independent variable (chemical concentration level). This data supports the alternative hypothesis that cadmium chloride and potassium tellurite have an effect on visible quality of quantum dots and that various concentrations have significantly different effects.

Honorable Mention

Pop or Poison: The Effect of Different Sweeteners in Colas on their Mercury Levels

Cassia Block, Washington-Lee High School

The purpose of this experiment was to try to see if high fructose corn syrup has higher mercury content in it than was legal. The hypothesis was that if different varieties of colas were tested for mercury, then the original Coke with high fructose corn syrup would have the highest concentration of mercury. The hypothesis was tested by testing the mercury levels of four different liquids; original Coca-Cola, Diet Coke, Mexican Coke (which has sugar, not high fructose corn syrup), and filtered water as a control. These levels were tested with mercury test strips that were color coded by an app. The results showed that the Coke that had high fructose corn syrup had more mercury than legal, and that the other drinks had little to no mercury. The liquids that did not have high fructose corn syrup had less than the maximum mercury requirement, while the Coke with high fructose corn syrup in it had mercury levels that were at maximum, and sometime even over it. It was concluded that drinking Diet Coke and Coke made with sugar was healthier than drinking original Coke due to the fact that it will be less likely to take in mercury. This may be due to a process used in most high fructose corn syrup factories. While making high fructose corn syrup, in which Chloralkali is often used, which has mercury in it. Therefore the research hypothesis was accepted.

Honorable Mention

How Ingredients Affect the Amount of Electrolytes in a Drink

Matthew Dabu, Washington-Lee High School

The purpose of this experiment was to find out what type of beverage would replenish the highest number of a user's electrolytes when consumed as electrolytes are needed after physical exertion. In order to test how many electrolytes were present, a multimeter was used to test the milliamps in distilled and filtered water, orange juice, apple juice, Gatorade, Powerade and coconut water. The hypothesis was that if the previously listed beverages were tested on their electrolyte counts that Gatorade would have the highest amount of electrolytes and water would have the least because of the type of ingredients they contain. Electrolytes are at the most effective state when there is a balanced mixture of substances like sodium, potassium, chloride and magnesium within a given type of drink. Based on the ingredients found within the types of drinks being tested, Gatorade had the most effective list of substances in its ingredients for replenishing electrolytes. After performing ten trials for each of the seven variables it was found that coconut water and Powerade had the most electrolytes within its contents and that after water, apple juice had the least electrolytes. This was surprising as it was thought that if not Gatorade, orange juice would have the most electrolytes, however both scored on the lower side of the results. An ANOVA test was run and the null hypothesis was rejected. Further t-tests were run in order to test the significance between the IV levels that were more closely related. In the end this experiment should be done again with research being brought to a deeper level to explore more specific ideas and the apparatus would be altered or different so that it would be more effective.

The Effect of Different Temperatures on Battery Voltage

Alejandro Andrade, Hanover High School

The purpose of this experiment was to determine the effect of temperature on the voltage of an electrolytic battery made by using Coca-Cola, as well as two commonly available metals, aluminum and copper. The hypothesis proposed was: if the temperature of the electrolyte was increased, then the voltage between the electrodes would also increase. This assumption was based on the observation that many chemical reactions occur faster at higher temperatures, so by increasing the temperature of the Coca-Cola battery then the voltage would also increase due to the faster reaction rates. The Coca-Cola was heated to five different temperatures (21 °C, 40 °C, 55 °C, 85 °C, and 100 °C) and the voltage between the electrodes was measured at each temperature. All of the temperatures were reached using stove top burners, and a thermometer was used to measure the temperature of the Coca-Cola. Ten centimeter strips of copper and aluminum were wrapped around a bamboo skewer and placed into a pot containing four cups of Coca-Cola. The voltage between the metal strips (aluminum and copper) was measured using a voltmeter. The results of this experiment were mixed. For the first four temperatures

the voltage increased linearly, as theorized in the hypothesis statement; however at 100 °C the voltage unexpectedly decreased. Some chemical reactions increase as temperature increases, which explains the higher voltages measured. In the battery system, at 100 °C the voltage decreased due to possibly the formation of an interface layer on the metal electrodes or a competing chemical reaction. More analysis would need to be conducted in order to determine the exact reason.

The Effect of Graphene on Voltage Produced by Titanium Dioxide Dye-sensitized Solar Cells

Laura Binczewski and Megan O'Briant, Yorktown High School

This experiment was to determine if the voltage of a titanium dioxide dye-sensitized solar cell increased with the addition of different quantities of graphene. It is very useful to know how to use solar cells efficiently and cheaply. Building titanium dioxide cells is simpler than using high temperature foundries for silicon or gallium arsenide cells but is less efficient. An attempt was made to recreate a previous experiment done on graphene and titanium dioxide dye-sensitized solar cells by Tsai, Chiou, and Chen "Enhancement of Dye-Sensitized Solar Cells by using Graphene-TiO₂ Composites as Photoelectrochemical Working Electrode published by the American Institute of Physics in 2010". They found that adding 1% of graphene to titanium dioxide dye-sensitized cells made them more efficient. The hypothesis in this experiment was if 0%, 0.01%, 1% and 5% of graphene was added to titanium dioxide dye-sensitized solar cells then 1% would produce the highest efficiency. Directions and procedures from Dr. Graetzel, who invented this dye-sensitized solar cell, were followed. The control solar cells were successfully recreated with no graphene. Solar cells were created. They successfully created electricity from light. However, the results contrasted the hypothesis. Adding graphene decreased the efficiency of the solar cells. Just comparing average voltage alone the control (0% graphene) had a voltage of 0.083 V, 0.1% graphene had .027 V, 1% graphene had 0.063 V, and 5% graphene had 0.031 V. The results from the previous research cited above were not recreated.

The Effect of UVA Radiation on Keratin Bonds

Victoria Bourgeois-Osborne, Mountain Vista Governor's School

Radiation treatments have been found to cause hair loss and other harmful effects on the human body. Little research has been done on how a more common type of radiation, ultraviolet radiation, affects human proteins. In this experiment, human hair was used to test the effect of Ultraviolet A (UVA) radiation on the protein keratin. The force at which the hair broke was tested after various periods of exposure time. The keratin bond broke at a lesser force after being exposed to radiation than after no exposure. The bond also broke at around the same force, no matter how long the UVA exposure lasted. This concluded that once the radiation broke the keratin bond, extra radiation exposure is irrelevant. The p-value was so low that no statistical significance was found between the radiation exposure time and the force at which the keratin bond broke.

What is the Effect of Amount and Type of Alcohol Additives for Gasoline on Engine Efficiency?

Kathryn Carlson and Hayley Roy, Washington-Lee High School

The purpose of this experiment was to find the effect of amount and type of alcohol additives for gasoline on engine efficiency. The hypothesis tested in this experiment was if different types and amounts of alcohol additives for gasoline are tested, then the 10% ethanol would be the most efficient because it is the most commonly used additive and engines have been adjusted to accept that concentration and type of alcohol. The hypothesis could not be supported nor rejected because the data was found to be not significant. The different types of alcohol additives tested were ethanol, isopropyl alcohol, and methanol. The concentrations tested were 10%, 15%, and 20% of the additives with EIO gasoline making up the rest of the fuel mixture. To test 10% ethanol the original EIO was used without adding anything else. When different concentrations of ethanol were tested, the engine did not run on any concentration higher than 10% ethanol. When different concentrations of methanol were tested, the engine did not run on any concentrations of the additive. When isopropyl alcohol was tested, the engine ran on 10%, 15%, and 20%

concentrations. A possible reason for this data was the energy content of the different fuel concentrations. The energy content for ethanol is 26.8 kilojoules per gram (kJ/g), 24.04 kJ/g for isopropyl alcohol, and 19.9 kJ/g for methanol. The engine did not run on methanol potentially because the energy content of methanol was too low. The engine did not run on concentrations of ethanol higher than 10% possibly because the engine could not take that much energy content in more of the alcohol. Isopropyl alcohol has an energy content value between those of ethanol and methanol, allowing it to run on the concentrations tested. An ANOVA test was done to determine if a statistically significant difference existed among the means for the treatment groups on which the engine started. The calculated p-value was 0.89, which is greater than the critical value of 0.05, which means that the null hypothesis cannot be rejected.

A Comparative Analysis of Caffeine in Common Drinks

Michael Dough and Rebecca Freeman, Gloucester High School

Caffeine is a highly addictive drug used as a stimulant for the central nervous system, but the drug is often consumed in large amounts and is abused. Caffeine is found in many common drinks and snacks such as: soda, energy drinks, coffee, chocolate, tea, and even different medications. When too much caffeine is consumed, it can cause harm to the body. Since caffeine is found so easily, it is consumed daily by millions of children and adults, but what they do not always know is how much caffeine is being consumed. The United States Food and Drug Administration (FDA) does not require for manufacturers to publish the content value of caffeine on their products; however, even for the products that have published amounts of caffeine on them, are the amounts shown correct? The purpose of this study is to determine the amount of caffeine in different products and compare the experimental values to the advertised values. Using dichloromethane and a method to extract caffeine in different substances is what was done in order to test the published values for accuracy. The variables being used were Monster Energy drink, 5 Hour Energy shots, and Stay Awake caffeine pills. After experimentation, it was found that the different substances published different amounts of caffeine than was actually present in each product.

The Effect of Metal Density on Conductivity

Heather Fogarty, Mathematics & Science High School at Clover Hill

The question addressed in the experiment is what the relationship is between the density of a metal and its conductivity? The original hypothesis for the experiment is if a metal's density increased, then the conductivity would increase. For the experiment, five samples of 18 gauge wire were collected of different metals, all varying in density. Using a metric scale and a measuring cup with 200 ml of water, the density of each sample was measured. Two eight inch lengths of each type of wire were obtained, and set up on a 9X12" board, so they were parallel with each other and organized by type, so that each sample was next to another of its type. The ends of a 9 volt battery were attached to one end, and a digital voltmeter was attached to the other to measure the amount of electricity that was conducted through the wire samples. The amount of electricity was recorded in volts out of 9.2, the full amount of electricity that could be conducted. Silver, the densest metal, conducted the greatest amount, while aluminum, the least dense, conducted the least. Copper, the control, was second in density and conductivity to silver, and brass, while more dense than steel, was the second most resistive behind aluminum. The data, with the exception of brass and steel, mostly supports the hypothesis.

The Effect of Preservatives on the pH of Apple Juice

George Gerardi, Washington-Lee High School

Fruit juices have been a popular food product for many centuries, as they are extracted from natural, nutrient rich fruits. Today, preservatives are often added to processed juices to enhance the juices' color, flavor and texture, frequently at the expense of its healthfulness. The purpose of this experiment was to learn what effects preservatives have on the "acidity" or pH of apple juice. The hypothesis for this experiment states that if preservatives are added to apple juice, then the pH of the apple juice will decrease at a slower rate than the pH of apple juice with no added preservatives. The reasoning behind this hypothesis is that after weakening, the acids of the preservative-enhanced juices will connect more slowly than the acids of the natural juices, followed by vinegar fermentation of the juices. The

methodology of this experiment was to pour 4 types of apple juices with different components into 12 unsealed glass containers (3 trials of the 4 different juices) with each juice type occupying 3 containers and all the containers being stored in the same location under the same conditions for 4 weeks. The pH value measurements for all containers were taken once every 7 days for a total of 28 days. The data support the hypothesis, as all the pH values of the juices with preservatives decreased at a more gradual rate than the juices without them. A key result was that of Trial 10 (Tamarack Farms Apple Cider, with preservatives) in which the pH value of 3 remained constant for more than half the storage time. Based on full analysis of the data, the most logical conclusion for the experiment is that preservatives do cause the pH of the juices to decrease more slowly than those of the natural/pasteurized juices.

The Effect of Fire Retardant Spray on the Temperature of a Flame (in Celsius)

Lauren Higgins, Mathematics & Science High School at Clover Hill

This project tested the effects of fire retardant spray on the temperature of a flame on a sheet of cotton (in degrees Celsius). Fire retardant spray was applied to half of the cotton sheets, while the untreated cotton acted as the control. Before conducting the experiment it was hypothesized that cotton treated with fire retardant spray would burn at a cooler temperature than the untreated cotton. The results of this experiment could pertain to anyone as it tests the effectiveness of fire retardant spray in relation to temperature and through the observations made during the experiment. Each sheet of cotton had the flame applied and the temperature of the flame was monitored through an infrared thermometer and the maximum temperature of the flame was recorded. According to the results of the experiment the hypothesis was supported with the treated cotton burning at an overall lower average than the untreated cotton.

Effect of Electronegativity on Voltage Output of Galvanic Cells

Justin Hoelscher, Mountain Vista Governor's School

The purpose of this study was to test whether electronegativity, an inherent property of elements, would have an effect on the voltage output of a galvanic cell. This was done by constructing multiple galvanic cells using the elements iron, zinc, copper, and aluminum and their respective sulfates. The voltage output of these cells was then measured using a voltmeter. Cells composed with zinc and zinc sulfate produced the greatest voltage output of the three studied. These results were achieved at the 0.05 significance level, which makes them statistically significant for the purposes of this study. The results found show that the element used in the creation of the cell does have an effect on the voltage output, but this cannot be directly tied to the electronegativity of the respective element due to uncontrollable confounding variables of the elements, such as the number of valence electrons in their outer shells and atom size. Additional studies should be conducted using more elements in order to increase the validity of these results.

The Effect of Acidity on the Production of Hydrogen and Oxygen in Electrolysis

Sean Howard, Washington-Lee High School

Electrolysis has many potential uses in colonization, energy, and medicine. This experiment sought to understand the relationship between water acidity and the production of oxygen and hydrogen gas in the process of electrolysis. It was hypothesized that acids would produce more hydrogen and bases would produce more oxygen. On a more specific level, it was also hypothesized that as the water became more acidic, more hydrogen would be produced. As the water became more basic, even more oxygen would be produced. Although the hypothesis was correct in that acids produced more hydrogen and bases produced more oxygen, the difference in gas production among specific pH levels was not significant. The experiment was conducted through a simple electrolytic apparatus. A nine-volt battery was the source for the electricity that ran through the electrodes and the buffer. Oxidation occurred at the anode, where oxygen gas was produced. Reduction occurred at the cathode, where hydrogen gas was produced. The overall electrolytic equation can be expressed as $2 \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{H}_2(\text{g}) + \text{O}_2(\text{g})$. A citric acid/sodium citrate was the acidic buffer testing at pH 5 and pH 6. The sodium carbonate/sodium bicarbonate was the basic buffer testing at pH 8 and pH 9 in the experiment. Distilled water, which has most of the impurities removed, was the control with a neutral pH 7. Acids increased the production of hydrogen because they have a higher concentration of H^+ ions. So H^+ ions bound to form hydrogen gas

through reduction $2 \text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2 \text{OH}(\text{aq})$. The electrons were given to the hydrogen cations (H^+), which produced hydrogen gas. Bases increased the production of oxygen because they have a higher concentration of OH^- . OH^- ions formed oxygen gas and water through oxidation $4 \text{OH}(\text{aq}) \rightarrow \text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) + 4\text{e}^-$.

Measures of Nitrates in Various Sea Salts

Maia Huntington, Southwest Virginia Governor's School

Sea salts have naturally occurring nitrates which are often not listed when you read the side of a bottle of sea salt. Consumption of high amounts of nitrates has been proven to increase risk of gastric problems and, while the studies have been inconclusive, is believed to be linked to cancer. Due to these health concerns, some companies, such as Hormel and Applegate Organic & Natural Meats, are now advertising meats as preservative-free, and therefore nitrate-free. This proved that sea salts contain naturally occurring nitrates could reduce someone's risk of these health problems by preventing them from curing or seasoning their nitrate-free meats with these sea salts. This project was formed to show that meats with no preservatives cured or seasoned with sea salts actually become full of nitrates due to those naturally occurring in the salt, and to make people more aware of what they are really eating. The project began by the study of previous research project about nitrate levels in water. In a specific journal entry from the Canadian Journal of Fisheries and Aquatic Sciences, the method to measure nitrates were described and was chosen to be a guideline for this experiment. Three different brands of sea salt and one brand of iodine-free kosher salt were purchased to use during experimentation. A nitrate sensor was used to predict the results of experimentation, but because of interfering factors in the salts, the data was invalid. Three trials of each brand of salt were conducted, finding the nitrate levels and total nitrogen of each. The data collected was analyzed and the results showed that two of the three brands of sea salts' average nitrate levels were higher than the levels found in the kosher salt, implying that using said sea salts on meat would make it no longer nitrate-free. Through the research, the hypothesis could be accepted.

The Effectiveness of Various Sources of Catalase Enzyme on the Chemical Decomposition of Hydrogen Peroxide

Harry Kamian, Washington-Lee High School

Hydrogen peroxide (H_2O_2) is a commonly used oxidizing agent with a variety of uses, depending on its concentration that resides both outside of the bodies of humans due to commercial usage and inside the human body to serve as a naturally produced antibiotic. However, similar to the effects of ingesting H_2O_2 from an external source, when not regulated, hydrogen peroxide is originally produced within organisms as the by-product of oxidative metabolism – the method by which cells use biochemical energy from nutrients in order to form adenosine tri-phosphate – can result in the deterioration of organs located within the human body. Therefore, the human body employs the catalase enzyme located within the liver to increase the speed of the chemical decomposition of H_2O_2 into oxygen and H_2O . The purpose of this experiment was to test and obtain data from three different sources of the catalase in order to conclude which was the most effective substance of the group and should be used for the commercial extraction of the catalase enzyme. Twenty pieces of cow (*Bos primigenius*) liver, pig (*Sus scrofa domestica*) liver and chicken (*Gallus gallus domesticus*) liver of 2.6 grams each were placed in a graduated cylinder containing 5 milliliters of hydrogen peroxide (H_2O_2). It was believed that each source of the catalase enzyme would prove to be as effective as the other independent variables in chemically decomposing the H_2O_2 . The data obtained conveyed that the cow liver contained higher concentrations of catalase enzyme than that of pig and chicken and should therefore be used as the primary source of the three organisms as the source of the protein for commercial usage.

The Effect of Different Types of Protein Powder on the pH of Simulated Stomach Acid

Jacob Larsen, Yorktown High School

The purpose of this experiment was to determine the effect of the type of protein powder on the change in pH of simulated stomach acid. It was hypothesized that if casein protein was used the pH of the simulated stomach acid would be affected the least. To test this hypothesis, various protein powders (casein, whey, egg, and soy) were tested. They were mixed with water, treated with a simulated saliva solution, and

added to a simulated stomach acid solution. Results showed that soy protein affected the pH of simulated stomach acid the least, followed closely by casein and whey proteins, and egg protein affected the pH the most. The soy and casein protein solutions affected the pH the least because they have naturally occurring adhesive properties. Statistical analysis showed that the results were significant at a 95% confidence level. The results partially supported the hypothesis.

Chemistry B

First Place

The Effect of Beverage on Glucose Concentration after the Addition of Invertase

Casey Spellman, Washington-Lee High School

The purpose of this experiment was to determine which common beverage (apple juice, orange juice, Gatorade, milk, or Coca-Cola) would result in the highest glucose concentration after the addition of invertase, an enzyme that emulates a bodily enzyme called sucrase. Both sucrase and invertase break down sucrose into simpler carbohydrates that can easily be absorbed into the human bloodstream. Applied to a real-life situation, this experiment identifies which beverage would get more glucose into the bloodstream of a diabetic going into hypoglycemic shock. The hypothesis was that Coke would result in the highest glucose concentration after the addition of invertase as it has the highest initial concentration of sucrose, the main sugar that is broken down by invertase and sucrase. A tablespoon of each drink was poured in a cup, and their glucose concentrations were determined before and after the addition of invertase with glucose test strips that were dipped into the cups. Ten trials were performed on each experimental group. An ANOVA test was done to determine the significance of the data. Several t-tests were also run between the experimental groups showing the significance in differences of the beverages' average glucose concentrations. The results partially confirmed the hypothesis as Coke had a significantly higher average glucose concentration than orange juice and milk, but not a significantly higher glucose concentration than Gatorade and apple juice. Therefore it supported the statement that Coke, Gatorade, and apple juice theoretically get the same amount of glucose into the bloodstream. Further extensions to the experiment would be to also measure the concentration of another simple sugar called fructose, commonly found in citrus fruits.

Second Place

Effect of Photovoltaic Cell Type on the Electrolysis of Water

Praveen Ravishankar, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to actuate the effect of different types of photovoltaic cells on the rate of electrolysis of water. In modern society, a continuous and readily-available supply of energy is fulfilled by the burning of carbon-based fossil fuels. However, not only are these fossil fuels non-renewable, but the burning of fossil fuels increases the level of greenhouse gases in the atmosphere as well. As a result sunlight, a renewable energy source, has been recently utilized by scientists in order to perform a variety of processes, such as the process of electrolysis. The electrolysis of water was powered by four different types of photovoltaic cells: 1.5 V 100 mA solar cell, 3 V 100 mA solar cell, 6 V 100 mA solar cell, and a 9 V 100 mA solar cell. After 90 minutes, the pH of each of the electrodes was measured using a pH probe. No control was present in this experiment due to the absence of a standard type of photovoltaic cell. A research hypothesis was formulated that if the voltage capability of the photovoltaic cell is increased, then the rate of the electrolysis of water will increase as well, thereby resulting in a greater change of pH in the electrodes. The results revealed that increased voltage of the solar cell increased the efficiency of electrolysis of water. T-tests performed on the data revealed that the data was significant for all of the comparisons of the different types of photovoltaic cells, implying that the results were most likely due to the independent variable. As a result, the research hypothesis was supported. It is believed that the results are due to the fact that more voltage causes more electrons to flow out of the cathode and into the anode, increasing the rate of electrolysis and producing larger amounts of hydrogen and oxygen gas. The research could lead to further studies that investigate the effect of different types of sulfates, different amounts of sulfates, and different types of electrodes on the efficiency of electrolysis of water.

Third Place

Molecular Weight Effects on Proton Conductivity in 1H-Tetrazole Polymers

Kaitlin Saunders, Chesapeake Bay Governor's School for Marine & Environmental Science

This study aims to report comparative data of proton conductivity in a polystyrenic alkoxy 1H-tetrazole of lower molecular weight, corresponding with a low glass-transition temperature. The results were examined in contrast to a higher molecular weight polystyrenic alkoxy 1H-tetrazole previously analyzed. Synthesis of the polymer with an amphoteric 1H-tetrazole side chain, possessing the ability to behave as an acid or base, includes converting 4-acetoxystyrene to 4-vinylphenol, addition of an alkoxy nitrile via an ether linkage, and concluding with click chemistry following the polymerization. Proton conductivities of thin films were measured in both anhydrous and hydrated atmospheres utilizing electrochemical impedance spectroscopy. The study did not produce a significant difference in conductivity on decreasing the polystyrenic alkoxy 1H-tetrazole glass-transition temperature by 20 °C, suggesting that conductivity is not related to polymer viscosity (Tg) at all.

Honorable Mention

The Effect of Ammonium Nitrate and Water Mixture on the Lowest Temperature Reached and the Time to Reach the Temperature

Milen Mehari, Washington-Lee High School

The effect of varying amounts of NH_4NO_3 (ammonium nitrate) mixed with water on the lowest temperature reached and the time to reach said temperature were examined. The experiment had a real world connection, in that; this reaction occurs inside cold packs. The overall benefit of cold packs came from their ability to quickly and easily be accessible to athletes and injured people alike, at anytime and anyplace. This experiment was responsible for testing the endothermic reaction that goes on inside cold packs and whether the amount of NH_4NO_3 affected the temperature of the mixture. The hypothesis stated that, if a mixture of 120 grams (1 1/2 packs) of NH_4NO_3 and 135 ml of water mixed then the solution would reach the coldest point as well as in the fastest time, because the greater amount of NH_4NO_3 the more ions water breaks down and the greater the energy absorbed would be. The average means of the data were calculated and analyzed to compare the results among the rest of the groups tested. The average lowest temperature reached was 1.3 °C which was from the 120 g NH_4NO_3 solution; this meant that the independent variable that had the most NH_4NO_3 was able to produce the most endothermic reaction. The fastest time for reaching the lowest temperature was 169 seconds, and resulted from 40 g of NH_4NO_3 . This was understood to be because there was less amounts of NH_4NO_3 , therefore water was able to finish breaking down ions in the quickest time. The results supported the hypothesis because more NH_4NO_3 produced the lowest temperature; but the hypothesis was not supported because the time to reach the lowest temperature was the fastest with 40 g of NH_4NO_3 and not with 120 g, which was what was predicted. The ANOVA tests that were conducted showed that the null hypothesis could be rejected because the results had statistical significance.

Honorable Mention

The Effect of the Color and Concentration of Solution on the Amount and Wavelength in Nanometers of Light Absorbed

Gail Muggill and Natalie Skoloda, Washington-Lee High School

A spectrophotometer is used to measure the intensity of various wavelengths of light. This experiment aims to develop a cheap and portable spectrophotometer using a cell phone. The purpose of the experiment was to find the effect of the color and concentration on the amount and wavelength of light absorbed. The hypotheses were that the complementary color of the solution would be the color of the light of maximum absorption, and if the color of the solution is darker, then the absorption of light will

increase. If the concentration increases, then the absorption will increase, and if the concentration changes, the wavelength of maximum absorbance will not be affected. The scientists created solutions of various colors and concentrations with dye and water. Light beamed through the solutions, a diffraction grating separated the light and an iPhone camera captured the light. Data were transferred to a computer software program that calculated the wavelength of maximum absorbance and the amount of light absorbed. The colors of light of maximum absorbance were the following: yellow-green for red solutions (566 nm), red-orange for green solutions (641 nm), blue-green for yellow solutions (507 nm), and orange for blue solutions (613 nm). The darker colors absorbed the most light. Green solutions had an average maximum wavelength absorption of 0.590 and the yellow solutions had an average maximum wavelength absorption of 0.302. The highest concentrations absorbed the most light with an average absorption of 0.510; the lowest concentrations had an average absorption of 0.360.

Honorable Mention

The Effect of Antacid Active Ingredient on Hydrochloric Acid Neutralizing Capacity

Sasha Volodin, Washington-Lee High School

The objective of this study was to determine the acid neutralizing capacity of three different active ingredients found in common drug-store antacids. The levels of the independent variable were: calcium carbonate in Tums, sodium bicarbonate in Alka-Seltzer, and aluminum hydroxide and magnesium carbonate in Gaviscon. It was hypothesized that the sodium bicarbonate would be most effective in neutralizing the hydrochloric acid because it is a very quick-acting antacid ideal for fast but temporary relief from heartburn and acid indigestion. For each of the ten trials, two tablets of the antacid were reacted with 20 ml of 0.1 M hydrochloric acid (HCl) and then back-titrated with sodium hydroxide (NaOH). The amount of NaOH added to neutralize the solution subtracted from the initial number of moles in the acid was the number of moles neutralized by the antacid. The results did not support the research hypothesis, showing instead that the calcium carbonate was the most effective antacid. The ANOVA statistical test determined that there was statistical significance in the data, thus the null hypothesis can be rejected. However, the t-test conducted for the sodium bicarbonate and aluminum hydroxide/magnesium carbonate testing groups showed no statistical significant difference between the means since they were so close in value. This may have occurred either because the two antacids were about equal in their acid-neutralizing capacity or because of errors during experimentation. A better conclusion could be arrived at if more trials were to be done. Possible future experiments include testing a larger variety of antacids with different chemical compositions. Also, it would be interesting to study how antacids affect overall health and if taking other medications with an antacid has an impact on its ability to neutralize acid.

Fuel Cell Catalysis

Makonnen Makonnen, T. C. Williams High School

The purpose of the experiment is to generate voltage using a fuel cell. It was hypothesized that if platinum wire is used then more voltage will be produced, and the hypothesis was supported by the data. In the experiment, a beaker was set up and filled it with water, then using platinum wires as a catalyst in the fuel cell; voltage was produced in volts and recorded using a multimeter. The platinum wire fuel cell produced an average of 1.24 volts and the nickel wire fuel cell produced an average of 0.595 volts. The platinum wire fuel cell probably produced more voltage because of the hydrophobic properties that platinum has, which assist in chemical reactions. The data is relevant because it shows that even though platinum creates more voltage than nickel, nickel can still produce a significant amount of voltage, and with more understanding of catalysts, nickel can replace platinum as a catalyst in the fuel cell market.

The Effect of Cake Mix Brands on the Mass of the Cupcake Made

Natalia Maamaria and Colleen Norton, Washington-Lee High School

This experiment tested the effect of cake mix brands on the mass of the cupcake following baking. There were three brands tested: Betty Crocker, Pillsbury and Duncan Hines. Ten boxes of cake mix from each brand were used in making the cupcakes. The purpose of this experiment was to find out which brand of cupcake mix would make the lightest cupcake measured in mass, which is also considered the best cupcake. The hypothesis stated that if the Pillsbury mix was used, then the mass of the cupcakes made would be the least because it is the oldest and most established brand. There was no control in this experiment because when comparing brand names there is no original brand that should be used in comparison. The procedure began with making the cupcakes following the directions on the back. After making the cupcakes, they cooled and were put on a triple beam balance to find the mass. Following this the mass means from each box of cupcakes was taken, and later the means of all the boxes were taken. The test results did not support this hypothesis. The mean for Duncan Hines was 24.5 g, the mean for Pillsbury was 42.4 g, and the mean for Betty Crocker was 38.4 g. Clearly, Duncan Hines made the cupcakes with the least mass. The standard deviation also showed that Duncan Hines was the brand name that worked the best. The hypothesis was unsupported, but with the analysis done, the experiment was successful in finding a result.

The Effect of Soil Type on pH of Graywater

Kelsey O'Malia, Washington-Lee High School

The purpose of this experiment is to find alternative filtration methods using different types of soil. Graywater is water recycled from showers, sinks, and dishwashers to be used as irrigation or toilet water. This project used the modern idea of graywater to realize the possibilities of using soil as a filtration method. Five types of soil were used and chosen because of abundance: topsoil, clay, sand, vegetated soil, and gravel. It was hypothesized that if sand is used to filter the graywater, then there will be more filtered water with the most affected pH. It is because at water purification plants today, sand is used in multiple steps to filter polluted water. If sand is used to filter the graywater, then there will be more filtered water with the most affected pH. This was hypothesized because of sand's known use in purification plants today. Sand was believed to be most successful because it is not very porous. Surprisingly, sand was the least effective variable because when packed down, it easily let the water drain through, not allowing it to filter. Topsoil, the control, was the most effective in improving the pH but absorbed the most amount of water. Grass was the most successful variable because it was effective in both improving pH and filtering the most amount of water. Since sand was predicted to be most successful, and performed the worst, an improvement to the experiment would be to use sand in different ways. This would allow an explanation as to why it performed poorly in the original experiment.

Food for Fuel: The Comparative Efficiency of Crop-based Biodiesels

Emma Potochny, Yorktown High School

Samples of biodiesel and diesel were burned in a bomb calorimeter to determine which type of fuel was the most efficient. $Q = \text{specific heat} \times \text{mass} \times \text{change in } T$, a standard calorimetry formula, was used to calculate enthalpies (and later on, average enthalpies) to find the fuel that had the most energy in its bonds; ergo the most efficient one. Proving the hypothesis, soybean biodiesel, with an average enthalpy of 27351.52 J, was the most efficient fuel. The rankings of the rest of the fuels went as follows: WVO biodiesel (Average Q: 24,670.16 J); Diesel (Average Q: 22973.61 J); Jatropha biodiesel (Average Q: 22,010.39 J); Biodiesel with additives (Average Q: 21,513.12 J); and lastly, Linseed biodiesel. (Average Q: 21,148.97 J)

Sunscreen Lotions and the Degradation of Swimming Pool Free Chlorine

Charles Reiter, Mills E. Godwin Specialty Center for Science, Math & Technology

Each summer, large quantities of people flock to nearby swimming pools to escape the heat, and in doing so, release various organic materials, such as urine, sweat, and saliva into the pool water. In addition to the bodily substances, the sunscreen that people apply to skin for radiation protection is also washed off and therefore, the purpose of this investigation was to test the effect of sunscreen lotions on the degradation of free chlorine levels in swimming pools. It was hypothesized that added sunscreen would result in lower free chlorine readings. Twenty-five samples of chlorinated water with sunscreen and 25 without sunscreen were measured over the course of 48 hours using the DPD color-changing method

and a colorimeter to give readings in parts per million. The samples with no sunscreen added served as the control group. The results showed that the sunscreen group's mean was 0.19 ppm less than the control group after the allotted 48 hours. A performed t-test indicated that the data was statistically significant between the two groups, thus implying that the results were not due to chance. The research hypothesis was supported by the results. The likely explanation for the results was that the sunscreen agents reacted with the free chlorine in the solution to form by-products and therefore lowering the readings of the samples. Future investigations could lead to more knowledge regarding the effects of different types and concentrations of sunscreens or environmental conditions on the degradation of the free chlorine levels.

The Effect of Type of Sugar on Mass of Rock Candy

Lauren Snyder, Yorktown High School

The purpose of the experiment was to find out the effect of the type of sugar on mass of rock candy. It was hypothesized that if the granulated white sugar was used in the sugar-water solution for the rock candy then the mass of the before mentioned rock candy will have the highest mass because the granulated white sugar had the largest crystals and were recommended for every recipe that was found. To test this hypothesis the procedures were to use the different types of sugar that were selected in the sugar-water solution for the rock candy. The solution would have been heated and as it cooled, the rock candy crystals would have formed along the string. In the end it turned out that the granulated white sugar grew the crystals with the largest mass and granulated light brown sugar grew the crystals with the smallest mass. The powdered white sugar did not grow any crystals and the powdered glucose did not grow crystals. The results did support the hypothesis.

The Effect of Brand of Oats on Gluten Contamination

Samantha Townsend, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effect of brand of oats on whether or not they were contaminated with gluten. Gluten is the protein commonly found in wheat, rye and barley. Recently, the gluten-free diet has become very popular, whether it is because of personal choice or Celiac Disease. The results of the study are beneficial in assisting the people following this diet in choosing oats that are gluten-free. The brands tested for their gluten contamination were Quaker, McCann's, and Kroger. A GlutenTox Pro kit was used to determine if the oats were contaminated or not. It was hypothesized that if all three brands were tested for contamination, they would all contain traces of gluten. The raw data indicated that Quaker contained gluten where McCann's and Kroger did not. However, these results were not statistically significant and did not support the research hypothesis. This is possibly due to the fact that only five trials were performed on each brand due to money constraints. If money was not an issue and many trials could be performed with the results following the same trends, they would very likely be statistically significant. This study could lead to further investigations involving variations of gluten contamination within a brand of oats.

Triethanolamine Versus Alternate Emollient Ingredients on Moisture Retention

Tanvi Verma, Mills E. Godwin Specialty Center for Science, Math & Technology

Triethanolamine is widely used as an alkalizing and moisturizing agent in skin emollients, but after research conducted by The National Cancer Institute, it was found that Triethanolamine could prove to be toxic and has the potential for conversion to the carcinogen N-nitrosodiethanolamine after dermal application. Therefore, the purpose of this experiment is to further investigate Triethanolamine, comparing it to alternate ingredients and making sure that Triethanolamine actually serves its purpose in moisturizers by testing its ability to retain moisture. The other independent variables along with Triethanolamine included mineral oil, glycerin, and the control in order to compare the effect of emollients versus natural moisture retention. Each of the Petri dishes were filled with 25 ml of prepared kosher gelatin, and 5 ml of the respective independent variable were placed with a pipette on the gelatin. The initial volume and height was recorded for each Petri dish at two then four hour intervals, for a total of 12 hours. At 24 hours, the heights and final volume were measured. Results showed that glycerin had the least moisture retention with an average water porosity of 18.9 g followed by the control, Triethanolamine, and then mineral oil. This did not support the hypothesis that Triethanolamine would retain the least

moisture. These findings may be useful when arbitrating Triethanolamine as a capable ingredient within moisturizers in the cosmetic industry. Further studies could comprise testing the carcinogenic properties of mineral oil and glycerin in order to ensure that consumers receive the safest and most effective emollient.

Chemical Fingerprinting Methods Thomas Woods, Gloucester High School

Forensic Science is a growing department in the Criminal Justice system. Fingerprinting is one of the best ways to identify someone, especially at a crime scene. The objective of this experiment was to see which chemical fingerprinting method works best on different types of surfaces. The methods that were used include: iodine fuming, silver nitrate, and ninhydrin. Chemicals were used to replicate procedures used in forensic labs. The four materials chosen were unpainted wood, glass, copy paper, and aluminum. Iodine fuming, silver nitrate, and ninhydrin were all effective in revealing fingerprints in at least one of the materials but iodine fuming was effective on the most surfaces. When heated, the iodine sublimates to a vapor and adhered the oils in the fingerprint. This method worked the best on the aluminum and paper but also worked better than the other methods on the glass and unpainted woods. The silver nitrate method only worked on the unpainted wood and the ninhydrin method only worked on paper.

The Effect of Varying Saltwater Solutions on pH, when CO₂ is Added Bryttani Wooten, Mathematics & Science High School at Clover Hill

Carbon dioxide absorption has been affecting many different aspects of the ocean, such as decreasing pH. The purpose of this experiment was to see if salinity had any effect on this drop in pH. Increments of 250 milliliters of water were added to thirteen containers with the following salt contents: 0 grams salt, 0.125 grams, 1.5 grams, 2.5 grams, 3.75 grams, 5 grams, 6.25 grams, 8 grams, 8.25 grams, 8.5 grams, 8.75 grams, 9 grams, and 9.25 grams. The initial pH was taken; then 10 grams of dry ice was added to each solution and the solution was left to sit for 15 minutes. Afterwards, the new pH was taken of each solution and recorded. This process was repeated until the solutions' pH did not change from one 10 grams increment to the next. It was hypothesized that the solution with no salt would have the lowest pH because there would be no salt acting as a buffer. The hypothesis was rejected because the solution with no salt did not have the lowest pH. Each of the solutions' ending pH was extremely close, the opposite of what was predicted to happen. The ending pHs of the solutions all fell in the range of 4.2-4.5. The solutions with 5-9.25 grams of salt became saturated quicker than the solutions with 0-3.5 grams of salt; but interestingly they all ended up with very close pHs. It was expected that the salt would act as a buffer, therefore preventing a pH change in the solutions with a higher salt concentration. Based upon this experiment, it was concluded that salinity does not have an effect on pH change, when CO₂ is added. However, it was hypothesized that if the salinity differences were greater, then the salt could possibly act as a buffer and prevent pH from changing.

Effects of Petroleum Based Diesel and Biodiesel on Polymer Engine Parts Brittney Worrell, Southwest Virginia Governor's School

Biodiesel is more beneficial to human life and to the environment because it produces less emissions and pollution than petroleum based diesel. Minimal research has been performed on the barriers prohibiting the use of biodiesel in modern engines. B100, or 100% biodiesel, quickly degrades many of the polymers found in fuel hoses within traditional engines; however lesser blends result in minor changes to the engine parts. This study aimed to provide information as to what polymers are most compatible with B100. The main attempt was to identify the fuel hose which absorbed the most biodiesel, and thus had the least tensile strength due to degradation. The method involved soaking two different types of fuel hoses (Type A nitrile rubber based and Type B synthetic rubber) in petroleum diesel and pure biodiesel for 24 hours. The specimens were cut into 40, 8-inch sections and labeled. Ten of each type of fuel hose was soaked in diesel or biodiesel. Weight and six measurements of outside diameter, before soaking were recorded; then weight and the same O.D. measurements were recorded after soaking so absorption could be calculated. Fuel line tensile strength was measured using an Instron at a local university to determine if degradation occurred. Type B in diesel and biodiesel sustained a higher peak load than Type

A. Type B also absorbed a larger amount of fuel than Type A, meaning that the hypothesis was rejected and synthetic rubber (as compared to nitrile based rubber) interacts better with biodiesel in engines.

The Effect of Different Temperatures of Water on the Average Rate of the CO₂ Formation after the Reaction with Alka Seltzer Begins (ml/sec)

Beraki Yosief, Washington-Lee High School

The effect of different water temperatures on the average rate of the CO₂ formation after the reaction with Alka-Seltzer® began was examined in an experiment. The factor examined was average rate of the CO₂ formation after the reaction with Alka-Seltzer® began. Also, an apparatus was built. The hypothesis was that if the Alka-Seltzer® was in hot water (49 degrees Celsius), then it would have the most volume of CO₂ in the syringe during the experiment and have the fastest rate. When the temperature rises, the motions of the reactant particles are faster and more chaotic, both the frequency of collisions and the number of particles that have enough kinetic energy to slip over the activation-energy barrier to become products. There were 40 Alka-Seltzer® and 4 different water temperatures. Ten Alka-Seltzer® were dropped in 7 degrees Celsius water, 10 in 14 degrees Celsius water, 10 in 21 degrees Celsius water, and 10 in 49 degrees Celsius water. Then, the data from those states were evaluated. A t-test was run between the rates of the CO₂ formation after the reaction of Alka-Seltzer® began. The results supported the hypothesis. The data was overall statistically significant and the hypothesis was supported. The significance of this result was that if you need fast pain relief, just use warmer water if you are in a hurry and/or if you cannot stand the taste.

Chemical Science A

First Place

The Effect of the Type of Containers on the Amount of Time It Takes in Minutes for Red Delicious Apple Slices to Turn Brown

Zoe Costello, George H. Moody Middle School

Red Delicious apples are one of the most popular apples purchased in America. However, when sliced they begin to quickly turn brown due to an oxidation process that occurs when the inside of an apple is exposed to water molecules and oxygen. However, the process can be slowed down if the apple slices are covered by something that prevents water and oxygen from reaching the apple slice. The purpose of the experiment was to determine which type of plastic storage material resulted in the longest amount of time in minutes it took the apple slices to turn brown. Fifteen Red Delicious apples of the same size were selected and cut into 60 individual slices. Then, the slices were divided into four groups. Group A's apple slices were placed in plastic bags, group B's apple slices were placed in plastic containers, group C's were wrapped in plastic wrap and group D's were not placed in any container. Each apple slice was then observed to determine the amount of time in minutes it took for it to turn brown. The results indicated that the apple slices placed in plastic containers had the longest elapsed time until turning brown, with a mean of 122.335 minutes, while the apples stored with no container had the shortest mean elapsed time of 10.391 minutes. The data did not support the hypothesis that apple slices in plastic wrap would take the longest amount of time to turn brown due to plastic wrap's barrier properties. However, based on the data found from the experiment, plastic containers appear to be most effective at preventing oxidation, and usage of any of the three plastic storage materials appear to prevent browning longer than using no container. Before this statement can be concluded, this experiment should be replicated with additional trials, and other types of apples.

Second Place

The Effect of Different Container Materials on Moisture Gain of Cheerios Cereal

Emily Dai, George H. Moody Middle School

Food packaging is very important to maintain food quality and safety by providing a barrier from external influences such as exposure to moisture, oxygen, dust, or light. One critical issue often observed in packaging is moisture permeability. The purpose of this study was to find out what was the best type of container to prevent cereal from gaining moisture. Glass bottles, plastic bottles, and cardboard boxes of the same size were selected for this study. Twenty grams of cereal was weighed and put into each of the containers. There were 12 cereal samples for each container material. The moisture gain of each sample was determined gravimetrically using an electronic balance at 7-day time intervals over a 4-week period. The hypothesis was that the cereal in the plastic bottles would gain the least amount of moisture because plastic bottles are the most common containers for dry food. The results for the experiment proved the hypothesis was not correct. The cereal in the glass bottles did not gain any moisture after the 4-week storage in this study. The cardboard boxes did very little to prevent the moisture gain of the cereal. The plastic bottles, as common containers for moisture-sensitive food, were found not to be the best container to prevent moisture gain. The moisture gain in the plastic bottles was proportional to the storage time (about 0.09 grams per week). The cereal in the plastic bottles is predicted to gain about 0.9 grams of moisture or 4.5% moisture if the experiment were to be continued to 10 weeks. Cereal became stale with 5% moisture. On the basis of this study, glass containers are recommended to keep moisture-sensitive foods for a long period of time in humid conditions. Plastic containers can be used to keep moisture-sensitive foods for a short period of time. It is not recommended to keep moisture-sensitive foods in cardboard boxes.

Third Place

The Effect of Beverages on the Staining of Eggshells

Katherine Brickley, Tuckahoe Middle School

The objective of this experiment was to figure out which commonly consumed beverage causes the human tooth the most discoloration. It was done to have people be aware of what they consume, because many foods and drinks consumed daily cause bad staining, which can lead to permanent discoloration of their teeth. Eggshells were used to test the staining. The beverages tested in this experiment were tea, coffee, Coke, grape juice (used to resemble wine), and water. The hypothesis was if eggs are placed in grape juice, Coke, tea, coffee, and water, then the grape juice will stain the most. Each of the eggs were placed in a Ziploc container with 350 ml of the specified beverage; after exactly 24 hours, the eggs were taken out of the drinks and measured based on a Likert scale developed by the experimenter. The hypothesis of this experiment was accepted. The eggshells placed in the grape juice stained the egg considerably more than the other beverages with an average of 5.50 degree of stain. The coffee and the tea both stained the same amount with an average of 3.25 degree of stain. The results concluded that grape juice will cause an extensively greater stain than the other beverages. The juice contains a darker pigment with more tannin, causing this darker stain. The other beverages also caused a stain that would be unwanted on any persons' teeth, but the one beverage to drink frugally would be grape juice or wine.

Honorable Mention

The Effect of the Length of Heat Exposure on the Amount of Bisphenol-A Released from Polycarbonate Bottles

Aashri Aggarwal, George H. Moody Middle School

Prolonged exposure to Bisphenol A (BPA), one of the chemicals found in polycarbonate plastics, is shown to cause adverse health outcomes including cancer and other endocrine problems. The purpose of this experiment was to determine the effect of heat exposure on the amount of BPA released from polycarbonate water bottles. An experiment was conducted to compare the BPA released from the polycarbonate water bottles in ng/ml when exposed to no heat and various levels of heat exposure. Polycarbonate water bottles were exposed to heat at 26.70 °C (800 °F) for 6, 12, and 24 hours and compared to water bottle with no heat exposure and tap water. Mass Spectrometry was used to detect ionized BPA atoms. The average number of counts in every screenshot was taken from every minute from the sample, and the data was collected in the unit counts. The means and standard deviation (SD) of the BPA released in each of the independent variables were compared. The main amount the BPA released from the polycarbonate bottles exposed to heat at levels Control (mean = 14.5 BPA molecules per mm of water and the SD = 2.63), 6 hours (mean = 14.2 BPA molecules per mm of water and the SD = 1.549193), 12 hours (mean = 15.5 BPA molecules per mm of water and the SD = 1.24), 24 hours (mean = 13.8 BPA molecules per mm of water and the SD = 2.45), and the tap water (mean = 24.6 BPA molecules per mm of water and the SD = 2.45) was statistically insignificant. All bottles were found to have some level of BPA. A further study that could be done could be finding out what actually did affect the tap water results. Recent increase in use of Chlorinated PVC in residential housing water supply and its' association with BPA may impose serious adverse health outcomes in mass populations.

Honorable Mention

The Effect of Different Leavening Agents Used in a Vanilla Cupcake on the Height of a Vanilla Cupcake after Being Baked Completely

Ava Cordero, George H. Moody Middle School

Leavening agents are the ingredients that help all baked goods, from cupcakes to bread loaves, rise to proper height. With the goal of improving baking results, the purpose of the experiment was to test and

conclude which leavening agent, out of baking soda, baking powder, active-dry yeast, and baker's yeast, would make basic vanilla cupcakes rise the highest. The hypothesis was that if baking soda, baking powder, baker's yeast, and active-dry yeast were used in vanilla cupcakes, then the vanilla cupcakes baked with baking powder would measure the highest in height. The procedure centered around a basic vanilla cupcake recipe that was executed identically four successive times, with the only difference being the leavening agent used in each of the four batches. The utensils, the ingredients, the baking and cooling times, the order and all aspects of the procedure were identical in each of the four batches of cupcake mix that were made and baked. After they cooled, the height of each of the 12 cupcakes within a batch or trial was measured at the center point and four identical outlying points. Reviewing the height data gathered from the experiment, it was observed that baking powder made the cupcakes rise the highest. In conclusion, when baking powder, baking soda, baker's yeast, and active-dry yeast were evaluated, baking powder was found to be the most effective leavening agent to use when baking classic vanilla cupcakes.

The Effect of Citric Acid on Electric Current Produced

Emily Alexander, Tuckahoe Middle School

Rising energy costs and resource depletion are forcing global leaders to research alternatives and provide the funding to make changes. Alternative or renewable energy not only protects against harmful by-products, but also helps to preserve many natural resources. This experiment evaluated a new source of electricity through something as ordinary as a citric fruit. The purpose of this experiment is to determine which type of citrus fruit produces the most electricity, and determine if it would be practical to use fruit to generate electricity. It was hypothesized if the fruit contains more citric acid, then it will produce more electricity. The testing was done on 4 different fruits: a lemon (*Citrus limon*), a lime (*Citrus aurantifolia*), a grapefruit (*Citrus paradisi*), and an orange (*Citrus sinensis*). A carrot (*Daucus carota*), was also tested, which served as the control since it has no citric acid. One initial trial was conducted, with a total of three repeated trials. The data was quantitative, measuring the voltage produced, using a multimeter and was recorded in volts. The hypothesis was supported, because it was discovered that the fruit containing more citric acid, the lime (5% to 10% of citric acid by weight), produced an average of 0.86 volts of electricity whereas the orange (0.6% to 1% of citric acid by weight), produced an average of 0.77 volts of electricity across the 4 trials. This experiment proved that using fruit containing citric acid in the production of electricity would not be feasible since the amount of electricity generated by each fruit was so minimal. The huge amount of fruit required to generate electricity for commercial purposes would not make sense economically. However, using alternative energy sources, such as citric acid, is an interesting idea in regards to small electronic devices which could change the way technology is powered.

Effect of Brands of Paper Towels on Absorption Rate

Cammie Allen, Tuckahoe Middle School

The hypothesis for the experiment was, if you spill 15 milliliters of water on a carpet and place paper towels on the spill, each for 10 seconds, then Bounty will clean up the area with the least amount of pieces. Spills are a daily challenge for everyone and it can become quite a pain. The purpose of the project is to test which paper towel brand will absorb spills in the quickest, most efficient way. The experiment was conducted by testing Bounty, Brawny, Scott, school room brown paper towels, and a dish rag. This is recorded onto a data table. The hypothesis was supported and Bounty got the wet area dry with the least amount of towels.

The Effect of Temperature on Vitamin C in Orange Juice

Ojas Amberkar, George H. Moody Middle School

The experimenter's purpose for this experiment was the interest in vitamins. The experimenter wanted to do this because he was able to find vitamins in nearly everything. His liking for oranges made him use orange juice for the experiment. Orange juice had a large quantity of vitamin C, which was the vitamin he wanted to use. His hypothesis was if the temperature was increased, then the amount of vitamin C will

decrease in the orange juice. He had thought that if heat can damage the particles in water, then why can't heat damage a water-soluble vitamin? The results supported the hypothesis. When more heat was added, less iodine was needed. The standard was one drop of iodine equals one mg of vitamin C. Concluding; the experiment was successful and was supported by the hypothesis.

The Effect of Different Liquids on the Corrosion of Copper

Thomas Bolles and Alexander Gallin, Gunston Middle School

Have you ever wondered why copper is commonly used in pipes and electrical wiring? What makes it so special? Why is it chosen over other materials? These are some questions that were asked and considered for the project. The purpose of the experiment was to test copper's reputation for being a reliable metal. Copper squares were exposed to water, Coca-Cola, apple cider vinegar, and bleach. Then they were rated on a scale of zero to four on corrosion. The experiment shows how copper responds to different liquids. Copper that is used in plumbing can corrode and create problems with the piping. Instead of using all acids, contrast was created by using bleach, a base, and water, which is neutral. Coca-Cola was used to test a common liquid that is consumed by many people.

The Effect of Agitation in Water on Level of Dissolved Oxygen

Julia Cassidy, Sabot at Stony Point

The amount of dissolved oxygen, or DO, in the water is vital to the health of the aquatic ecosystem. If the aquatic ecosystem fails, that will affect all ecosystems. In many parts of the world, bodies of water are suffering from critically low levels of dissolved oxygen. The experiment was conducted to test whether turbulence, plants (the waste product of photosynthesis), or diffusion could dissolve the most oxygen into the water. A hand mixer, a fish tank bubbler and leaving the water out represented the different ways for oxygen to be dissolved into the water. The water was tested for a dissolved oxygen level before the test and then was agitated for two minutes and then tested after. A final oxygen reading was taken and the difference was calculated between the beginning and ending amount of dissolved oxygen. The data results from the experiment were different from research done about how turbulence affects dissolved oxygen levels. Research shows that more turbulence dissolves more oxygen. The hypothesis, "If the level five setting on the mixer takes place then that will create the most dissolved oxygen in the water" was rejected. Two experiments were performed, one with colder (four- eight degrees Celsius) water and one with warmer (18-20 degrees Celsius) water. In both experiments the results showed that the level one agitation dissolved the most oxygen into the water. Another conclusion that could be drawn from the data was that there were higher rates of dissolved oxygen in the warmer experiment. The overall dissolved oxygen average for the warmer temperature experiment was 3.8795 mg/L (difference between the beginning and ending level of dissolved oxygen). The overall average for the colder temperature was 1.8332 mg/L (difference between the beginning and ending level of dissolved oxygen).

The Effect of Parsley on Water Contaminated with Heavy Metals

Sachi Cooper, Kenmore Middle School

Water contaminated with heavy metals is a major problem all over the world. The scientist wanted to find a cheaper and more accessible alternative to water treatment plants for countries who cannot afford it. The scientist's hypothesis was that parsley will remove copper from a copper-water solution. The independent variable was the parsley, and the dependent variable was the copper-water solution. The control was distilled water. The scientist placed the copper-water solution and the parsley in a sealed Tupperware container and waited 12 hours. The scientist then removed the parsley from the water and tested the water with water testing strips. The scientist found that parsley removed at least 220 ppb of copper from the solution. The scientist's hypothesis was accepted.

The Effect of Beverages on Teeth

Connor Crabtree, Tuckahoe Middle School

Scientific studies have shown that acid from food and drinks can cause tooth decay. People consume large amounts of beverages such as soda and coffee throughout their lives. The purpose of this

experiment was to find which beverages cause tooth decay. The approach taken was to use hard boiled eggs as a substitute for tooth enamel and then place the hard boiled eggs inside cups filled with a certain beverage. The results have concluded that not only does soda promote tooth decay, but so does coffee and orange juice. The conclusion shows proof that not only soda can be bad for your health, but orange juice and coffee can be bad as well.

The Effect of Different Aquarium Additives on the pH of Water

Emily Deyerle, George H. Moody Middle School

The purpose of this science experiment was to see the effect different aquarium additives had on the pH of water. The hypothesis for this experiment was if different aquarium additives are added to water then the stress coat will change the pH the most. This was researched and experimented to find if any of these specific additives should not be used with fish. This is important because fish do not do well with changes in their environment unless they are barely noticeable. This experiment was done by putting 295.735 milliliters into ten glasses and then adding one ml of an additive or non-additive. Then the glasses were left to sit for an hour and then litmus paper was used to test the pH. Safety precautions were taken throughout the tests. The pH values were recorded and the results were written and conclusions were drawn. In this experiment the hypothesis was supported. The data showed that the control group of regular water had a pH of 6 and the stress coat changed this pH almost an entire unit to a 6.9 on the scale. This shows that the stress coat did in fact change the pH the most. However, looking at the true proportions of water to additive that would actually be used in an aquarium it was shown that the additives would hardly change the pH if they even changed it at all. This experiment did have some data trends with the control group's tests all having a pH of 6 and almost all of the stress coats trials having a 7, which does show a slight change in pH but not much. It was found that the change in pH did not come from the amount of ingredients in the stress coat and that it probably came from the individual ingredients. It was finally concluded from more research that most of the ingredients in the stress coat could have added together and made the pH of the water change as much as it did. However, the other additives still changed the pH showing that the changes in acidity were not completely special to the ingredients in the stress coat.

Effect of Electrolyte on Power of Fuel Cell

Evan Donnellan, Tuckahoe Middle School

The experiment was conducted for the purpose of utilizing a clean energy source and finding the most efficient way to harness it. Fuel cells are an extremely efficient counter to harmful energy sources such as fossil fuels, which are an extremely common energy source. Eventually, the supply of fossil fuels, which are a non-renewable energy source, will be exhausted. The world has prepared for this by completing research on alternate energy sources, such as a fuel cell. In this experiment, the cathode was oxygen harnessed from the air, the electrolyte was salt water, and the anode was magnesium. The electrolyte had three different salinities: 20%, 40%, and 60%. The hypothesis of the experiment was if the salinity of an electrolyte in a magnesium-air fuel cell differs from 20% salinity to 60% salinity in increments of 20%, then 20% salinity will produce the most electricity in the fuel cell. The quantitative data supported the hypothesis, and it was learned that a 20% salinity electrolyte is the most efficient energy source. This information will be useful to scientists who are researching clean energy or for any people interested in the efficiency of clean energy in an environmentally-friendly world.

Effect of Orange Juice Brand on Vitamin C Amount

Emily Duong, Tuckahoe Middle School

Vitamin C is necessary for humans. It has many health benefits, like the repair of tissue, and since it cannot be made by the human body, it must be consumed through sources like orange juice. The purpose of the experiment was to find which brand of orange juice (Florida's Natural, Minute Maid, and Tropicana) contained the most amount of vitamin C. The control of the experiment was fresh squeezed Navel orange juice. The hypothesis was if different brands were tested, then fresh squeezed Navel orange juice would contain the most amount of vitamin C. This was hypothesized because fresh squeezed juice comes from a direct source, whereas store-bought juice goes through a complicated process before being placed on the shelves. To test the hypothesis, a 1% DCPIP

(Dichlorophenolindophenol) solution was made along with a 50% vitamin C solution for each level. The DCPIP solution served as an indicator. Forty milliliters of the vitamin C solutions were poured in 50 milliliter beakers labeled with the brand. The vitamin C solution was placed on a hot plate with a magnetic stirrer. The DCPIP chemical was pipetted drop by drop in the vitamin C solution while the hot plate, set at a stirring speed of four, mixed the chemical into the solution. The amount of drops until the DCPIP solution changed the color of the juice was recorded. The level with the least amount of drops was the brand with the most amount of vitamin C. The data did not support the hypothesis. The control contained the least amount of vitamin C and the most amount of drops with an average of 39.2 drops. The results suggested that Florida's Natural contained the most vitamin C with a mean of 21.2 drops.

The Effect of Type of Sugar on the Texture of Cookies

Kayla Ehrlich, Gunston Middle School

People love to make cookies for special occasions, and they always use the classic white granulated sugar, but is that the best sweetener to use when it comes to the texture of cookies? This project looks at which sweetener gives a sugar cookie the best texture out of white granulated sugar, brown sugar, raw sugar, Splenda and Stevia. The cookies were prepared before the experimenting started. After, participants in 8th grade (ages 13-14) were gathered. The cookies were tested by 30 participants and rated on a scale of 1 to 5 (1 being smooth and moist and 5 being rough and grainy). The hypothesis for this experiment was if brown sugar is used, then it will have little to no effect on the texture of the sugar cookies. After the experiment was conducted it found that the data did support the hypothesis and that it was Splenda that gave the cookies the best texture with a mean of 3.13 out of 5. The experiment also showed that white granulated sugar actually doesn't give that good of a texture with a mean of 2.4 out of 5. The purpose of this experiment, and the reason the scientist chose this experiment, is to help other bakers by letting them know what sugar they should use for the best textured sugar cookies.

The Effect of Washing on Flame Resistance of Sleepwear

Carolyn Ellis, Tuckahoe Middle School

The experiment conducted had a complex set-up and interesting results. The purpose of the experiment was to find out if allegedly flame retardant materials can withstand their resistance even after washing. There were three trials with a control of three 8 cm by 8 cm swatches of fabric from each of the three different brands. While the other three 8 cm by 8 cm swatches from each fabric were washed. The control was repeated with every trial. The average for how long it took the unwashed, blue fabric (control) to catch on fire was 1 minute and 35.36 seconds out of all three control trials. The average for how long it took the unwashed, pink fabric (control) to catch on fire was 28.03 seconds. The average for how long it took the unwashed, orange fabric (control) to catch on fire was 34.69 seconds. The average for how long it took the washed, blue fabric to catch on fire was 24.38 seconds and the average for how long it took the washed, orange fabric to catch on fire was 37.38 seconds. The average for how long it took the washed, pink fabric to catch on fire was 36.86 seconds. The overall results were rather inconclusive. The pink and orange fabrics actually showed the fabrics taking longer to catch on fire after being washed. However, the blue fabric showed a great range in the control and the washed fabric. When the fabric was unwashed the average was 1 minute and 10.98 seconds more than the average for the washed fabric. This shows that the hypothesis was not proven accurate since the blue fabric cost the most at eight dollars and it lost its resistance the most.

Effect of Different Oils on the Mass of Cupcakes

Teagan Fenderson, Tuckahoe Middle School

The hypothesis for this experiment was: If different types of cooking oil (Vegetable Oil (control), Extra Light Olive Oil, and Corn Oil) are baked into cupcakes, then the Olive Oil cupcake will have the most mass. One key ingredient in cupcakes is oil. Bakers need to find a kind of cooking oil to use in cupcakes that will please their different customers and is not overly expensive. What is the best oil to use too achieve this goal? This experiment tests which type of oil would make the cupcake have the most mass. There were three total trials and 18 cupcakes tested in each trial. There were three different cupcake pans and in each pan there were different oils tested in the cupcakes. The hypothesis was not supported. The corn oil cupcakes had the most mass, which was 53.91 grams.

The Effect of Pozzolans on the Strength of Cement

Dominic Gammino, Sabot at Stony Point

The purpose of the experiment was to see if the more durable Roman concrete contained a higher MPa than the common Portland cement, which lasts anywhere from 100-150 years or less, especially underwater. The production of Roman concrete also produces less carbon emissions, which would be a good thing for the environment since 7% of emissions come from the production of Portland cement. To increase the MPa of a slab of concrete sometimes pozzolans, such as fly ash, are added, though they generally never completely replace the hydrated lime. The hypothesis was that when pozzolans were added it would increase the strength of the cement. The results, however, showed that with the addition of pozzolans, mixed using the same formula that was used in the Pantheon in Rome, the cement was not as strong as using Portland cement. Using hydrated lime and volcanic ash with salt water was stronger than hydrated lime with fly ash and salt water. Due to the variability, though it is unlikely, it cannot be proven that fly ash will be less strong than volcanic ash one hundred percent of time. The same holds true for Portland cement and volcanic ash, hydrated lime, saltwater. In the experiment the Portland cement was generally stronger than the volcanic ash.

Chemical Science B

First Place

How Does the Amount of Water in Mortar Affect Its Strength?

Wyatt Mingus, Sabot at Stony Point

The purpose of this study was to see how the amount of water mixed with unhydrated mortar would affect its strength. The hypothesis for this experiment was that the strength of the cured mortar would decrease as the level of the independent variable increased (the amount of water mixed with the mortar) and that the mortar would decrease in strength when less than 240 milliliters of water was mixed with the unhydrated mortar. To test this hypothesis, 2.25 kg of unhydrated Masterflow 713 Plus mortar was mixed with 240, 360, 470, 590, or 710 milliliters of water depending on the level of the independent variable. After the mortar was mixed with the water specified by the level of the independent variable, five 50 mm cube molds were filled with the mortar. The mortar was then allowed to hydrate and harden for three weeks before being tested using a Testmark 600,000 lb Compression Machine to determine how many kilopascals of force the mortar sample could withstand before fracturing. The results produced from the testing showed that when 360 milliliters of water was mixed with the two and a quarter kilograms of unhydrated mortar, it was able to withstand the most pressure and also distributed the pressure evenly across all trials, therefore the hypothesis was rejected.

Second Place

The Effect of Difference Catalysts on the Electrical Output of a Proton Exchange Membrane Fuel Cell (PEMFC)

Kelsey Levine, George H. Moody Middle School

Hydrogen fuel cells and fuel cell cars are an emerging green technology with the potential to significantly reduce greenhouse gas emissions. While there are many different types of fuel cells, PEMFCs are the most practical for powering a car or house. The problem with these fuel cells is that platinum, the best catalyst for use in fuel cells, is a rare and expensive precious metal. To determine why platinum is an effective PEMFC catalyst, this experiment tested platinum, copper, nickel, and molybdenum catalysts on the electricity produced by a PEMFC. In this experiment, a PEMFC was constructed by placing wire electrodes in 350 ml of water and connecting the wires to a multimeter and battery clip. To operate the fuel cell, a battery was touched to a battery clip. The battery applied electricity to the water, splitting the molecules into hydrogen and oxygen. The electrodes catalyzed the reaction of hydrogen and oxygen to form water and electricity, and the amount of electricity produced was shown on the multimeter. Group 3, which received nickel catalyst, generated the most electricity, with a mean of 25.2 mA. Groups 1 and 2, receiving platinum and copper catalyst, each generated a mean of zero mA. The effectiveness of a fuel cell catalyst is determined by the change in oxygen binding energy, or ΔE_o . Since the ΔE_o value of platinum is optimum for a PEMFC, there is likely another factor in the experiment that produced these results. Temperature, pressure, and flow rate of the hydrogen and oxygen gases affect the performance of PEMFCs and may have caused this unexpected result. Understanding why platinum is a good fuel cell catalyst is essential for finding an inexpensive alternative. The next step in this experiment is to test a material with a similar ΔE_o to platinum and compare the results to the control. If an efficient and affordable replacement for platinum catalyst can be found, fuel cells may be on the road towards replacing gasoline-powered cars.

Third Place

The Effect of Surfactant on the Removal of Oil

Annagrace Hamson, Tuckahoe Middle School

The research objective of this experiment was to determine which surfactant, out of Dawn Ultra Original, Tween 20, and Triton X-100, is the best at removing motor oil from feathers. The results from this experiment may potentially improve survival of birds affected by oil spills by ensuring that the best surfactant is used to remove oil from the birds. An analysis of variance (ANOVA) was performed to determine the significance of the results. The null hypothesis was rejected because the p-value was 0.042. Triton X-100 received the lowest mean rating of 2.13. Dawn Ultra Original had a mean rating of 2.85, Tween 20 had a mean rating of 2.44, and water, the control, had a mean rating of 2.57. Triton X-100 should be considered as a method of removing motor oil from birds because of its superior performance over other surfactants. In further experimentation it may be beneficial to test Triton X-100 with real birds that have been affected by oil spills, with different levels of salinity, or with different levels of pH.

Honorable Mention

The Effect of Teeth Whiteners on Coffee Stained Eggs

Jarrett Gouldin, Tuckahoe Middle School

Many people want a beautiful smile and don't want to spend a lot of money in order to get white teeth to go with that smile. This experiment was conducted testing three different over the counter (OTC) teeth whiteners: Crest whitening strips, Crest whitening toothpaste, and Crest whitening mouthwash, and the control Crest non-whitening toothpaste, to see which one whitens teeth most effectively. An egg was used because an egg is a calcium-based composite, just like tooth enamel. It was hypothesized that the whitening strips would whiten the most. In the experiment there were four repeated trials for each level of the IV for a total of five trials in all. A numbered Likert scale was used to measure the effect each whitening agent had on the coffee stained egg. The color of the egg was compared to a corresponding color on the numbered Likert scale. Whitening products were applied for the amount of time suggested by the company. Before and after the experiment, the color rating was taken and the difference of the two numbers was used to determine the effectiveness of the two agents. The most effective was whitening toothpaste with a rating of 3.2. Second was non-whitening toothpaste with a rating of 3. The whitening strips were the third most effective with an average rating of 2.8, and last was the whitening mouthwash with a rating of 1.6. In conclusion, Crest whitening tooth paste whitened the most effectively and Crest whitening mouth wash whitened the least effectively.

Honorable Mention

The Effect of Fabric Softener on the Flammability of Materials Used in Clothing

Joshua Haueis, George H. Moody Middle School

Many fabrics have been introduced to mankind over the years. One such fabric is cotton. Cotton was first grown in India in 2500 B.C.E. It quickly spread throughout the world as an item of trade. Polyester was invented in 1941 by John Whinfield. It was not mass-produced until 1950, when DuPont opened a factory in Delaware that produced polyester. It became the cheapest fabric to produce in 1960 and has been ever since. The first successful experiment to create fire retardant fabrics was in 1820. However, the experimenter found out very little, except that two salts reduced the flammability of fabric. Fire retardant fabric was perfected in the early 1900s by adding stannic oxide to clothes. Fabric softener was invented in the early twentieth century. It was not sold in large quantities and usually was made in one's home. Research was done throughout the twentieth century and eventually, Procter and Gamble began mass-producing fabric softener. The purpose of this experiment was to see whether or not fabric softener affects the flammability of materials used in clothing. The materials tested were 100% cotton, 100% polyester, wool, 65% cotton 35% polyester blend, and fire retardant fabric. Ten equal pieces of each fabric were treated with fabric softener. They were ignited for two seconds and allowed to burn for two more seconds. They were then snuffed out. The height of the scorch mark was recorded. The above was

repeated for ten equal pieces of each fabric that were not treated with fabric softener. The results of the experiments supported the hypothesis that materials used in clothing, when treated with fabric softener, would become more flammable. The data showed that fabric softener does increase the flammability of materials but by varying amounts. The most dramatic increase was in the fire retardant material. The average scorch mark height increased by 10.5 cm. However, the cotton fabric increased by 1.5 cm, the wool increased by 0.35 cm, the blended fabric increased by 3.45 cm, and the average scorch mark of the polyester material increased by 4.6 cm. Further study into the flammability of clothing materials could include further investigation into why the flammability of fire retardant materials are so greatly affected by fabric softener.

Honorable Mention

Got Lactose? The Effect of UHT Pasteurization on the Lactose Content of Milk

Calder Lowenthal, Swanson Middle School

The purpose of the experiment was to find the effect of ultra-high temperature (UHT) pasteurization on the lactose content of milk. Curiously, some people who are lactose intolerant have found that they can digest non-lactose reduced milk in certain countries where the milk is UHT pasteurized. The hypothesis stated that the milk that was UHT pasteurized would have lower lactose content than the milk that was not UHT pasteurized. The data were varied, but the data did not support the hypothesis. The lactose content of the UHT pasteurized milk was on average greater than that of the non-UHT milk, however, each mean was within the other variable's range (excluding the lactose free milk). Based on the fact that the average lactose content was very similar, it might be concluded that the process of UHT pasteurization has no effect on the lactose content of milk.

Effect of Method of Preservation on Amount of Oxidation

Emina Hodzic, Tuckahoe Middle School

It was hypothesized that if the methods of preservation are changed, then the *Malus pumilas* (apples) that are sliced and banded together with a rubber band would keep the oxidation at a minimum. Enzymes, known as polyphenol oxidase, can cause oxidative browning as soon as the fruit is peeled or cut. Browning can cause loss of vitamin C. Vitamin C is needed for the growth and repair of tissues in all parts of your body. It is used to form an important protein used to make skin, tendons, ligaments, and blood vessels, heal wounds and form scar tissue, and repair and maintain cartilage, bones, and teeth. *Malus pumilas* were preserved using different methods and were tested to see how much oxidation was shown. The hypothesis was supported because it was discovered that the *Malus pumilas* that were banded together showed the least amount of oxidation consistently. It was shown that *Malus pumilas* that were just sliced showed the most amount of oxidation. It was found that the *Malus pumilas* that were preserved using the method of rubber bands showed the least amount of oxidation. Based on the results, it was discovered that the *Malus pumilas* that were preserved using the method of rubber bands showed the least amount of oxidation due to minimal contact with oxygen.

The Effect of the Way to Cool the Soda on the Temperature of Soda

Brody Karton, Kenmore Middle School

When salt is added to ice water, it takes the place of some of the water molecules. The ice then starts melting more quickly, lowering the temperature of the water. This project is about finding the fastest way to lower the temperature of liquids. In this experiment the liquid being used is Coca-Cola. The purpose of this experiment was to find the fastest way to cool a can of soda. It was hypothesized that if the Coca-Cola is placed in a container of ice water with salt then it will cool the fastest. Each of the three Coca-Colas were placed in their respective cooling containers. After 5, 10, 15, and 20 minutes the temperature of the soda was measured. The Coca-Cola in the freezer had the smallest drop in temperature after 20

minutes. The soda in the container of ice water dropped the second most and the Coca-Cola in the container of ice water with salt had the largest temperature drop. The hypothesis was accepted.

The Effect of Acid on Chalk Erosion

Gelila Kassa, Kenmore Middle School

The experiment is a study of how fast certain acids erode chalk. Chalk, also known as a form of limestone, is a rock that can be eroded by acids. The purpose of this experiment was to find out which acid eroded the chalk the fastest. The hypothesis was that if chalk was put in different types of acid then citric acid would dissolve the chalk the fastest. A piece of chalk was placed in three different containers with 200 ml of three different types of acids and timed for 60 minutes. Every five minutes the chalk was weighed to see how much each acid had eroded the chalk. The results were that the citric acid eroded the chalk the fastest, then acetic acid, and finally carboxylic acid. The control was the last, weighing 12.5 grams at 60 minutes. The hypothesis was accepted; citric acid eroded the chalk the fastest.

The Effect of Acids on Rate of Corrosion

Vaneeza Khan, Tuckahoe Middle School

The problem to be figured was how can the different acids affect the amount and speed of corrosion on the steel wool? The hypothesis of this experiment was if the fruit with higher acidity level (lemons) comes in contact with the steel wool, then it would corrode the steel wool greatly. The independent variable was the different types of acids. The independent levels were distilled water, lemon juice, orange juice, tomato juice, and grape fruit juice. The dependent variable was the effect of the acids on the steel wool. The procedures taken were, one, steel wool was cut into 5 inch by 5 inch pieces while wearing gloves to avoid splinters. Two, ½ cup of distilled water was mixed with 2 ml of each type of juice. Three, one piece of steel was added to each acid and water mixture. Observations were made for 3 consecutive days. This experiment had a total of 6 trials. The data had been recorded by using a time line, a bar graph, and a pie chart. To support the evidence pictures were taken each night. The pH levels had also been recorded. The distilled water, surprisingly, had a higher pH level. During these observations, the acid base had changed colors from red to blue or green, or clear to copper. The hypothesis was not supported. This is because the distilled water had created the most corrosion on the steel wool in the course of all 3 trials. The benefit of this experiment was to find the reasons of rust so that the protection measures can be adopted.

The Effect of Varied Fabrics on the Amount of Time it Takes Them to Burn

Sabrina Lee, George H. Moody Middle School

The speed that fire spreads is incredibly fast, causing anything that is flammable to ignite no matter what. There have been many deaths caused by fire, especially those of children. The choice of sleepwear for children is highly important at night, because if there was a fire, they would want the type of fabric that took the longest time to catch fire. The amount of time depends on the fibers within the fabric. Fabrics such as cotton have cellulosic fibers that catch fire easily while polyester has manmade fibers that take longer to catch fire. The purpose of the experiment was to determine the effect of varied fabrics on the amount of time it takes them to burn. The experimenter's hypothesis was if different types of fabrics and textiles were burned, then polyester would take the longest amount of time (in seconds) to burn. Thirty 10 cm x 10 cm pieces of fabric were cut. Ten pieces were polyester, ten were silk, and the last ten were cotton. The pieces were placed on a long stick with a hook on the end and a fire was lit. When the fire was lit, the stopwatch started. Once the fabric was about 2 cm x 2cm, the fabric was dropped into a box. The results sided with the hypothesis, saying that if different types of fabrics were burnt, then polyester would take the longest amount of time. The average time that polyester took to burn was 117.3 seconds, while silk was 38.41 and cotton was 37.31. Polyester left a black liquid-like substance, while silk left dry and brittle ash. Whereas the burnt part of the cotton crumbled into the box. Since the average time for polyester (117.3 seconds) was significantly greater than cotton (37.31 seconds) and silk (38.41 seconds) the hypothesis was supported.

Effect of Milk Variety on the Time Taken to Spoil

Jacob Lesley, Tuckahoe Middle School

The purpose of this experiment was to find out which of five types of milk stays unspoiled the longest. The experiment was conducted by measuring the pH of milk every day at 5:30 P.M. A major finding of this experiment was that the unpasteurized milk did not expire the fastest considering that the bacteria was still present in the milk. This may imply that bacteria in unpasteurized milk do not affect unpasteurized milk's ability to remain fresh. This experiment was conducted to see how long different milks last even when the expiration date is the same. This information could be useful to people with problems financially or anyone wanting to save a little money on milk. During the experiment it was found that all of the milk expired after the expiration date and the skim milk had an insignificant difference in the time it took to spoil.

The Effect of Time on Oxygen Exposed to Vitamin C

Grace Lu, George H. Moody Middle School

Vitamin C is well known as an ascorbic acid that can help the immune system stay healthy, make bones stronger, and fight off any sicknesses or viruses. The main source of vitamin C is found in citrus, especially oranges. However, oxygen is known for taking nutrients away from a substance when in contact. The purpose of this experiment was to determine the effect of amount of time exposed to oxygen on an orange's nutritional value. An equal amount of orange juice was put in ten identical bowls. Every hour, the orange juice was tested to see how much vitamin C was left. Vitamin C testing strips were used to get precise and accurate results. The experiment was to test how freshly squeezed orange juice would react to oxygen hourly, until three hours was reached. It was hypothesized that if oranges are exposed to the oxygen in the air for three hours, then it will have a lesser amount of vitamin C. My hypothesis was accepted because the vitamin C in the orange juice did decrease over time. This is because since the vitamins and minerals found in the orange juice reacted with water, it lost its nutritional value. Compared to other scientists, the experiment was accurate. This is because other scientists have stated that vitamin C is a vulnerable vitamin that can lose nutritional value easily when combined with different elements or compounds.

The Effectiveness of Different Brands of Sunscreen

Zoe Manning, Tuckahoe Middle School

In the summer, people are outside and active, and go everywhere from the beach to the pool. What most people don't know is that the sun's harmful rays are affecting them everywhere they go. Wearing sunscreen is very important to skin health. Without it, people are at risk of getting sunburn, skin aging, and even the possibility of skin cancer. There are many types of sunscreens available at pharmacies and convenient stores, but they can be expensive. Do the top brands work the best? Some are expensive and claim to be the best, but do they work as well as an inexpensive brand? The experiment objective was to test the effectiveness of different sunscreens. The problem question in this experiment was, "Which sunscreen brand works the best?" The sunscreen products chosen were Coppertone Water Babies, Aveeno Active Naturals, Banana Boat Sport, Coppertone Sport, Neutrogena UltraSheer, and Target Up & Up Sport. A control of no sunscreen was used. The sunscreens were tested by using sun sensitive paper, a paper that reacts quickly when exposed to light. The sun sensitive paper was used to represent skin because it turns different colors after being exposed to light. The active ingredients in each sunscreen type varied because each was a different brand or type. The hypothesis was that Coppertone Sport would be the most effective since it has highest percentages of many active ingredients. The results supported the hypothesis because the Coppertone Sport had the greatest blockage of sun and the most consistent results. All brands blocked more sun than the control. The research collected was very helpful in understanding why some of these brands are more effective than others and what active ingredients are worth spending money on.

Effect of Antacids on the pH of Lemon Juice

Langdon Martin, Tuckahoe Middle School

In the United States more than four out of ten adults suffer from heartburn. Antacids are commonly used to neutralize the pH level of stomach acid relieving heart burn. In this experiment different types of

antacids were tested to see which brand would be the most successful at relieving heartburn and other associated health issues. The purpose of this experiment was to determine the effect of type of antacid on the neutralization of lemon juice simulating stomach conditions. Lemon juice was chosen to simulate stomach acid because it had a pH (2.0) close to the acid in the human stomach (1.0), but it was a safe alternative that would not harm the eyes, skin, or environment. The hypothesis for the experiment was: if Pepto-Bismol was added to lemon juice, then the pH of the lemon juice would be closer to neutral (increase the most) than the pH of the lemon juice tested with other antacids. The experimenter chose Pepto-Bismol as the antacid most likely to neutralize the lemon juice because it contained the active ingredient bismuth subsalicylate, a strong stomach relief agent. The other antacids tested were Tums, Alka-Seltzer and Pepcid AC. To conduct this experiment one dosage of each antacid was put in the lemon juice. Then the experimenter tested and recorded the pH level of the mixture. Three repeated trials were performed. The results indicated that Alka-Seltzer was the most effective at neutralizing the simulated stomach acid with a mean pH of 4.75. This was probable because not only did Alka-Seltzer contain anhydrous citric acid, but also sodium bicarbonate. Pepcid AC was the least effective with a mean pH of 2.75. The data did not support the research hypothesis that if Pepto-Bismol was used, then the pH of the lemon juice would increase the most.

The Effect of Laundry Detergents on Plants' Health

Elizabeth McCoy, Tuckahoe Middle School

Many people are concerned about what the cleaning products they use in their homes are doing to the environment, such as polluting and killing plants. In this experiment, the experimenter wanted to find out which kind of laundry detergent was the worst for the environment in terms of how tall the plants grew and the leaf color. There are many natural and organic products out there, but the experimenter wanted to determine if they were actually better for the Earth, as it is easy for consumers to believe. While doing research, the experimenter found that the label "natural" actually does not mean anything. The label "organic" only means something if the packaging has the U.S. Department of Agriculture's "Certified Organic" logo on it. This logo means that the ingredients were grown without synthetic fertilizers or pesticides. The organic detergent used did have this logo on the packaging. Regular (commercial-brand, normal detergent), natural, and organic detergents were tested. The hypothesis was: If natural, organic and regular detergents are mixed with water and used to water plants then the regular detergent will have the worst effect on the plants' health. Three trials were run, with four plants in each trial. The dependent variables were the heights of the plants and the colors of the leaves. After analyzing the data, it was concluded that the hypothesis was supported. Both the regular detergent (Tide) and the natural detergent (Mrs. Meyer's) caused the leaves to become darker and shrivel up, but it took fewer applications of detergent for the Tide to harm the plants.

What is the Effect of Different Types of Nails on the Amount of Rust?

William Montgomery, Thomas Jefferson Middle School

When building an outdoor structure, it was important to choose the right materials, including the right type of nail. It was believed that different types of nails rusted more than others. It was important to know this so that the nail that will keep the structures strong for a longer amount of time is chosen. The experiment tested four types of nails to see how much each nail rusted in a solution of water and vinegar. The four types of nails used were common nails, painted common nails, galvanized nails, and electric galvanized nails. The nails were soaked in a vinegar and water solution until the liquid evaporated. Photographs were taken daily to document the amount of rust. Using the Likert scale, rust was observed on the nails and the data was recorded. The results from the data showed that using a Likert scale of 0 to 5, the common nail rusted the most with a value of 4 and the painted common nail rusted the least with a value of 1.25. The galvanized nail had a value of 1.5 and the electric galvanized nail had a value of 3. Based on the results of this experiment, the best nail to use for an outdoor structure was a painted common nail. The nail to avoid using for an outside structure was the common nail.

The Effect of Colored Insulation on Solar Power Production

Victor Mukora, Tuckahoe Middle School

It is not unusual to see countless efforts by man to produce power without using fossil fuels such as oil, natural gas, coal, etc. One very promising method is solar power. It would be excellent if the cost of solar production was lowered to make renewable energy more efficient. If solar production was lowered, then more and more people would have access to clean and renewable energy. That being accomplished, fossil fuel emissions (CO₂) would be lowered substantially. If solar power was changed to better increase the power-efficiency of the cells, old methods of producing electric power (oil, gas, fossil fuels, etc.) would be reduced due to a large extent. In comparison to solar power, fossil fuels would be used less due to their low efficiency, and high damage to the natural world, (higher natural disasters, oil spills, etc.) thus making solar fuel more favorable. In effect, causing a significant decrease in carbon emissions (CO₂), ridding the air of unnecessary pollution. With reduced carbon emissions, solar power would be more open and available to people in low-income and untouched areas. Could a method be used to increase the productivity of solar panels? To accomplish this task, the solar insulation was changed to the color which produced solar power the best. What was this specific color? That is what this experiment was trying to accomplish. The experiment tested which level of the IV (Independent Variable) would best produce the most solar power. The IV levels are red, white, black and the control of the experiment was no color. The results were numerically in value and the results favored my hypothesis. The hypothesis for the experiment was that if the color of the solar insulation was changed to black, it would produce the most power. Black would produce the best results, due to its absorption of heat and light. Solar panels with black insulation got the highest mean average of 0.283 (DC Voltage), versus 0.066 (DC Voltage) for no color. Black produced the best results overall.

The Effect of Different Liquids on the Amount of Voltages Produced

Shreya Murali, George H. Moody Middle School

Batteries are the heaviest, costliest, and least eco-friendly components of electronic devices. They are used in toys, games, electronic devices, and many more. The purpose of this project was to determine the effect of soda, orange juice, water, and detergent on the amount of voltages produced. The hypothesis was that soda would produce the most volts. The battery was created by placing a strip of copper and aluminum inside the plastic container. This was done to each of the four liquids ten times. According to the results, the soda produced the greatest amount of volts; detergent was second highest; orange juice was third; and finally water (control) was the least. The soda average for soda was 0.33 volts. The detergent was 0.241 volts. The orange juice was 0.11 volts. The water was 0.73 volts. Therefore, the data has supported the hypothesis made by the experimenter.

The Effect of Different Types of Drinks on Electrolytes Produced

Patrick Murphy, George H. Moody Middle School

Athletes and other people who commonly partake in physical activity need to make sure they are hydrating themselves correctly. Different drinks produce more electrolytes than others, and those are the drinks that should be used in physical activity. It is important for everyone to go through proper health education to know how to control what to drink. The purpose of this project was to find out whether Powerade, Gatorade, orange juice, or water would produce the most electrolytes in order for athletes to see what they should be drinking to stay hydrated. The hypothesis stated that if the conductance of each drink was tested ten times, then Powerade would produce the most electrolytes, or have the highest conductance. A circuit was made using a multimeter with a DCA 200 milliamp setting, alligator clips, copper wires, and a straw. The straw was placed into the drink, sending a reading along both copper wires all the way to the multimeter, which calculated milliamps. The milliamps were then converted to amps, which showed the conductance, and a higher conductance means more electrolytes. The results indicated that Powerade had the highest mean conductance (0.029 amps) than Gatorade, orange juice, and water. Water had the lowest mean conductance (0.002 amps). Based on the results, drinks with a wider variety of electrolytes produce more electrolytes than those who don't contain any or focus mainly on one. There may be other drinks that have more electrolytes than Powerade, but a good improvement would be to create a unique solution that is heavy in multiple electrolytes and see how that compares to Powerade. No conclusion that Powerade is the best drink for electrolyte replenishment can be made yet due to many other drinks that are used to hydrate athletes or other people who are participating in physically demanding activities.

The Effect of Different Sodas on Tooth Decay

Quinn Murphy, Tuckahoe Middle School

In the world today, sodas are a very widely consumed substance. People drink soda in large quantities multiple times a day. In this experiment, the experimenter will test different sodas to see which soda is the worst for teeth. These results will educate people on how bad the sodas they drink everyday are for their teeth. In this experiment, chalk was used to represent a tooth. The sodas used were Pepsi, Coke, Sprite, along with water, the control. The independent variable was the type of soda. The dependent variable was how much damage was caused to the piece of chalk. The hypothesis was if different sodas are used, then Coke will cause the most damage to the piece of chalk. To conduct this experiment, cups with 355 ml of each type of soda were used, and then a piece of chalk was placed into each cup. Observations were made throughout the experiment. After 24 days, the observations were made to see which soda had caused the most damage to the chalk. The results of this experiment did not support the hypothesis made. Even though Coke and Pepsi had similar results, Pepsi had the biggest effect on the chalk. The water and Sprite did not cause much damage to the chalk.

Chemical Science C

First Place

Does Anthocyanin Really Cause Carrots to Turn Green?

Nathaniel Sperry, Mary Ellen Henderson Middle School

Last year, it was determined that carrot color was related to the amount of baking soda in carrot cake. Varying the baking soda amount likely affected the pH level of the cake, and last year's project concluded with the formation of this year's hypothesis: If a color change was observed in carrots, then it reflects both a change in the color of a carrot pigment called "anthocyanin" and a change in pH. A series of experiments was performed to try to support the hypothesis. The first experiment measured the pH of the batter and baked cake. The results showed batter pH 7.8 and baked cake pH 10.1 in cakes with baking soda and batter pH 6.7, baked cakes pH 7.3 in cakes without baking soda. The second experiment compared the color spectrum of purple carrot juice to red cabbage juice (an anthocyanin-based pH indicator) in a range of pH solutions. Purple carrots were used because they contain many times the amount of anthocyanin of orange carrots. Purple carrot juice showed a color spectrum similar to red cabbage juice's spectrum. Most importantly, the purple carrot juice at pH 11-11.5 was greenish in color, just like the red cabbage indicator. The third experiment looked at the color of purple and orange carrots in baked cakes. In cakes with baking soda, all the purple carrots turned a greenish-black color after baking, whereas in the cake without baking soda, the carrots stayed their original purple color. The hypothesis was supported because the pH of the baked cake with baking soda was in the 10-11.5 range, and the pH at which purple carrot anthocyanin extract turns green was in the 11-11.5 range, so most likely the anthocyanin in the carrots in the cake with baking soda should and did turn green when it was baked.

Second Place

The Effect of Sugar on Characteristics of Sugar Cookies

Catherine Nelli, Tuckahoe Middle School

The hypothesis for this experiment was if different sugars (granulated, Splenda, Stevia, and sugar in the raw) were used to bake sugar cookies, then the cookie baked with granulated sugar would have the best smell, appearance, and texture. The experimenter used a chocolate chip cookie recipe because sugar cookies are generally very hard and thin. Many bakers, culinary chefs, and weight watchers alike enjoy cookies, but strive to produce a healthier, better tasting, and more appealing cookie. This experiment tested which level of the independent variable scored the highest grades for appearance, texture, and smell. There were three trials run for each level of the independent variable, and nine sugar cookies were tested in each trial. There were three granulated sugar cookies, three Splenda cookies, three Stevia cookies, and three sugar in the raw cookies tested in each trial. All cookies were judged by three judges on grading scale sheets. After recording and averaging all scores, the hypothesis was not supported. The cookies baked with granulated sugar, on a scale from one to five, received an average score of 4.1 in appearance, 4.6 in texture, and 4.0 in smell. The cookies baked with Splenda, on a scale from one to five, received an average score of 3.3 in appearance, 2.6 in texture, and 3.4 in smell. The cookies baked with Stevia, on a scale from one to five, received an average score of 3.0 in appearance, 3.1 in texture, and 3.3 in smell. The cookies baked with sugar in the raw, on a scale from one to five, received an average score of 4.7 in appearance, 4.8 in texture, and 3.3 in smell. Cookies baked with sugar in the raw scored the highest, on average, in appearance and texture, while granulated sugar scored the highest, on average, in smell.

Third Place

Which Electrolyte Produces the Highest Rate of Hydrogen Production during Electrolysis?

Audra White, Scott Memorial Middle School

The United States produces about 9 million metric tons of hydrogen every year. Its uses vary from making ammonia to being an alternative source of energy. Electrolysis occurs when current is passed through an electrolyte creating a chemical reaction. It produces hydrogen by splitting water (H_2O) molecules. This experiment was designed to determine which of three electrolytes would produce hydrogen at the fastest rate during electrolysis. The electrolytes chosen were sodium chloride (non-iodized salt), sodium bicarbonate (baking soda), and magnesium sulfate (Epsom salt). The hypothesis made was that if the concentration of sodium chloride, sodium bicarbonate, and magnesium sulfate were increased during electrolysis, then the rate of hydrogen production would increase as well, with sodium chloride resulting in the highest rate of hydrogen production. Ninety-one electrolysis trials were run (28 per electrolyte and 7 of control). Each electrolyte had 7 trials performed with 2 g, 4 g, 6 g, and 8 g to show consistency. The results showed that the sodium chloride had the fastest hydrogen production rate with an average time of 44.10 minutes for the 2 g trials, 24.15 minutes for the 4 g trials, 20.32 minutes for the 6 g trials, and 13.72 minutes for the 8 g trials. The overall average times per electrolyte were 25.57 minutes for sodium chloride, 59.15 minutes for sodium bicarbonate, and 84.35 minutes for magnesium sulfate. These results supported the hypothesis that increasing the concentration of the electrolyte increased the hydrogen production, with sodium chloride having the highest rate of hydrogen production. It was also observed through the analysis of the data from the multimeters that as the amps increased, the Ohms decreased confirming Ohm's Law in all trials.

Honorable Mention

The Effect of Drink Type on Electrolyte Content

Franklin Pugh, Tuckahoe Middle School

The objective of this experiment was to test levels of electrolytes in common beverages. The hypothesis for the experiment was: of the six types of beverages tested (A [tap water], B [orange juice], C [grapefruit juice], D [grape Juice], E [apple juice], and F [Orange Gatorade]); orange juice would have the highest levels of electrolytes. The methods used during the entire experiment were to insert a conductance sensor made of plastic straw and copper wire into the desired beverage, and measure the conductivity using a digital multimeter. The amount of conductivity was used to measure the amount of electrolytes in the beverage. The experimenter used a digital multimeter connected to a circuit, and the conductivity appeared on the screen of the digital multimeter. It was found that tap water had the most electrolytes, with an average conductivity of 177.8. Gatorade had a conductance of exactly 177.0 for each of the three trials. To replenish the most amounts of electrolytes that an athlete sweats out during workout, the experimenter concluded that tap water should be the athletes chosen beverage. This was found because the tap water had the highest level of conductivity, therefore having the highest amount of electrolytes. The experimenter notes, however, that the levels of electrolytes across beverages are very close, so there may be little practical differences between them.

The Effect of Leavening Agents on the Size of Muffins

Jillian Neri, Gunston Middle School

Nothing was quite as appetizing as a huge blueberry muffin. Having always enjoyed baking, it was often wondered what the difference was between baking soda and baking powder. The purpose of this investigation was to find out which three leavening agents produced the largest muffin. The three leavening agents used were baking soda, baking powder, and yeast. These leavening agents were chosen because they were the most common leavening agents. The hypothesis of the experiment was that baking powder would produce the largest muffin because it included baking powder and various other acids. The researcher found a recipe that had baking powder as the only leavening agent. This was

decided as the control in the experiment. The researcher then replaced the baking powder with the same amount of baking soda and yeast to create three different batches of muffins. Careful attention was paid to measurement of the ingredients. All batches of muffins were cooked for 24 minutes at 190 °C. All batches were cooled and measured. The data did not support the hypothesis and showed that baking soda was the most effective leavening agent. It also showed that yeast was the least effective leavening agent for muffins.

The Effect of Cooking Methods on Ascorbic Acid Content in Bell Peppers

Sarah Newman, George H. Moody Middle School

Ascorbic acid, or vitamin C, is an essential nutrient for a high reacting and functioning body. Bell peppers contain a high amount of vitamin C, making it a vital vegetable for human consumption. Cooking different foods creates a new variety of textures and tastes to add to foods being fried, baked, and boiled. An increase in temperature can change the ascorbic acid content by manipulating the properties inside of the food, causing a change in the vitamin level. The purpose of the experiment was to see if boiled, baked, stir-fried, or plain peppers lost the most vitamin C after being tested. The hypothesis of this experiment was if stir-fried, microwaved, roasted, and raw peppers were tested using an iodine solution then the raw peppers would have the highest content of vitamin C. The peppers were tested using an iodine-cornstarch solution. Each pepper trial was individually blended and placed in separate test tubes to be observed. The colors were record and used to compare the difference in vitamin C levels. The results of the experiment were that the hypothesis was proven because the raw peppers had the highest content of vitamin C after being tested. This was followed by the roasted, microwaved, and stir-fried in order from most to least of the vitamin. Concluding the experiment, it was supported that cooking bell peppers changes the vitamin C content. Each pepper group changed because of some sort of exposing to high temperatures, which decreases the amount of vitamin C found in the substance.

The Effect of Different Antacids on Neutralization of Acids

Matthew Oley, Tuckahoe Middle School

High acidic content in food has become one of the leading issues in pursuing a healthy life. It leads to heartburn, indigestion, heart disease, and a shorter life expectancy. Good food choices keep the body healthy and help protect a person from contracting any diseases. The objective of this study was to determine the effectiveness and acid eliminating power of four different antacids. The hypothesis in this experiment was: if different antacid brands were used, then the Alka-Seltzer brand would work the best and most effectively neutralize the acidity. The dependent variable in this experiment was the change of pH. The control was the lack of antacid. The degree of acid removing capability was measured based on a pH scale. In this experiment, various acidic liquids were used to represent different acidic food. The various antacid products were applied in pairs of two into each liquid for 30 minutes and the results were recorded and the data was analyzed accordingly. Among the results and data analysis procedures and values, the average and standard deviations of the different trials were recorded. The most effective antacid brand was Alka-Seltzer, and the other three levels of the independent variable (IV) had very minimal change on the pH. Alka-Seltzer had the highest average value change in pH, therefore had the greatest neutralization power among the various products tested. The higher the pH number, the more acid was neutralized. In conclusion, the Alka-Seltzer changed the pH by a whole number, which was significantly higher than any other level of the IV.

The Effect of Different Substances on Black Ink

Aida Pehlic, George H. Moody Middle School

Scientists noticed that black ink isn't really black; it is a mixture of purples and blues. To find that out, the scientists had to preform experiments using harsh chemicals, or common household substances. The purpose of this experiment was to find out which household item had the most effect on black ink. Fifteen paper towel strips were placed on a wood cutting board with a 4-centimeter line of black sharpie and then placed into the one cup of the substance until the smear was completely spread out, and then measured in centimeters to see if the line increased in length. Results show that water had little to no effect, vinegar had some effect, nail polish remover had the most effect, and oil had no effect on the ink. The data supported the hypothesis that if the use of a substance affects the ink, then the ink will have a different

reaction for every substance used. Based on the data, the experiment concluded with nail polish removers being the harshest substance to the sharpie line.

Effect of Type of Flour on Cupcake Height

Sophie Roberts, Tuckahoe Middle School

The hypothesis for this experiment was if the type of flour is changed in a recipe for vanilla cupcakes, then all-purpose flour will make the cupcake the tallest. More and more bakeries are moving towards cupcakes because they are a better portion than large cake slices. Most cupcake bakeries want their cupcakes to look better than any of their competitions. The bakers want them taller and rounder. This experiment tested which level of the independent variable would make the cupcake the tallest. There were six total trials, and six cupcakes were tested in each trial. There were six cupcakes that were baked with all-purpose flour, six with Spelt flour, six with bread flour, six with unbleached cake flour, six with self-rising flour, and six with whole wheat flour. The final measurements were calculated and recorded. After averaging out all of the cupcake heights, the hypothesis was supported. The cupcakes baked with all-purpose flour rose to an average height of 6.43 cm opposed to the cupcakes baked with the other flours which rose to an average height of between 5.42 cm and 6.2 cm. The Spelt flour cupcakes rose to an average height of 5.48 cm. The bread flour cupcakes rose to an average height of 6.2 cm. The unbleached cake flour cupcakes rose to an average height of 6.02 cm. The self-rising flour cupcakes rose to an average height of 5.57 cm. The whole wheat flour cupcakes rose to an average height of 5.42 cm.

What Is the Effect of Different Brands of Multivitamins on Dissolution Time?

Eli Sampson, Kenmore Middle School

People take multivitamins to stay healthy. Because multivitamins come in pill form, dissolution of the multivitamin is key to getting the supplements into the body. The purpose of the experiment was to figure out which of the most popular multivitamins would dissolve the fastest. It was hypothesized that all multivitamins tested would dissolve at the same rate and that they all would stay at relatively the same weight. The scientist first placed five brands of multivitamins in to five cups for 15 minutes. After 15 minutes the scientist removed the multivitamins and weighed them. The procedure was then done for 30 minutes, 45 minutes, and one hour. The scientist's results were that Costco Kirkland brand dissolved the fastest; One-a-Day brand weighed the most in the end and the beginning, and also had the slowest dissolution rate. The hypothesis was rejected.

The Effect of Beverages on Level of Penny Corrosion

Jakob Sanne, Tuckahoe Middle School

This experiment was on the effect of beverages on corrosion of pennies. It was chosen because many people have gotten tooth corrosion because of the acidity levels in these beverages. This was created to find out which household beverages would corrode teeth the most. These household beverages included many that were drunk daily and some that were used daily, but not drunk. They were water, Coke, lemon juice, coffee, orange juice, and apple juice. The hypothesis was if different beverages were used to corrode a penny, then lemon juice would corrode the penny the most. This hypothesis was correct and lemon juice did corrode the penny the most. The independent variable was the beverages and the dependent variable was the amount corroded. The beverages were poured into cups and had pennies placed in them. These pennies would be the "teeth" of this experiment as they are like teeth, with a hard outside and soft inside. These pennies would determine which beverage corroded teeth the most over a 15-day time period. Lemon juice corroded the penny the most, making it the worst to use out of the six beverages. Coffee and Coke also were scored high, making them bad for your teeth. Stereotypically, the beverages that are bad for you will corrode your teeth the most, while beverages like orange juice and apple juice will still corrode your teeth, but nowhere near as fast as other beverages.

The Effect of Drinks on Staining of Eggs

Abigail Sebold, Tuckahoe Middle School

The question of this experiment was: do different drinks stain teeth over time? In that experiment, 27 hardboiled eggs were put in 118 milliliters of different drinks (water for the control, Coca-Cola/Coke, Folgers's Coffee, Twining's English Breakfast Tea, Sprite, Orange Fanta, Mountain Dew, and Minute Maid Pink Lemonade) each with three trials, and two repeated trials. After the eggs were submerged in the beverage for a week, they were removed and rated for the amount of stain. The hypothesis was if an egg was put in different drinks (Coca-Cola, Pepsi, Orange Fanta, Mountain Dew, Folgers's Coffee, Twining's English Breakfast Tea, Sprite, Minute Maid Pink Lemonade, and water), then Coca-Cola will stain the teeth the most. In the end the hypothesis was supported, with Coca-Cola averaging to 11.33 on the 14 point scale, just above Pepsi with a score of 11. This experiment has showed that water was the best for your teeth with a score of one. This experiment is helpful to the real world because it lets people know which drinks to avoid. It will also help people keep their teeth white.

The Effect of pH on Amount of Lead Extracted from Lead Sinkers

Shreya Senthil, George H. Moody Middle School

Lead is a chemical element in the carbon group with the symbol Pb and with an atomic number of 82. If ingested, lead can cause a variety of health effects like, behavioral problems, damages to the nervous system, seizures, and brain disorders. The pH scale measures how acidic or basic a substance is. It ranges from 0 to 14. A pH less than 7 is, acidic. If it's greater than 7, it's basic. Pure water is neutral, so it has a pH of 7. The purpose of this experiment was to determine the effect of pH on amount of lead extracted from lead sinkers. The researched hypothesis was if the pH's 3, 5, 7, 11, and 13 are used then the liquid with the pH of 3 will have the most amount of lead extracted from lead sinkers. Ten disposable cups were set up on a table and labeled: trial number one, trial number two, and so on up until ten. They were then filled up with the pH of 7 (control), about 1/3 from the bottom. One lead sinker was placed in each cup in order from 1 to 10. It was then allowed to soak for 12 hours. Once the 12 hours are complete, from each cup the Coke was poured until the ¼ marking in each one of the test tubes. Then, four drops were dropped in the plastic test tube with the indicator solution that was given in the lead testing kit. The results indicated that, the pH with the smallest value had the most amount of lead extracted. The average of the most amount of lead extracted was 4.8 ppm. Before it can be concluded, the experiment and research prove that when a solution having a pH of greater than 7 is filtered for lead, the concentration of lead is approximately 1-3 ppm. That's because the lead-II ions were observed to oxidize to lead-IV oxide until a minimum concentration was reached. The pH seems to be the controlling factors of this reaction. The oxidation of lead-II ions occurred only at pH values above 7.

Effect of Various Processes on Oil Removal from Water

Vivian Slye, Tuckahoe Middle School

Ever since oil started polluting the Earth's waterways, scientists have worked to discover ways to remove oil from water more efficiently. The purpose of the experiment was to find which method (using mushrooms, sphagnum moss, cotton balls, a filter pump, a skimmer net, marshmallows, or pantyhose and hair) removed the most oil. It was hypothesized that if all the different ways to remove oil from distilled water are tested, then the filter pump removed the most oil. The research was performed in a residential kitchen. The experiment was completed four times after the first trial, for a total of five trials per level of the independent variable. The data from the trials was quantitative, and was measured using a large graduated cylinder. Each experiment began when 100 ml of coconut oil was poured into 500 ml of distilled water in a glass container. The independent variable consisted of the materials (mushrooms, sphagnum moss, cotton balls, a pump, a skimmer, marshmallows, and pantyhose and hair), and the dependent variable was the amount of oil that was removed. The control was the skimmer net. The hypothesis was not supported, because it was found that the skimmer net had the highest average (96.6 ml). The pump had the lowest average (0 ml) because the filter in the pump was so fine that it mixed the oil with the water so that the oil became emulsified and the water and oil would never separate. This information could be used by scientists and those who are working on ridding the Earth's waterways of oil. If the workers collect the oil using a skimmer, then they will be able to remove the oil quicker.

The Effect of the Type of Fuel on the Amount of Energy Released

Roby Straus, Sabot at Stony Point

Coal is not a renewable resource, however, wood is. Coal is also less environmentally friendly than wood. Renewable resources like solar power, wind power and hydropower are more environmentally friendly than wood, but they require more upfront costs and require special environments to work well. This experiment was designed to test the energy produced by different types of fuel. The three fuels that were tested were oak wood, pinewood and coal. I had two hypotheses for this experiment; the first one was that coal would have more joules per gram than wood. The hypothesis for this experiment was that coal would produce more joules per gram than either wood. The average values for the different types for each fuel in this experiment were: coal (11,200 joules per gram), oak wood (2270 joules per gram) and pinewood (3770 joules per gram). The data from the experiment shows that, on average, coal has more joules per gram than pine wood or oak wood, and on average pinewood has more joules per gram than oak wood. The unpaired t-test comparing oak wood to pinewood was $T(18) = 0.184$, $p = 0.99$, the t-test comparing oak to coal is $T(18) = 5.74$, $p = 0.0001$ and the t-test for pine to coal is $T(18) = 6.14$, $p = 0.0001$. The null hypothesis is that the fuel does not impact joules per gram. The t-tests comparing coal and both woods show that the probability that coal and either wood's joules per gram is not different is 0.0001, therefore the hypothesis that coal has more joules per gram than wood is supported.

The Effect of Common Beverages on Eggshells (a Proxy for Teeth)

Jonathan Tyler, George H. Moody Middle School

The main purpose of this experiment was to find out which common beverage in the selection was the best for human teeth. Other purposes included comparing diet and regular beverages, testing to see if tea helps human teeth, and to determine if light beverages were worse than dark beverages for human teeth. Since teeth could not be obtained, eggshells were used as a proxy. The experiment was strengthened when it was discovered through multiple sources that sodas were bad for your teeth. Also articles were found describing which beverages were worse. The articles shaped the experiment to find out which articles were right. The hypothesis was that if eggshells were exposed to lighter sodas, then the eggshells will lose more mass than if they were exposed to darker sodas. This was to accommodate one of the purposes for the experiment. The experiment was conducted by recording the mass of each eggshell, putting the eggshells in different groups, and putting them in cups labeled with the group number and trial number. Then the cups were filled with different drinks according to the groups. After a week, the ending mass was recorded for the eggshells. The control was water, the IV was the type of beverage, and the DV was the percentage of mass loss. When the data was recorded, lemonade had the least mass loss percentage and apple juice had the most mass loss percentage. A bar graph shows the comparison between the beverages. There is a data table with the mass loss percentage for each beverage. Overall, the darker beverages had less mass loss than the lighter beverages. The tea also did well as it had the second least mass loss, the lemonade which showed the least mass loss may have lost more eggshell and added back mass with the deposits.

The Effect of Folgers Coffee, Lipton Tea, Coca-Cola and Deer Park Water on How It Affects Teeth

Vida Vousoghian, Swanson Middle School

The purpose of this project is to find out how different common beverages (Folgers coffee, Coca-Cola, Lipton Tea, and Deer Park water as a control) stain teeth. In this project, the teeth are represented by hollow eggshells. The eggshells are placed in the beverage and left there for one day. The next day, the colors have changed, and are compared on an egg color scale. Whichever changed the most in color means that that beverage would cause the most stains on teeth. This project is very unique and practical. Everyone wants to know if the myths about different common beverages staining teeth are true, and which beverages stain teeth more, and in this project, all of that is answered. The hypothesis was that if all different beverages are tested, that Folgers coffee will result in the most difference in color. In this project, Folgers coffee resulted in the most stainage, next was Coca-Cola, after that was Lipton tea, and last was Deer Park water. The approval of the hypothesis could indicate that many people are aware of coffee staining the teeth, but most just don't find it a big deal. To conclude, this project opens the eyes of many to show how common beverages that may put morning smiles on faces could be making those smiles less brilliant.

Effect of Type of Light on Fading of Ink

Caroline Wall, Tuckahoe Middle School

The objective behind this scientific investigation was to find out which types of light fades ink the most. By discovering the answer to this question, the experimenter would obtain the knowledge that could be provided to museums and other historical places so that they know how to best display special documents printed in the 21st century, if they do not know already. But most of all, this information can help ordinary people know the best way to keep important papers in their own homes. In order to obtain these answers, a scientific experiment was conducted. The independent variable was the type of light used, levels being incandescent bulb, fluorescent bulb, halogen bulb, LED bulb, sunlight, and no light (control). The dependent variable was how much ink faded. It was hypothesized, based on prior research, that if the light source was changed, then the sunlight would cause the ink to fade the most. This experiment was tested by placing a paper printed with a black square of ink on it under each specific light source. As for no light, the paper was put into a closet. After one week, results were collected and organized into a data table. This data was based on a previously made Likert scale. This process was repeated twice for a total of three trials. After organizing the data, it was found that the sunlight faded the ink the most, and the hypothesis was supported. In all three trials, the ink under the sunlight faded one shade lighter than the original color. However, even though there is research to support this conclusion, none of the other light sources faded the ink at all, making the experimenter believe that one week was not long enough to gather conclusive results. The experimenter would make this change as well as other changes to the experiment before testing again to find clearer, more reliable results and answer the original problem question.

The Effect of Different Electricity Voltage in Salt Water on the pH Level of the Salt Water

Jessica Wen, George H. Moody Middle School

Everything and everyone needs water to survive. This includes humans, but humans need purified water. They can't just drink water from the ocean because of the salt and harmful wastes. Many harmful wastes can change the pH of water to become either too acidic or basic. The purpose of this experiment was to determine if different voltages of electricity can affect the pH level of salt water. It was believed that if the salt water was exposed to a higher voltage of electricity, then the pH would be more acidic. To test this hypothesis, 35 grams of salt and one liter of water was mixed in a bowl. Next, the electricity source was made by taking two wires, 30 centimeters in size, and cutting off one inch of the rubber insulator with wire cutters on both ends of each piece of wire. One end of each wire was then connected to opposite terminals of the battery and taped on with electrical tape. When testing with other voltages, more 1.5 volt batteries were taped together. The negative side of one battery was connected to the positive side of another battery and taped together. Then, 1/4 cup of the salt water mixture was put into a plastic cup, and then the electricity source was put in. After five minutes, the wires were removed and the pH was measured. Ten trials were done for the control, which was just the regular salt water, and 10 trials were done for each level of the independent variable, which were 1.5, 3, 4.5, and 6 volts of electricity. Results show that the higher the voltage of electricity, the more basic the salt water became. Based on this, it was concluded that the hypothesis was incorrect.

Effect of Different Kinds of Fabric on How Well They Hold Dye

Anna Williams, Thomas Jefferson Middle School

Tie-dying is a craft that has been practiced for years. This project examined different fabrics and how well they held dye. The fabrics for the experiment were silk, cotton, wool, and polyester. The goal of the project was to find the effect of different fabrics on how well they held dyes. The hypothesis for this project stated that if different fabrics were tested, then cotton would hold the dye the best. The four fabrics were first soaked in vinegar to make the dye stay. A natural blueberry dye was made. The fabric was soaked in the dye. Lastly, the fabric sat on a surface for 24 hours and then the saturation of the fabric was measured. The silk had a saturation of 61. The cotton had a 52, and the wool and polyester had a saturation of 30 and 29.9. The results did not support the hypothesis. The experiment demonstrated that silk holds dye better than wool, cotton, and polyester.

Ecology and Earth Sciences A

First Place

The Effects of Different Types of Treated Greywater on the Growth of *Pisum sativum*

Anupama Jayaraman, Robert Frost Middle School

Climate change can affect access to fresh water due to sea level rise, flooding, runoff, and drought. Water used for land irrigation and food production puts a large amount of pressure on the global fresh water supply. Greywater can be used to partially offset the increased demands on fresh water for agricultural purposes. The objective of this study is to determine the effects of different types of treated and untreated greywater on the growth of *Pisum sativum* (pea plant). For this study, simulated greywater was prepared using shampoo and laundry detergent. The greywater was treated using sand-filters and cloth-filters, made for this study, using recycled materials. The effects of treated and untreated greywater on the growth of 21 Alaskan and 21 Green Arrow Pea plants were examined, relative to tap water, which was used as the control. It was hypothesized that if sand filter-treated shampoo greywater was substituted for tap water, its plant growth would be equal to that of tap water. The study was conducted for a 20-day period. The study results were analyzed using absolute and relative daily growth values, statistics, and graphs. Microsoft Excel was used for recording the raw data, calculating the mean, standard deviation, and coefficient of variation, and for developing line and bar graphs. In this study, sand filter-treated detergent greywater outperformed the controls. The hypothesis for this experiment was not supported by the data. Instead, the results of the study showed that plants watered by sand filter-treated detergent greywater performed the best, and plants watered by unfiltered shampoo greywater performed the worst.

Second Place

The Effect of Nanofilters and Other Types of Water Filtration Methods on Water Purity

Aditya Kannothe, George H. Moody Middle School

Clean water is a critical resource that some people take for granted. However, in third-world countries in Asia and Africa, safe drinking water is incredibly hard to come by. Most of the water that is available in these countries is dirty and contaminated with metals and minerals. These impurities can cause diseases such as cancer and heart disease. The purpose of this experiment was to study the effect of different types of water filters on water purity. Three water filtration systems; a sand filter, a composite nanomembrane filter, and a granular activated carbon (GAC) filter, were tested. The hypothesis was that the composite nanomembrane filtration system would purify water the most effectively. Before the experiment began, 30 grams of fertilizer was added to 23 liters of Chickahominy river water to simulate harmful Total Dissolved Solids (TDS) present in polluted rivers. The procedure began by testing the TDS of the contaminated river water using a TDS meter. A TDS level of 386 ppm was recorded for the control. The next step was to pour 178 ml of river water into the sand filter. After this the water was filtered, the filter was removed from the beaker, and the TDS was tested again. This exact procedure was repeated five times and data recorded after each trial. The same procedure was then repeated five times each for the composite nanomembrane filter and GAC filter, respectively. The results showed that the sand filter removed more TDS (246.8 ppm) than either the composite nanomembrane (288.8 ppm) or GAC (294.8 ppm) filter. This finding rejects the research hypothesis. The poor performance of the composite filter could be because it was a commercial product that advertises bacteria and pathogen filtration rather than TDS filtration. Further research can be done to study the efficiency of these filters in removing both TDS and bacteria/pathogens.

Third Place

The Effect of Different Materials on the Rate of Biodegradability

Minoti Kishor, George H. Moody Middle School

In today's society, the issue of rapidly filling landfills with the large amount of non-biodegradable waste that households produce is huge. It is important to find alternate materials to plastic and paper that are easily biodegradable and compostable to help reduce the waste that ends up in landfills. A variety of materials representative of common household waste was chosen for the experiment. Both man-made materials such as a plastic spoon and naturally occurring material such as a leaf were chosen. Materials that claimed to be biodegradable such as cartons and biodegradable plastic were also chosen to test the validity of their claim. The purpose of this experiment was to determine the effect of the type of material on its rate of biodegradability. A compost bin was constructed and the materials were all cut to be the same size. Each material was weighed and then placed in the compost bin, and the weight was measured every two weeks to determine decomposition. The leaf biodegraded the most in the shortest amount of time with an overall weight loss of 48% in ten weeks. The plastic spoon was the material which biodegraded the least with an overall percentage weight loss of only 0.4% in ten weeks. Man-made biodegradable materials such as cartons showed less decomposition than expected, but showed better biodegradability than plastic and foil. The hypothesis for this experiment stated that the leaf will take the least amount of time to biodegrade. The hypothesis for the experiment was supported because the leaf biodegraded in the least amount of time compared to the other materials.

Honorable Mention

The Effect of Different Types of Sediment Compositions in an Unconfined Aquifer on Aquifer Confined Recharge

Rachel Alexander, George H. Moody Middle School

Water is an important resource that occurs in many forms and many places, including underground. Underground water is stored in naturally-occurring aquifers, of which there are two types: unconfined and confined. Depending on the type of sediment composition in an underground unconfined aquifer, the storage ability of the aquifer differs. When the water flows down, it hits a confining layer, under which lies a confined aquifer. These aquifers are slow to recharge, but contain usable water. The purpose of this experiment was to find the effect of different types of sediment compositions in an unconfined aquifer on confined aquifer recharge. Gravel, sand, silt, and hardened mud were the independent variables. Models of the underground water system were created to test this hypothesis; if silt is used to model the unconfined aquifer, then the confined aquifer will recharge the slowest. The models were built in plastic Ziploc containers, and within the models, there was always a layer of topsoil, then the unconfined aquifer, and then the confining layer. Holes were drilled at the bottom of the container to allow the water to filter into the confined aquifer which was represented by a plastic pan placed under the model. Two hundred milliliters of water was poured into each model, and five trials for each variable were conducted. The mean amount of water that filtered into the model confined aquifer for gravel was 52.8 ml; 30.6 ml for sand; 10.4 ml for silt; and 33.2 ml for hardened mud. Among other things, it was observed that the color of the water that recharged the confined aquifers in the gravel and hardened mud models was dark. These results of the experiment proved the rule that the more porous and less permeable a sediment composition is the more water it holds and the less it drains. The porosity and permeability of the materials greatly affected these results and proved the hypothesis.

Honorable Mention

The Effect of Park Location on the Amount of Ground-level Ozone

Sam Colaccino, Kenmore Middle School

The problem in this experiment is whether park location affects the amount of ground level ozone. To test the experiment, ozone test sticks were used to measure the amount of ground level ozone. Four parks from different locations in Arlington, Virginia were selected for the study. The parks were then visited five

times and tested in the same location for each test. The hypothesis was that the park closest to an interstate highway would have the highest amount of ground level ozone. However, the results of the experiment did not show this. This is most likely because in the fall and winter months, ground level ozone is at a decline because of the lack of sunlight. It is unclear why the park farthest from an interstate highway had the highest amount of ground level ozone. For further study, it is recommended that this experiment be conducted in the summer months, because higher levels of ozone are more likely to be detected than in the winter or fall months.

Honorable Mention

Composting and Heat Energy

Dylan Klapper, Thomas Jefferson Middle School

The world is facing a major energy crisis. There are not enough clean, renewable, and affordable sources of energy. However, biomass energy is a familiar one that can be harnessed in a unique way. The purpose of this experiment was to determine the effect of additional compost materials on the amount of heat energy produced by the compost. In order to conduct this experiment, four compost piles were built. Each contained a basic composting mixture of dirt, potatoes, hay, and a blend of manure and sawdust. In three of the bins, an additional ingredient; radishes, carrots, or tomatoes, was added. Each compost bin was monitored and aerated daily, and water was added each day over the course of eight days. At the end of the eight days, the heat energy produced by the compost piles was calculated. The compost pile with the carrot addition produced the most heat energy with a mean value of 5903.655 joules (J). The compost with tomatoes, radishes, and nothing added (control), produced mean heat energy amounts of -453.483 J, -1838.352 J, and -2053.931 J respectively. In conclusion, heat energy from composting can be used as an inexpensive and effective heat source, especially in developing countries. Of the test groups, compost made with carrots generated the most heat energy.

What a Load of Rubbish

Christian Autor, Mary Ellen Henderson Middle School

The question this project attempted to answer was: "Do bioreactors reduce the environmental impact of landfills by improving the efficiency of decomposition?" The hypothesis for this experiment is if a bioreactor is used in a landfill, it will speed up decomposition by circulating water and air through the garbage, thereby reducing the environmental impact of the landfill. The procedures for this experiment were to use seven empty 2-liter soda bottles to create three landfills, three bioreactors, and one control. Measurements of mass, volume, density, and temperature were taken regularly. The constants in this experiment were: the soil type, the location, and the amount of sunlight. The data showed that the bioreactors tended to lose more mass, volume, and density indicating that they make decomposition more efficient. For example, bioreactor A showed a decrease in volume of over 8 cubic inches, whereas landfill A decreased by approximately 6 cubic inches. Moreover, the mass of bioreactor A decreased by 102 grams, and the mass of landfill A decreased by only 9 grams. The results of this experiment supported the hypothesis, that if a bioreactor is used in a landfill, it will reduce the impact of a landfill on the environment because bioreactors circulate water and air through the garbage to speed up decomposition, therefore taking up less space.

Where Did All The Stars Go?

Kylee Baines, Gildersleeve Middle School

In this experiment the goal was to find out how light-pollution is affecting our night sky. The steps used to approach this problem were simple: gather the materials needed, pick a testing location, measure the surrounding lux, count some stars, average them by ten, and use a formula to receive an estimate of the number of stars visible, then repeat for each trial and location. In a fully lit area such as City Center, with a lux measurement ranging from 0.95-1.97 the most stars seen in the sky was 42, the lowest being 21. However, while testing in an area with no light at all and a lux measurement of 0.00, the number of stars

visible ranged from 749-801, a very drastic difference. In conclusion, light-pollution does in fact affect the number of stars that we see in our night sky.

The Effect of Common Household Chemicals on Gas Released during the Decomposition of Organic Waste

Aarthee Baskaran, George H. Moody Middle School

The gases released due to human-initiated activities, such as fossil fuel usage for transportation and energy production, have contributed to many environmental issues, majorly global warming. Components of above crisis from organic wastes are comparatively small, but due to its growth over recent years, this cannot be easily ignored. Furthermore, individuals can make a difference, and this study finds ways to accomplish that. The purpose of this experiment was to find the most effective, yet easily accessible household chemical to reduce to the most amount of released gases. The hypothesis stated that if water, vinegar, charcoal, and soapy water were all used, then vinegar would reduce the most released gas. This was inferred due to vinegar's acidic composition. A box of grass was sprinkled with the appropriate IV and was measured. After the allotted time, it was measured again and the decrease in container weight indicated that some resulting gas had exited the container. The data presented showed that the soapy water was the most effective in neutralizing the released gas with its average of 1.2 grams. Charcoal had an average of 2.1 g, which was the highest average. Additionally, the null hypothesis was supported with 99% confidence for vinegar vs. water and vinegar vs. charcoal. The results indicated that soapy water neutralized most of the released gas, which helped conclude that the majority of the gas was acidic. The vinegar did the second best, while the water was the control with an average of 1.8 g. Finally, the chemical that did the most poorly was charcoal, as it was considered to be neutral. It was concluded that the substances that were not neutral, were the chemicals that neutralized the most gas.

The Effect of Soil on Erodibility

Alina Batchila, Kenmore Middle School

The topic of this experiment is the erodibility of different soils. Three soil samples were gathered from different parts of Northern Virginia. The purpose of this experiment was to find out which soil would be most prone to erosion. It was hypothesized that, when tested, the soil from the Occoquan River would be least erodible. The three soils were set up in pans, and then water was poured on them to simulate rainfall. The eroded soil was then heated in the oven to evaporate the water, and the amount of soil was weighed to find out how much eroded. The soil from the Occoquan River eroded the least, with the eroded soil weighing 6 grams, while the eroded soil from the Potomac River weighed 8 grams. The eroded soil from the Shenandoah weighed 38 grams. The hypothesis was accepted.

Effect of Elevation on Height of Baked Cake

Emily Campbell, Tuckahoe Middle School

Does the elevation of a location affect the height of a baked cake? The experimenter wanted to conduct an experiment to answer this question. The independent variable was the elevation of the three ovens used to bake the cakes. The levels of the independent variable included 53.64 m located in Richmond, Virginia; 156.97 m located in Woodstock, Maryland; and 2890.03 m located in Breckenridge, Colorado. The dependent variable was the height of the baked cake. The experimenter hypothesized that if the cake is baked at the highest elevation, then its height will be the greatest. The hypothesis was proven incorrect. At 53.64 m in Richmond, Virginia, the two cakes were 2.9 and 3.1 centimeters. In Woodstock, Maryland at 156.97 m, the cakes were 3.6 and 3.8 centimeters tall. At the highest elevation in Breckenridge, Colorado at 2890.03 m, the cakes were 1.3 and 1.6 centimeters high. The experimenter concluded that the higher the elevation, the less the cake will rise. The experimenter also concluded that elevations around 156.97 are best for baking cakes because the cakes will rise higher. The experimenter found that cakes baked at higher elevations will not rise as high as cakes baked closer to sea level.

The Effect of Different Types of Henrico County Surface Soils on the Water Retention Capability

Conner Childs, George H. Moody Middle School

In 1975, soil tests were conducted in Henrico County, Virginia to create a Soil Survey. It states that for a plant to properly grow, the moisture content in soil must hold enough water in its pores to provide water to the root. Tests were conducted to see which soil holds the most water. This investigation was conducted to inform local farmers about which soil types would produce the best crop. By showing them which soil is better for plant growth, this will help them with producing an abundance of crops, and for the agricultural companies to fulfill their demand. Five different soils in the county were collected and tested on water retention capability. The hypothesis in this experiment was if silt loam soil is drained, then the drainage level (in millimeters) would be the lowest, thereby retaining the most moisture. Before, draining each soil, the construction of the soil holder was completed. A cardboard box, with two holes cut on the top to hold each categorized sample cup, was built. Then another cup labeled for drainage, was placed underneath the drilled cups above. One cup of water was poured on the compacted soil samples and the timer began for 60 minutes. The results indicated that loam soil retained the most water in the soil, only draining (on average) 135.3 ml of water. The soil retaining the least amount of water was sandy loam with a drainage amount of 181 mE. The data collected did not support the hypothesis of if silt loam soil was drained, and then the drainage level would be the least. Based on the average drainage levels, loam soil (control) would provide the most water to the plant; however further studies could be completed by growing a plant from each category to test which soil grows the healthiest plant.

The Effect of Acid Rain on Plant Growth

Rheanna Collins and Myanh Le, Hines Middle School

This experiment was conducted to see how acid rain can affect the growth of a pea plant. With the air pollution that has been created, and in connection with the water cycle, it must have an effect on plants. Acid rain can also be caused by natural sources too, such as erupting volcanoes. The hypothesis for the experiment was if one plant was watered with lemon juice (acid rain) and the other with plain water, then the acid rain plant will grow slower because the lemon juice will destroy the nutrients the plant needs. Twenty pea seeds were planted in the twenty cups provided. Each cup was then watered everyday with 10 ml of regular water. After each plant had grown at least one leaf, half of the peas were watered with 10 ml of lemon juice and 236 ml of water daily, and the other half with plain water. This was repeated daily for the next 24 days, along with measuring the plants. Every couple days, the plants would have their pictures taken to accompany the data. The data showed that acid rain does have an effect on plants. Most of the data collected showed that the pea plants that received acid rain ended up being shorter than the regular water pea plants. The plants watered with lemon juice grew an average of 9 cm, and the plants watered with regular water grew an average of 10 cm. During the experimentation, the acid rain plant was always 2 cm shorter than the plain water plant. In addition to being shorter, the acid rain plants' soil was more dry and flaky than that of the regular water plant. In the end, the hypothesis was supported by the data. The plant watered with lemon juice grew slower than the plants that were given regular water.

The Effect of Runoff Content on Nitrate Levels in Pond Water

Michael Haddad, George H. Moody Middle School

Nitrates (NO_3) are the salts of nitric acid, a very acidic compound that contains nitrogen. Nitrates are an essential nutrient for plants, which is the reason NO_3 is one of the principle ingredients in fertilizer. The problem with fertilizer in large amounts is that it gets into the runoff and eventually gets into large bodies of water. When the excess nitrogen is in a large, still body of water, such as the Gulf of Mexico or Chesapeake Bay, it can spark an algae bloom. An algae bloom blocks sunlight from reaching aquatic plants and prevents the water from getting oxygen from the air. The purpose of this experiment was to find out what pollutants affect nitrate levels the most, including oil, dog feces, soil, and fertilizer. To simulate runoff the tester put a small amount of the substance into a bucket of pond water. After letting the water sit the tester used nitrate testing strips to find the nitrate content of the water. Adding dog feces to pond water increases its nitrate content by 80%. Adding fertilizer only increases the nitrate content by 40%. Oil and soil decreased the amount of nitrates in water by 100% as they both had no measureable nitrates.

The Effect of Different River Locations on Pollution

Drew Hopkins, Tuckahoe Middle School

In many undeveloped countries, people have to use river water or other large water sources to meet their needs. In many of those water sources, humans pollute the water in between the origin of the water and where the people use the water. Even in developed countries, people pollute the water, and instead of people getting sick, the environment suffers. The purpose of this experiment was to find out which part of the river contained more pollutants: the upstream (uninhabited) or downstream (densely populated) part of the river, and to find out what was in the middle that could affect the river pollution. The experimenter used two water bottles to collect water samples from each part of the river (downstream and upstream). There were two trials that each had four water samples in each trial. The water samples were collected twice in each section of the river (the downstream section and the upstream section of the river) for each trial. Altogether, and including the control, there were a total of nine water samples. The water samples were all tested for pH, nitrite, nitrate, GH, and KH. The downstream part of the river was concluded to have more water hardness and nitrate than the water samples taken from the control and the upstream part of the river. Since the downstream part of the river had more pollution, the experimenter found out that there was something in the middle that created the pollution. The experimenter figured out that methods should be thought of to decrease the pollution in not just the river that the water samples were from, but for ways to decrease all of the pollution one small step at a time.

The Effect of the Brand of Water Bottle Filter on Amount of Total Dissolved Solids (ppm) Filtered Out of Water

Anjali Jain, George H. Moody Middle School

Most filtered water bottles contain carbon filters like ones used in faucet and pitcher filters. The filters do not eliminate all the harmful substances in water, but do remove 50 to 60 percent of bacteria and dissolved solids. Filtered water bottles remove dissolved solids by absorbing them in the carbon filter. The purpose was to find out which water bottle filtered the water the best. First, 800 milliliters of rain-water was collected in a liter-sized container. Water (200 milliliters for each water bottle, with same amount of TDS) was poured in each water bottle. The amount of TDS after the water was filtered was subtracted from the amount of TDS before the water was filtered to find the amount of TDS filtered out of the water. The null hypothesis was disproved because the water bottles filtered out different amounts of TDS. The results supported the research hypothesis that the Livpure water bottle would filter out the most amount of TDS. The cause may have been the two filters inside of the water bottle. The Livpure bottle had a carbon filter and an antimicrobial filter, and the other water bottles only had a carbon filter, so the added water filter could have detracted more TDS from the water.

The Effect of Different Types of Terrain and Water on Heat Radiation

Nitya Madhu, George H. Moody Middle School

Heat radiation is the energy radiated by solids, liquids, and gases in the form of electromagnetic waves as a result of their temperature. It is also known as thermal radiation. Heat radiation is one of the causes of global warming. It comes from the sun and gets trapped within the Earth's atmosphere. Different types of terrain and water can be influenced by heat radiation. The purpose of this experiment was to determine the effect of different types of terrain and water on heat radiation. Ten infrared heat lamps were placed on a flat surface. Five transparent glass jars were placed under each lamp. The sand, soil, water, and salt water were measured and put in their respective jar under each lamp and a thermometer was placed inside each jar. All other factors were kept constant including the jars, infrared heat lamps, location, and thermometers. The temperature for each jar was recorded every five minutes. The results showed that soil absorbed the most heat radiation because at the conclusion of the experiment it had the highest average temperature of 80.4 degrees Fahrenheit. The data supported the research hypothesis that if radiation is applied to different types of terrain and water, then soil will absorb the most radiation. Based on the data collected, there appears to be a correlation between the texture and color of a substance and its ability to absorb heat radiation, however, further studies are required to determine this.

Ecology and Earth Sciences B

First Place

The Effect of Runoff Barriers on the Amount of Pollutants Entering a Body of Water

Hannah Parker, Sabot at Stony Point

Chemical runoff, also known as pollutants, poses a problem for many bodies of water. This is a long standing issue. Often pollutants enter a body of water and promote algae growth on the surface. Algae consume oxygen and thereby reduce dissolved oxygen in the water. Lesser quantities of dissolved oxygen can cause fish and plants to die and render the water unusable. When fish and plants die it affects ecosystems, creating areas called "Dead Zones". This experiment was designed to test the effect of runoff barriers (used to stop pollutants) in preventing pollutants from entering a body of water. Runoff barriers are common but are not consistently efficient. Three different runoff barriers (sod, berm, trees) and a control (no barrier) were placed along a model river bed. Sugar water (representing pollutants) was poured over the model river bed at a consistent rate. The hypothesis was that grass berm barriers would be the most effective barrier between pollutants and water. The results showed that the trees permitted the least amount of sugar solution, an average of 276.8 grams per 237 milliliters to flow into the river. The berm came in second with an average of 279.5 grams. The landscape fabric allowed an average of 280.5 grams. The control (no barrier) proved to be the least efficient with an average of 282.6 grams. The ranges for the data were very large so a t-test was performed. According to the t-test it can be concluded that the berm and trees both perform better than the control, the same conclusion cannot be drawn for the landscape fabric. Based on the t-test it cannot be reliably concluded that any of the barriers performed better than the others. Therefore the hypothesis was rejected, perhaps because the models did not effectively represent reality.

Second Place

The Effect of Different Filter Feeders on Water Turbidity

Ian Street, Tuckahoe Middle School

Bivalves can help save the Chesapeake Bay. The main bivalves of the Chesapeake Bay include *Geukensia demissa* (ribbed mussels), *Mercenaria mercenaria* (hard clams), and *Crassostrea virginica* (eastern oyster). These filter feeders help filter and clean the Bay's water by feeding on plankton and filtering sediment and pollution out of the water at the same time. This filtering removes suspended solids from the water reducing turbidity. This experiment tested which filter feeder filtered Bay water the fastest and the most effectively. A turbidity meter was used to measure the decrease in suspended solids in the water in NTUs (Nephelometric Turbidity Units). Equal masses of the three species of filter feeders, *Geukensia demissa* (ribbed mussels), *Mercenaria mercenaria* (hard clams), and *Crassostrea virginica* (eastern oyster), were put into equal volumes of water with equal volumes of sediment added. The result of this experiment was that the *G. demissa* filtered the water the fastest and the most effectively, and the *C. virginica* filtered the water the slowest of the filter feeders and the least effectively. These results show that it is not only *C. virginica* that are important for cleaning the Chesapeake Bay, but more effort should be focused on other filter feeders especially, *G. demissa*, to help the Bay return to a healthier state.

Third Place

Do Farmed Oysters Require Washing to Maximize Growth and Survival?

Clayton Reppert, Gunston Middle School

Many people who live in Virginia want to take part in cleaning our beloved Chesapeake Bay. However, not very many of them want to spend hours doing backbreaking work to accomplish this. Recently, oysters have become nearly extinct, but if they come back it would save the Chesapeake. Multiple sources all say that farmed oysters need to be washed. In order to wash oysters, the farmer needs to pressure wash them, which is time consuming. This experiment tested if oysters actually need to be washed. The scientist bought 1,008 baby oysters and raised the oysters in four farms, with 252 oysters in each. The procedures included cleaning three of the farms, while the other was left untouched for five months. The scientist hoped to see that the results would be the same for each farm, which would indicate that oysters do not need to be washed. The hypothesis was that the oysters would need to be washed, because without washing they would have a higher death rate and a lower overall weight gain. The results showed that the scientist's hypothesis was not supported, and oysters do not need to be cleaned. At the end of five months, the unwashed farm had 236 total oysters, while the other farms had 241, 245, and 233. The weight gained in the unwashed farm was 6.8 kg, while the others gained 7.03, 7.48, and 5.67 kg. This experiment will be shared with Chesapeake Bay Associations and will hopefully be used to inspire more homeowners to farm oysters.

Honorable Mention

The Biological Effects of Simulated Acid Rain on the Viability of *Hedera helix* Plants

Aadi Sharma, George H. Moody Middle School

Acid rain has been known to damage the flora of our environment. The acidity deprives the soil of its nutrients and eventually results in the plants dying or becoming extremely weak. *Hedera helix*, the common ivy plant also referred to as the English Ivy, is an outdoor plant that grows in gardens and residential areas. When unsheltered, it is very susceptible to acid rain. The purpose of this experiment was to research and observe the effects of different levels of pH of simulated acid rain on the viability of *Hedera helix*, or the common ivy plant. It was hypothesized that the acid rain solution with a pH of 2 would harm the *Hedera helix* plant the most and slow down its growth. Four *Hedera helix* plants were first bought and cut to an equal stem length of 6 cm each. They were then planted in similar individual clay pots filled with commercially available garden soil. The test solutions were then prepared. The first solution was made by mixing 27 ml of white vinegar with 500 ml of distilled water in a glass beaker. The pH was checked and found to be 3. Next, 2 liters of distilled water and 20 ml of vinegar were mixed in a beaker to create a second solution with a pH of 4. The final solution had 2 liters of distilled water mixed with 30 ml of white vinegar to get a pH of 2. Each *Hedera helix* plant was then labeled and watered with an assigned solution. The control (watered with distilled water) was Group A, Group B had a pH of 3, Group C had a pH of 4, and Group D had a pH of 2. Each group was watered every day at 8 pm for 12 days. Observations such as height and condition of the plants were recorded. The steps were repeated four more times to ensure accuracy. On the twelfth day, the mean plant height for all the trials in Group A was 8.3 cm, for Group B, 6.4 cm, for Group C 7.7 cm, and for Group D 7.4 cm. The results of this experiment were similar to the published literature because the plants watered with more acidic solutions did not grow as tall as those receiving distilled water.

Honorable Mention

The Effect of Various Materials on the Absorption of Motor Oil

Jonathan Spears, George H. Moody Middle School

Oil is a very valuable natural resource to humans across the globe. When oil spills occur, the effects are disastrous to the environment and cleaning it up is extremely expensive. Cleanup efforts for oil spill disasters often require absorbent materials to soak up oil. Absorbents can vary in type, cost, and accessibility. Some materials, because of their ease of use or design, are better than others in soaking up oil. Research in this experiment seeks an inexpensive, easily accessible substance that will soak up oil efficiently without damaging the environment. The purpose of this research project was to determine what

common, household material absorbs the most motor oil. Ten 5 cm x 5 cm squares of sponges, cotton, and disposable diapers were placed in a 12 oz. container of motor oil (20 ml) floating on water (200 ml), for the same amount of time (1 mm). These amounts were chosen in an attempt to imitate the ratio of oil to water in a real-world oil spill, as well as to create continuity in the experiment. The results of this experiment supports the hypothesis that if sponges, cotton, and disposable diapers (mainly the absorbent sodium polyacrylate found inside) are placed in 20 ml of motor oil floating on water for the same amount of time, then the disposable diapers will absorb the most oil. The average amount of the initial 20 ml of motor oil absorbed by each independent variable was 5.1 ml of oil with the sponge, 9 ml of oil with cotton, and 19.4 ml of oil with the disposable diapers. Since the diapers absorbed nearly 4 times the amount of oil as the sponge, and over twice the amount as the cotton, the evidence gathered in this investigation strongly concludes that sodium polyacrylate found in disposable diapers is the most effective material for absorbing oil.

Honorable Mention

The Effect of Common Household Substances on Oil Extraction

Lilly Yowell, Tuckahoe Middle School

The purpose of the experiment was to find out what common household substance extracted the most oil from Mallard Duck, or *Anas platyrhynchos*, feathers. Each year, wildlife and their habitats are harmed and destroyed from oil spills. To be better informed in the event of an oil spill, the experimenter wanted to know which common household substance was the most efficient and effective to remove the oil out of *A. platyrhynchos* feathers. The experimenter chose Dawn dishwashing liquid, Trader Joe's baking soda, Great Value white vinegar, and tap water to see which substance extracted the most oil from *A. platyrhynchos* feathers. The independent variable was the type of common household substance. The dependent variable was the amount of oil extracted from *A. platyrhynchos* feathers. The experimenter's hypothesis was if Dawn dishwashing liquid is mixed with water, then it will extract the most oil from *Anas platyrhynchos* feathers. To conduct the experiment, the experimenter took *A. platyrhynchos* feathers, rubbed them in oil, and then submerged them in water with baking soda, dishwashing liquid, vinegar, or tap water. After rubbing the feathers in the water, the experimenter measured the amount of oil extracted, and recorded the data. There was one trial with two repeated trials, for a total of three trials. After conducting the experiment, the results were as follows: Dawn dishwashing liquid extracted the most quantity of oil from *A. platyrhynchos feathers*, extracting a mean of 6.7 ml, Great Value white vinegar extracted the second most oil, extracting a mean of 4.4 ml, Trader Joe's baking soda the third most oil, extracting a mean of 3.8 ml, and tap water the least quantity of oil from *A. platyrhynchos* feathers, extracting a mean of 1.6 ml. This shows that Dawn dishwashing liquid should be used when cleaning oil off of bird feathers. This also proved the experimenter's hypothesis to be correct.

The Effect of Different Soil Materials on Water Retention

Grace Mayer, George H. Moody Middle School

Soil quality and water retention both have great impacts on the health of plants such as trees, grasses, flowers, fruits, etc. When rainfall or irrigation soaks down into the soil, it depends on the size and shape of the mineral particles and the amount of organic matter in the soil to determine whether it will be percolated or retained. The purpose of this experiment was to determine the effect of soil, clay, sand, and peat on the time it takes water to percolate and how much water is retained. Each level of the independent variable were collected and were each tested in PVC pipes rested on a screen with wooden leg blocks attached. One cup of water was poured through and the time the water started to percolate and the amount of water that was percolated into the bowl underneath the screen were recorded. The inches of the water that was percolated were then converted to milliliters and the data was put into graphs and charts. The results showed that the clay percolated the slowest at an average of 25.989 seconds and that the peat retained 66% of the water that was poured through, which was the highest of all of the levels. Parts of the data supported the hypothesis that if water is poured through different soil materials,

then peat will retain the most water and percolate the slowest, and the other half did not. Based on the results, it is evident that there is no correlation between the soil material and the time it takes to percolate or how much water is retained.

The Effect of Adding Nitrogen Activators in Altering Temperatures of Household Compost

Paige Murphy, George H. Moody Middle School

For years scientists have studied the effect of chemical fertilizer on ecosystems from neighborhood lakes to oceans and rivers. A direct result of the fertilizer run off is algae growth and changes to water affecting aquatic life. If people used organic household compost instead of chemical fertilizers, the growth of algae would decrease and the harmful effect on fish and other sea life would be reduced. The experimenter discovered that successful compost is one that includes carbon and nitrogen activators (such as chicken manure or red worms). This led to the experiment "The Effect of Adding Nitrogen Activators in Altering the Temperatures of Household Compost." The purpose of this experiment was to determine the best household compost by testing the effect of adding nitrogen activators to compost. As the microorganisms changed the organic waste to compost, the temperature of the compost increased as heat was generated in this process. Carbon activators (leaves, grass, soil, vegetable peels) were added into 30-gallon Zip Lock bags. Two red worms were added each to ten bags and 100 g of chicken manure to another ten bags. The last ten bags were the control compost with no nitrogen activator. The temperature of the compost bags was recorded every day at six o'clock for 21 days. The compost with chicken manure had the highest mean temperature of 24.41 °C, red worms' compost had 23.62 °C, and the control compost had the lowest at 23.12 °C. This did not support the experimenter's hypothesis that red worms added to a compost heap would result in a higher temperature than both the control compost and the manure compost. The research proved that good compost should include a nitrogen activator and organic household compost that contains chicken manure would be the best alternative to chemical fertilizer.

Greenhouse Gases

Georgia Nabors, Kenmore Middle School

Global warming affects many things on Earth and is caused by the greenhouse effect. The greenhouse effect happens when energy or radiation in the atmosphere increases in heat. Certain greenhouse gases can cause more damage to the environment than others. The purpose of this experiment was to discover which of the three main greenhouse gases harms the atmosphere the most. The three gases being tested were carbon dioxide, nitrous oxide, and methane. It was hypothesized that nitrous oxide would be the most harmful gas. During the experiment the scientist mimicked the greenhouse effect on a smaller scale. The experimenter placed indirect sources of the greenhouse gases into identical jars. The jars were placed four feet away from a heater and the temperature of the air inside the jar was taken every five minutes. The scientist's hypothesis was accepted.

The Effect of Various Environmental Pollutants on the Level of Dissolved Oxygen in Water

Jui Paithane, George H. Moody Middle School

Any harmful or dangerous items in the environment are defined as pollution. The two main types of pollution are air and water pollution. When water gets polluted by chemicals and organic waste, the dissolved oxygen levels in the water become affected. Dissolved oxygen is concentrated oxygen in water; this is how marine creatures breathe. In this investigation, the effect of various environmental pollutants on the level of dissolved oxygen was determined. The different environmental pollutants were the independent variable and the level of dissolved oxygen in water was the dependent variable. The control group was plain water without any pollutant. Based on the previous research and experiments done by scientists about the effect of oil on the dissolved oxygen levels in water, it is believed that if oil was put into water, then the dissolved oxygen level would be the least. Ninety cups were filled with 200 ml of tap water, 15 were filled with an extra 50 ml of water (control – group A), 15 were filled with 50 ml of oil (group B), 15 were filled with 50 ml of bleach (group C), 15 were filled with 50 ml of organic waste (group D), 15 were filled with 50 ml of fertilizer (group E), and 15 were filled with 50 ml of pesticide (group F). After 24 hours, the amount of dissolved oxygen in these cups was measured for the next five days. The results indicate that the organic waste – group D – produced the lowest dissolved oxygen levels consistently, with a maximum drop of 90%. Bleach seemed extremely close to the amount of dissolved oxygen in the

water on the first day, with an average of 8.6 mg/L and water with 8.7 mg/L. The data did not support the research hypothesis because oil had a maximum drop of 4.4% in dissolved oxygen but organic waste produced a maximum drop of 90%.

The Effect of Fertilizer on the Attraction of Worms

Julia Paraiso, George H. Moody Middle School

Fertilizer and earthworms have significant effects on the growth of plants and the amount of nutrients found in the soil. Since earthworms eat and digest the organic matter in soil and fertilizer in order to create castings to give nutrients to the soil, the more organic compound in a fertilizer, the greater amount of worms will be attracted to the material. The purpose of the experiment was to determine the effect of fertilizer on the amount of earthworms attracted in a 24-hour time period. Based on the research that stated that earthworms are more attracted to fertilizers with more organic matter, it is believed that if different fertilizers are used, then the group receiving Vigoro fertilizer will attract the most number of worms after one day. For experimentation, a vermiculture bin was created and divided into four equal sections. Miracle-Gro, Vigoro, Earthgro Topsoil, and soil with no fertilizer were each placed in individual sections. At the beginning of each trial, five earthworms were placed on the top of each section. At the end of the trial, the amount of worms in each fertilizer section were counted and recorded. The results indicated that the greatest amounts of worms were found in Vigoro fertilizer. The data supported the research hypothesis because Vigoro had the most amount of organic matter compared to the other tested groups. Based on observations of the results, there is a direct correlation between the organic compound in Vigoro fertilizer and earthworm attraction. The earthworms found in Vigoro fertilizer were noticeably healthier and stronger. To further the experiment, a larger vermiculture bin could be produced and more worms could be tested for a longer period of time.

The Effect of the Type of Soil on Liquefaction Susceptibility

Amruta Ponugupati, George H. Moody Middle School

Soil liquefaction can be defined as a saturated or unsaturated amount of soil losing tension due to perpetual degrees of stress. The saturation levels of soil can be influenced by soil type, grain organization, or soil composition. The purpose of this experiment was to reach a conclusion on which type of soil has the highest liquefaction susceptibility rate when exposed to one effective degree of stress. The soils of sand, clay, loam, and silt were used as the independent variable, and the amount of time required for the soil to liquefy in seconds was used as the dependent variable. If different types of soil (1000 grams) are placed in 1000 ml of water, then sand will take the least time before liquefaction occurs using a Black & Decker MS800B Mouse Detail Sander to simulate stress. Four different types of saturated soil were exposed to the same degree of effective stress (11,000 orbits per minute) until fully liquefied. Sand, silt, loam, and clay (1000 grams) were placed into separate containers. Water (1000 ml) was added to the containers, fully saturating the soil content. There were 10 trials for each level, 40 containers total. The palm sander was turned on and was placed on the bottom exterior of each container. A stopwatch timed how long it took for each level of soil to liquefy (seconds). Sand soil liquefied quicker than the remaining levels, with the mean timing for liquefaction occurrence as 94.8 seconds. Clay liquefied at 466.7 seconds, silt soil liquefied at a mean of 268.7 seconds, and loam at 351.2 seconds. Data showed that sandy soils were the most susceptible to liquefaction than the other types of soil, therefore supporting the original hypothesis. Cohesive soils contain sufficient amounts of clay content, and have plasticity. Plasticity of clay fraction will increase the resistance of the soil to liquefaction. At a given effective stress level, looser, sandy soils are more susceptible to liquefaction than dense, clay soils. There was a direct correlation between soil composition and liquefaction susceptibility.

The Effect of Recent Changes in the Polar Jet Stream on the Yearly Average Temperature of the United States

Kavya Puthuveetil, George H. Moody Middle School

Despite the fact that temperatures have been increasing in the United States since the 1970's, changes in the polar jet stream have altered this trend. The jet stream follows the paths of strong fronts and controls the weather. The polar jet stream, one of the major jet streams that travels above the US, began to display

unusual behavior in 2013, swinging north and south dramatically while increasing in size and splitting into two. The purpose of the experiment was to observe the effect of the changes in the polar jet stream on the average temperature of the United States. The hypothesis was if the average temperature of the United States in 2013 is compared to the average temperature of previous years, then the average temperature of 2013 will show significant variation. To find the average yearly temperature of the United States, data was collected from the NCDC. The data was then recorded on an Excel Spreadsheet and analyzed. The results indicated that the mean temperature of the US was 53.89 °F. The range between the maximum (55.3 °F in 2006) and minimum (52.3 °F in 2013) was 3 °F. Although the average temperature in 2013 was the lowest recorded, the difference between the temperature in 2013 and in other years was not great enough to be considered statically significant, only producing a p-score of 0.1312. Therefore, the results did not support the research hypothesis. It was determined that the average temperature of the United States was gradually decreasing and would continue to do so as a result of climate change. Before it can be concluded that climate change will continue to lower temperatures in the US, further research must be done to ensure that that the behavior of the jet stream in 2013 will become a reoccurring trend in future years.

The Effect of Heat on Rate at Which VOCs Evaporate

Andrea Quezada Vargas, Gunston Middle School

An experiment was conducted to determine what factors cause volatile organic compounds (VOCs) – toxic fumes that smell like a gas station and that evaporate quickly from certain hydrocarbon liquids like petroleum or mineral spirits – to evaporate at different rates. It was hypothesized that hot weather would cause these fumes to evaporate from gas stations and parked cars faster than cold weather. To test the hypothesis, a plastic tray containing liquid VOC (mineral spirits) was placed inside a small greenhouse modified for the experiment with duct tape and a plastic tube. The quantity of VOCs accumulating in the atmosphere of the sealed greenhouse in parts per million was then measured over 15 minutes at 5 minute intervals, using a photo-ionization detector. Ten trials like this were carried out, 5 with heat and 5 with no heat. In some of the trials, the initial temperature of the greenhouse was kept at ambient temperature – 70° Fahrenheit. In other trials, the greenhouse was heated to 85° Fahrenheit before inserting the VOC tray. In the experiment's results, VOCs accumulated faster in the greenhouse atmosphere in the heated trials than in the unheated trials, supporting the hypothesis. The results suggest that one way to reduce the amount of pollution in summertime in the air near VOC sources, like cans, trays of paint, paint thinner, or cars parked in an open-air lot, would be to put some shade such as a tent over the source.

The Effect on Different Roofing Types on How Much Heat the Roof Reflected or Absorbed

Natalie Quick, George H. Moody Middle School

All roofing types have their own advantages and disadvantages. In this experiment, the independent variable tested was different roofing types. The types including asphalt shingles, metal roofing, slate roofing, and rubber membrane roofing. An indoor-outdoor thermometer was used to find out how much heat the roof reflected or absorbed. The purpose of this experiment is to simulate a building to find out which roofing types keep a building cooler and which roofing types make a building warmer. The hypothesis stated that if asphalt shingles, metal roofing, slate roofing, and rubber membrane roofing are used, the asphalt shingles will absorb the most heat while the metal roof will reflect the most heat. To simulate a building, four identical boxes were constructed with a different roof on each building. The four boxes were lined up and a heat lamp was placed nine inches above the center of each box. Indoor-outdoor thermometers showed the temperature on the top of the box and the temperature under the box. Data was collected every fifteen minutes for three hours. The results showed that the metal roof allowed the least heat to transfer through the roof, while the rubber membrane roof allowed the most heat to transfer. If this experiment was to be repeated, a real rubber membrane roof would be used instead of a simulation one. During the experiment, the rubber was overheated and began to emit small amounts of steam. Also, a different heat source could be used to better simulate the sun. Other studies could be done to find out more about different roofing types, and the results of those studies should be put somewhere where all homeowners and building owners can access it and determine which roof they should install with appropriate background knowledge.

The Effect of the Type of Soil on the Amount of Water Absorbed

Grant Sasina, George H. Moody Middle School

Soil is one of the most important things in the world. Without soil, there is no plant life, and with no plant life, there is no oxygen, without oxygen, there are no humans. The purpose of soil is to be a median for plants grow in. It is there to absorb water and nutrients that plants need and to anchor it down to the ground. There are so many things that can influence how much water soil absorbs. Some of these things are particle size, material, and type of soil. The purpose of this project was to determine the effect of different types of soils on the amount of water absorbed. Ten cups were set up with holes in them to let water drain through into another cup. Two hundred milliliters of soil was put into each cup, and then 237 ml of water was added. It was measured by subtracting the amount of water in the cup from 237. That would give the amount of water absorbed in the soil. The results showed that gardening soil by far absorbed the most water. This happened because gardening soil had the smallest particle size allowing it to pack close together, which traps water better. It also has more empty space within the soil and its particles, which allows lots of space for water to be absorbed.

Soil Composition on the Percolation Rate of Chemicals from Fertilizer

Katharine Schlachter, Gunston Middle School

The purpose of this experiment was to inform Arlington county residents of the danger that household fertilizers pose to the health of the Four Mile Run Watershed. This was an important problem because harmful chemicals in household fertilizers cause plant and fish death in freshwater ecosystems. The scientist's goal was to find the effect of different types of soils on the percolation rate of phosphates, nitrates, and nitrites and how well the different soils in the county hold these potentially dangerous chemicals. To do this, the scientist collected seven soil samples and put them in seven homemade filtration systems. The scientist then poured Miracle-Gro plant fertilizer on top of the samples. When the fertilizer had percolated through the samples the scientist tested it for phosphates, nitrates, and nitrites. The results for phosphorus proved the Troy Street Park sample did the best at holding the chemical. It held an average of 64% of the phosphates in the original fertilizer mixture. Topsoil did the best at holding nitrates, which on average held 78% of the nitrates that were in the original fertilizer mixture. Lastly, the Troy Street Park sample again, on average, did best and held 95% of the nitrites from the original fertilizer mixture. The scientist discovered the soil samples from the Four Mile Run Watershed did hold some portion of the tested chemicals. Overall the samples did not prove to be an effective barrier to phosphates, nitrates, and nitrites. The scientist intended to talk to Arlington County about ways to improve the soils in the Four Mile Run Watershed to help prevent these chemicals from entering our streams.

The Effect of Soil Liquefaction on Different Mineral Compositions

Daniel Wu, George H. Moody Middle School

Soil liquefaction occurs when the sediments of soil temporarily lose its shape and strength and becomes more of liquid rather than a solid after or during an earthquake. Water begins to fill the voids between the soils and then exert pressure onto the soil, causing the sediments within the soil to become less compacted. The purpose of this experiment is to find the relationship between different types of mineral compositions on soil liquefaction after an earthquake. The experimenter hypothesized that if different types of soil were used to hold a building upright while water is poured after an earthquake, then loam soil would hold the building upright above ground the longest. Three types of soils, topsoil, sand, and loam, were placed into a flower pot at a height of 9cm with a 100 ml scooper. A building was placed into the middle of the flower pot after a simulated earthquake. Afterwards, 150 ml of water was poured each consecutive 20 seconds until the building fell or sunk. The results indicated that loam held the building upright the longest compared to sand and topsoil. Loam absorbed an average of 874.2 ml per trial for an average time of 107.3 seconds, sand absorbed an average of 590.7 ml per trial for an average time of 69.6 seconds, and topsoil absorbed an average of 711.1 ml per trial for an average time of 90.9 seconds. The data collected from the experiment supported the hypothesis that if different types of soil were used to hold a building upright while water is poured after an earthquake, then loam soil would hold the building upright above ground the longest. Based on the average amount of water each soil absorbed, loam would be the best to limit liquefaction since it contains clay and silt. Since clay and silt are relatively able to resist liquefaction, the combination of both allowed loam to hold the building upright the longest. An

improvement for this project would be to include more soils, such as clay and silt. Since only three soils were experimented on, it is not possible to tell which soil would be the best to combat the effects of liquefaction.

Engineering

First Place

A New Wrist Brace Design

Andy Page, Mountain Vista Governor's School

Athletes often choose not to wear wrist protection because it immobilizes the wrist joint. Therefore, wrist protection tends to be used during the recovery phase after an injury. The objective of this study was to design, build, and test a wrist guard that would allow for flexion movement, but provide resistance against extension movements. This was achieved by placing a series of trapezoidal blocks on the ulnar side of the forearm and placing a memory foam pad at the heel of the hand. To determine the efficiency of the new design compared to existing ones, testing included three independent variables. The new design, the Mueller 300, and a control (no protection) were all tested in both a simulated forward and backward fall. The first three peak forces of each impact were recorded. Only the second peak force was used in the statistical analysis because the first peak was the impact of the fingers, the second peak was the impact of the wrist, and the third peak was a rebound of the whole analog hand. Compared to the Mueller 300, the new design decreased the peak force by 22.9% in the backward fall simulation, and decreased the peak force by 40% in the forward fall simulation. The data was statistically significant and allowed the researcher to conclude that the new design allowed a greater range of motion and still provided sufficient protection. The null hypothesis was rejected, and the alternative hypothesis was supported, that the brace design did affect the recorded force of the impact.

Second Place

Enhanced Performance of Airsoft Guns Utilizing Brushless Motor Technology

Nicholas Anselmo, New Horizon's Governor's School for Science & Technology

Brushless motors offer significant benefits over brushed motors, including higher efficiency, higher torque, and longer life. However, they require external commutation circuits, which are bulky and expensive. In addition, hall-effect sensors are required to provide high startup torques, but these sensors are only found on large industrial sized motors. The objective of this project is to design a self-contained brushless motor that remains competitive with high power brushed motors in terms of cost and size, while outperforming them in specific power (power output per unit volume), efficiency, and service free lifetime. A working prototype of a brushless motor has been constructed, and a dynamometer has been designed and built to measure motor performance. All engineering goals have been successfully achieved. Dynamometer tests have shown that the specific power of brushless motors can be nearly twice that of a standard brushed motor, while also achieving greater efficiency and longevity.

Third Place

Ethanol Production from Horse Manure

Michelle White, Mountain Vista Governor's School

The objective of this study was to examine the feasibility of creating ethanol from the excess cellulose present in horse manure. Two horses were exclusively fed cracked corn and alfalfa for two weeks. Twenty samples were taken, ten from each horse, and 10 g of cellulase was added to 5 samples from each horse, while 2 g of cellulase was added to the remaining ten samples. In addition, 10 samples made of hay and cracked corn were taken as control groups, in which 5 samples had 2 g of cellulase added and the other 5 had 10 g of cellulase added. After the samples were hydrolyzed they were fermented and

distilled. This yielded a small percentage of ethanol from all samples, except one lost to error. The hypothesis, which stated that if a horse consumed and digested more cellulose than its body could absorb, then its manure would contain enough cellulose to produce ethanol, was accepted. The null hypothesis, which stated that if a horse consumed and digested an excess of cellulose then its manure would not contain enough cellulose to produce ethanol, was rejected. This study proves that ethanol can be produced from excess cellulose found in horse manure.

Honorable Mention

Self-balancing Robot

Michael Bambha, West Potomac High School

The purpose of this project was to build a two-wheeled, actively stabilized robot, develop control programs for it, and to analyze the robot's ability to stay upright. In the process, a new method for finding the best loop time constant of a proportional-integral-derivative (PID) program was developed. The robot used a gyro sensor to measure angular velocity (how fast the robot is rotating), and sensors on the two motors to measure linear velocity (how fast the robot is traveling along the floor). The program controlled the motors based on sensor output to keep the robot from falling. Sensor calibration and sensor drift were taken into account. Five increasingly complex control programs were written. The best setting for each control program was determined by measuring the stability of the robot, and used in the next program. The results showed that the most complex program performed the best, and that the new method for determining parameters of the control programs was effective.

Honorable Mention

The Effect of Different Cooling Methods on the Efficiency of a Solar Panel in High Temperatures

Lauren Berry, Yorktown High School

Solar energy is a renewable form of energy that offers huge potential for the future with solar panel usage increasing at a rate of about 20% a year over the past 15 years. However, studies show that solar panels are less efficient in high temperatures because higher temperatures cause increased electrical resistance within a solar panel, which reduces the energy output of the solar panel. The purpose of this experiment was to test whether the addition of a water-cooling system to a solar panel would increase the energy generation of the panel in hot temperatures. This experiment analyzed the effect of two different cooling methods, including spraying and misting, on the energy generated by a solar panel in hot temperatures. The first hypothesis argued that when a solar panel is cooled with water, the panel would be more efficient (generate more energy) in hot temperatures. The second hypothesis considered the ambient air around a solar panel and argued that when a misting method is used to cool off both the ambient air around a solar panel and the solar panel, the panel would be more efficient (generate more energy) than when a spraying method is used. A 100-watt solar panel, irrigation system, voltmeter, and weather website were among the many materials used to perform this experiment. The season, the solar panel, the amount of cloud coverage, the angle of the solar panel and the temperature were kept constant for each trial. The average energy generation (in volts) was recorded and compared across the cooling methods and the control. There was a statistically significant increase in the amount of energy generated when water was applied to the panel on hot days, and the solar panel generated more energy when the misters were used rather than the sprayers.

Honorable Mention

Effects of Nail Rotation on Torque Resistance and Collapse Trends

Seth Peacock, Lee Davis High School

This experiment was the fourth year of continuation in a study investigating torque resistance in two-nail timber joints. The nails used had diverged by 30°. In 0° nail rotation, the upper nail was angled directly up and the lower nail directly down. In -45° and 45° nail rotations, the direction in which the angle was applied was rotated the designated amount. Counterclockwise torque was used. The nails were made to support an effort arm holding an increasing mass of water until the effort arm dropped 20°. Mass supported at a 20° drop was recorded, and videos of each trial were graphically analyzed as scatter plots of time and angle of collapse. Masses supported were converted into Newton-meters of torque and tested by ANOVA; no significant difference between nail rotations was found. This supported previous evidence that nail rotation has less effect on torque resistance than other factors. Graphical analysis of trial videos showed exponential collapse trends and catastrophic collapses in -45° and 0° rotation joints and a gradual oscillation of acceleration of collapse in 45° rotation joints. In -45° and 0° joints, friction failure due to sudden shifts may cause the catastrophic collapse. The necessity of nail deformation in 45° joints may prevent catastrophic collapse. “Stick-slip” friction may be involved in the oscillation of the acceleration of 45° joint collapse. An ANOVA test showed no significant difference between when -45° and 0° joints catastrophically collapsed. Trendlines were created for the scatterplots of all trials in the form $Y = ae^{bx}$, where Y is degree of collapse and X is time. An ANOVA showed significant difference in b between -45° and 45° joints, indicating a more rapid increase in collapse rate before catastrophic collapse in -45° than in 45°. Joints using 45° nail rotation were found to be optimal for withstanding counterclockwise torque, as they are not significantly weaker than other joints and do not catastrophically collapse.

3D Printed Propellers for Multirotor Use

Cameron Buss, Blacksburg High School

The purpose of this investigation is to determine if it is possible to 3D print a propeller equal or greater in thrust to a traditional injection molded propeller. Printed propellers were printed with a selective laser-sintering printer and tested for thrust and current draw. The propellers have possible future use on military drones. Military bases could print the propellers in less than 12 hours with little equipment. The printed propeller generated 66% more thrust, but pulled almost 200% as much current as the injected molded propeller. The printed propellers also weighed twice as much compared to the injection-molded plastic with similar densities. This suggests the shape of the printed propeller and the imperfections of the surface create additional drag.

Effect of Shape of Building on Time Taken to Fall in a Mock Earthquake

Maeve Cantwell, Washington-Lee High School

The purpose of this experiment was to study the effects of shape of building on time taken to fall in a mock earthquake. This experiment was chosen because of many recent earthquakes in third-world countries where there are few or no earthquake-engineered buildings. Four different building shapes were tested: triangle, rectangle, pentagon, and hexagon. The hypothesis for this experiment was if four different building shapes are tested in a mock earthquake, then the triangular building will be able to stand up the longest. For the test the buildings were built on a shake table out of identical wooden blocks (each building used the same number of blocks, so that the weight would be the same). The shake table was then turned on, and the time for the building to completely fall down was measured. The mean times were as follows: for the triangular building, 28 seconds; for the rectangular building, 26 seconds; for the pentagonal building, 26 seconds; and for the hexagonal building, 27 seconds. An ANOVA-F test was run, and the resulting p-value was greater than 0.05, making the results not statistically significant. Therefore, the null hypothesis was accepted.

The Effect of Parachute Material on Rocket Descent Time

Maxwell Cloe, Hanover High School

The purpose of this project was to determine whether or not the material of a parachute had an effect on the descent time of a rocket. It was hypothesized that if a polyethylene parachute was used, then the rocket would descend slower than rockets with a polyester or cotton parachute. It was thought that this

would occur because the polyethylene parachute has a lower density than the other parachutes. Three parachutes of equal area were constructed out of low-density polyethylene, cotton, and polyester. One parachute was attached to the rocket at a time and the rocket was launched. The rocket was launched on ground level in an area of constant climate. A timer was started when the parachute was released and was stopped when it landed. This was repeated five times per level of IV. The rocket with a polyethylene parachute had the longest mean descent time, followed by the cotton parachute. The polyester parachute had the shortest mean descent time. This is because the density of the parachute affects the length of the descent time. The polyethylene parachute had the lowest density, meaning it can inflate quicker and cause more drag, slowing the descent time. The cotton and polyester parachutes had higher densities, thus causing a faster descent.

Engineering a Highly Effective Firefighting Suit with Carbon X and Rust-Oleum Never Wet

Willis Lam, Lee Davis High School

In 2012, 69,400 fire fighters were injured. Of these injuries, 5.8% were caused by thermal stress and 5.7% were caused by burns. Line of duty injuries to fire fighters have been estimated to cost between 2.8 and 7.8 billion dollars per year. Normal firefighting gear is heavy and does not protect against steam that can cause painful injuries. The goal of this project was to fuse two novel products, Carbon X and Rust-Oleum, to make a composite material that is water and fire resilient. Hopefully, this effective composite material could replace current firefighting gear and lower firefighting related injuries. Carbon X is composed of OPAN fibers that expand and oxidize in order to prevent the ignition of the fiber. Rust-Oleum is a silicon-based spray that provides materials with super hydrophobic properties. Fire and water testing were conducted in order to test the resiliency of the composite material. Char measurement and smoldering time was recorded. Rust-Oleum provided the composite material with super hydrophobic properties, but slightly diminished the fire retardant abilities of Carbon X. The result of the composite material was a product that was able to repel water and maintain fire resilient properties. Further studies can be conducted in order to improve the fire resilient and super hydrophobic properties of Carbon X treated with Rust-Oleum.

The Effect of Types of Insulation on Cool Down Time

Alicia McNulty, Mathematics & Science High School at Clover Hill

The goal was to determine what kind of insulator is the most effective in retaining heat. I hypothesized that spray foam insulation would be the most effective insulator. To conduct the experiment, heat up an uninsulated wooden box containing a light bulb and thermometer for 20 minutes and let cool for 20 minutes. Repeat the process twice for a total of three trials. For the next level, add fiberglass insulation to the box. Heat up and cool down, and then repeat trials. Next, add a thin layer of spray foam and then reinstall the fiberglass insulation. Heat up, cool down, and repeat trials. Remove fiberglass and fill the rest of the cavity with spray foam; heat up, cool down, and repeat trials. On average, the uninsulated box heated up 10.74 degrees and cooled down 5.19 degrees. The fiberglass insulation heated up 12.78 degrees and cooled down 4.44 degrees. The spray foam insulation heated up 12.41 degrees and cooled down 4.82 degrees. The combined fiberglass and spray foam insulation heated up 11.67 degrees and cooled down 4.45 degrees. Of the materials tested, fiberglass insulation is the best insulator, closely followed by the combined fiberglass and spray foam. Any kind of insulation makes a big difference in heat retention, but fiberglass is the most effective insulator.

Programmable Logic Controller Regulated Electrical Wires

Edward Morgan, Southwest Virginia Governor's School

Thousands of houses in the United States are destroyed each year because of electrical fires. Many of these dangerous fires are caused by faulty or malfunctioning electrical wires. Obviously there is a distinct need for electrical wires that are drastically more resilient than current models. In this project, a wire apparatus was made that, if partially severed, was able to autonomously reroute electrical current and therefore prevent dangerous electrical fires due to sparking wires. A two-wire apparatus was constructed using a Programmable Logic Controller (PLC) and four analog ammeters to measure output charge. Two wire configurations each consisting of a positive and negative wire were created using one input terminal on the PLC and two output terminals. In this way, if the wire was intact, then the current would continue

through the first output; if the input wire was disconnected or cut, the current would be redirected through the secondary output. Four ammeters were connected to each of the output terminals. In this way, current from each of the outputs was measured as being present (triggered) or not. After the physical configuration was made, a program was prepared using xLogix ladder logic, the system by which PLCs are programmed. When this configuration was tested, it was shown that the system using the wire configuration and the program worked, rerouting power automatically when a wire was cut. In the future, a more prototypical version could be constructed, one that could be put into use in everyday devices the world over.

The Impact of Porosity on the Accuracy of Rangefinders

Todd Parker, Mountain Vista Governor's School

This paper discusses the impact of porosity the accuracy of a sonic rangefinder. This was tested by measuring the distance to squares of material using a Vernier Motion Detector 2. Fifty repeated trials were done at a 0% open space to free space ratio, 25% ratio, and 50% ratio each. An ANOVA test yielded high F-statistics. This led to a rejection of the null hypothesis that the porosity of a material has no impact on the accuracy of a rangefinder and tended to support the alternate hypothesis that there was a negative correlation between porosity and the accuracy of a rangefinder. It was concluded that because the openings in the materials were larger than the sound waves emitted by the rangefinder, there was a much higher chance that they would not be reflected back normally by the material, thus leading to an incorrect reading by the rangefinder.

Charging Methods of Lithium-ion Batteries on Battery Discharge Rates

Uday Patil, Mills E. Godwin Specialty Center for Science, Math & Technology

All portable consumer electronics have batteries, and depending on the use of the device, the types of batteries change. These devices have used lithium-ion batteries with great success. However, many people do not know how to prolong the battery life of their device, resulting in the full discharge of the device and the statement, "My phone is dead, can I borrow yours?" There are many myths and rumors regarding ways to increase the longevity of the battery in devices, but most of them are false and are based on opinions and guesses. The purpose of this experiment was to determine what type of battery usage affected the service life and current capacity the most; which method of charging and discharging the battery resulted in a higher or lower overall battery life. The tested methods of charging and discharging were 100-95%, 100-40%, and 100-5%, which was the control. The hypothesis stated that the 100-95% group would result in the highest current capacity when tested. The batteries were tested in a setup that was to be as accurate and autonomous as possible. With assistance, a circuit was created for the purpose of regulating the charging and discharging states of the batteries, and to allow for the logging of data from certain points in the circuit. The data was collected using a special USB device and was then analyzed on a computer. The 100-95% group had the highest current capacity, which supported the hypothesis. The 100-40% group however, was more reliable, and more logical for the use of an electronic device, which would be meant to be used away from a wall outlet for extended periods of time. Some future possibilities that could be considered for this would be to test punctuated power draws versus steady power draws on the battery to determine the effects. The domain of lithium-ion batteries is enormous, and there are many possibilities for testing as well as for uses in electronics.

The Effect of Different Wave Barriers on the Distance Water Travels on Shore

Kathleen Reid, Mathematics & Science High School at Clover Hill

The purpose of this experiment was to determine which wave barrier best protects shoreline communities from tsunami waves. The goal of the experiment was to discover the structural success of barriers when faced with the force of water. It was hypothesized that the clay wave barrier would most effectively prevent water from travelling onto a shore. The Independent Variable was three different types of wave barriers: a clay barrier, a wooden barrier, an artificial grass barrier, and no barrier (control). The Dependent Variable was the distance water travelled onto shore. To execute these experimental goals, a wave simulator was constructed, with one piece of plywood sloping to each end of a plastic tub. One barrier was placed on a wooden shore attached to the tub, which was filled with water. By dropping

weights, waves were created, and their distance travelled was recorded. Each level of the IV was tested for 20 trials to examine how far water would travel past each barrier. All calculated t-values of the data were larger than the table t-value, indicating statistical significance: rejecting the null hypothesis that the different wave barriers would have no effect on the distance water could travel onto shore. The research hypothesis was not supported; the clay barrier was not the most effective in preventing water passing onto shore. The wooden barrier, with the lowest mean, was the most effective in limiting the travel of water onto shore, followed by the clay barrier, with the artificial grass as the least effective barrier.

The Effect of the Type of Insulation on the Resistance to Change in Temperature

Prakrit Shukla, Atlee High School

The purpose of this experiment was to determine how different insulations protect air from a heating source and observe how they affect its final temperature. The research hypothesis for this experiment was that aluminum foil insulation would keep air temperature the coolest by protecting it from a heat source. To commence the experiment, a cardboard box possessing one square face opened, was acquired. One type of insulation (fiberglass insulation, Styrofoam, or aluminum foil) was slid into a slit in the center of the box. A thermometer was hung from the ceiling of the box's interior, and the temperature was recorded. A lamp (aimed at the thermometer) was then turned on for 10 minutes. When the 10 minutes had passed the lamp was turned off and the temperature was recorded. The difference of the final temperature and the starting temperature of the air behind each type of insulation was used to determine the mean change in the temperature of the air. The mean change in the temperature of the air was greatest (6.16 degrees Celsius) with no insulation. The mean values decreased to 3.9 degrees Celsius with fiberglass insulation, 3.06 degrees Celsius with Styrofoam™, and 2.015 degrees Celsius with aluminum foil. The standard deviation was greatest (0.295) at no insulation and least (0.156) with fiberglass. The data, therefore, did support the research hypothesis that the aluminum foil insulation would have the least mean temperature change. A possible explanation for the results might be that this experiment used heat that was transmitted by radiation, and the only insulating material that was known for efficiency against electromagnetic waves of heat was the aluminum foil because of its reflective surface. Ways to improve this experiment would be to restore the initial temperature of the area that is heated and the initial temperature of the thermometer more effectively and quickly to save time. Another possible study would be to test which light bulb gives off the most heat in an area.

Reducing Air Resistance and Drag to Boost Electric Car Efficiency

Collin Smith, Southwest Virginia Governor's School

Electric cars (EVs) are vehicles that are powered by nothing but electricity from batteries. These cars give off no tailpipe emissions, but are limited by their short range. Charging these cars can take anywhere from 30 minutes to 8 hours, creating an inconvenience for those who use them. This distance limitation creates a need to improve the efficiency of these EVs and increase the convenience of these cars. The main objective of the project was to develop a proof-of-concept to ascertain if the range of these cars could be improved by modifying the bodywork to reduce the effect of drag and air resistance. A control along with three model cars containing different design modifications were drawn, printed and tested in a wind tunnel. Drag force data at specific wind speeds for each of the 4 models were collected and compared using their lines of best fit. All modified models reduced drag from 0 to 20 miles-per-hour, with the two-hole and three-hole cars showing increased efficiency beyond 25 miles-per-hour. The modified car designs could potentially be applied to electric cars to increase their range or change how we think about car aerodynamics and design. A full-scale test needs to be done to determine if these modifications would work on an electric car in everyday conditions.

Self-sorting Beverage Container Recycling Bin

Derek Sturgill, Southwest Virginia Governor's School

The Earth continues to be abused by humans. Everyday more and more landfills are becoming full and new landfills must be created. These new landfills are constructed on perfectly good land that could be used for expansion for humans or be preserved for wildlife. Our terrible way of living is taking a toll on the planet, and soon enough we will be paying dearly for our misuse of the Earth. However, there is a simple solution that will help solve the issue: recycling. The problem with recycling though is that it really has not

taken off yet. It can be a taxing process and many people do not see it as being worth it. The goal of this machine is to make it more convenient for people to recycle and to take away the work aspect of recycling. All a person has to do is insert a beverage container and let the machine sort it into one of four compartments: glass, plastic, aluminum, or trash if the item does not match the requirements for the other compartments. It utilizes an Arduino Uno R3 with a photocell to determine the transparency of the item and two servos attached to a pan/tilt bracket to place the item into the correct compartment. Since it uses an Arduino, new coding can easily be uploaded to update the machine as new types of bottles arise. This machine allows people to easily recycle by only determining the transparency of the item. If widely implemented, it could lead to a huge spike in the recycling rates of these three types of material, thus helping preserve the planet one beverage container at a time.

The Effect of Infill Density of a 3D Printed Object on the Impact Force It Can Withstand

Thomas Twomey, Washington-Lee High School

Recently, 3D printing has been heavily discussed by mainstream media due the low cost of 3D printers pioneered by the RepRap movement. The purpose of this experiment was to understand the correlation of a 3D printed object's infill density with the impact it could withstand. This information would be useful for rapid prototyping, where items must be printed quickly and maintain their strength. The hypothesis was that there would be a linear correlation between infill density and impact resistance. To execute this experiment 4 sets of 20 test pieces were printed at densities of 0.0%, 33.3%, 66.6% and 100.0% on a Printbot Plus 3D printer. A testing apparatus was designed and constructed using 3D printed parts and other components so it dropped a weight onto a secured test piece from heights increasing by 10 cm until the test piece broke. The test blocks with 0.0% infill broke at an average drop height of 11 cm. The test blocks with 33.3% infill broke at an average drop height of 21 cm. The test blocks with 66.6% infill broke at an average drop height of 31 cm. The control group having an infill density of 100.0% broke at an average height of 24 cm. The hypothesis was rejected as the 100% infill test group averaged a drop height 7 cm lower than the 66.6% infill group. The results were determined statistically significant by an ANOVA test resulting in a p-value of $1.15E-26$. The results were unexpected and not found in the research done before the experiment.

Engineering and Math A

First Place

The Effect of Different Microwave Oven Enclosures on Influenced Wireless Internet Speed Measured in Megabits per Seconds

Naren Kasinath, George H. Moody Middle School

The conventional microwave oven uses microwaves to heat food. The microwaves are generated by a magnetron tube, a device that is an adaptation of military radar technology, at the frequency of 2.45 gigahertz. Similarly wireless internet, a revolutionary communication technology, uses internet routers that also operate on the same frequency of 2.45 gigahertz. Due to this frequency overlap, the microwave oven when in operation causes destructive interference, thereby significantly reducing the wireless internet speed. The purpose of the experiment was to test three different types of microwave oven enclosures to reduce interference. The three enclosures that were used were a wooden enclosure, an aluminum wire mesh enclosure, and an aluminum solid metal enclosure. The research hypothesis was that the aluminum solid metal enclosure would be most effective in reducing the interference. During the experiment the wireless internet speeds were recorded at a specified distance from the microwave oven while it was in operation, with no enclosure and when it was enclosed with the three enclosures used. This same procedure was repeated 15 times to ensure accuracy. The aluminum wire mesh enclosure and the aluminum solid metal enclosure (mean speeds of 49.36 and 50.86 megabits per second) showed statistically significant ($p = 0.05$) reduction of interference when compared to no enclosure and the wooden enclosure (mean speeds of 36.58 and 32.70 megabits per second). However when aluminum wire mesh enclosure was compared to the aluminum solid metal enclosure, no statistically significant difference existed between the two groups, implying both enclosures were equally effective in reducing the interference from the microwave oven. Microwave oven enclosures built using aluminum wire mesh or solid metal in a cosmetically acceptable manner for residential areas would further enhance wireless internet speed.

Second Place

The Effect of the Type of Queuing System on the Expected Waiting Time of Customers

Isabella Dula, George H. Moody Middle School

This project evaluates two different types of queuing systems and their effects on customers waiting time. Two types of queues were tested: the single line/multiple servers and the multiple lines/multiple servers system. In the multiple lines/multiple servers system there is one line for each server. This system is often observed at a grocery stores, and airport checking counters. In the single line/multiple servers system there is one line common to all servers. This kind of queue is observed every day at post offices or banks. The hypothesis is if the single line system was used, then the customers' waiting time would be shorter and with less variability than when a multiple lines system is used. The two queuing systems were compared with a computer simulation, in which 50 virtual customers were followed through the two types of queues. Total average waiting time, total time spent in the system, number of customers who must wait for service and probability of waiting were calculated under the two queuing protocols. The two systems are not equivalent means of queuing customers. The single line/multiple servers system is more efficient, as it always lead to a smaller total waiting time, smaller number of people waiting, smaller probability of waiting and short time spent overall in the system. The results of the experiment support the hypothesis.

Third Place

The Effect of Different Building Materials on the Internal Temperature of a Model UHI Building

Akankshya Jena, George H. Moody Middle School

In 1810, Luke Howard, a British manufacturing chemist and amateur meteorologist, noticed that there was a significant temperature change in his town, being warmer at night and cooler in the daytime. After much investigation, he was one of the first people to begin to research an environmental problem known as "Urban Heat Islands" (UHI). A UHI is usually a metropolitan city where temperatures are notably higher than normal temperatures in suburban or rural areas. The purpose of this experiment was to determine how different building materials affect the internal temperature of a model UHI building. The identical model buildings were built using sheets of metal, blocks of glass, and boards of wood. Glue was used to seal the open sides together. Then, the buildings were placed under a lamp holding a 60-watt light bulb, which was 6 inches over the buildings, for 6 hours. The initial temperature was recorded, followed by the internal temperature checked every hour. The results indicated that metal had the least average internal temperature. The data did not support the research hypothesis that if glass, metal, and wood were used as different building materials, then glass would have the least internal temperature. While metal was a mere 2 °F above the average temperature of 70 °F, glass was a full 9 °F over the average temperature. Based on the average temperatures determined in this research, there appears to be a direct correlation between the photons emitted from the 60-watt bulb and the overall density of the specified building material. Before it can be concluded that the high density of the metal was the sole cause of the low temperature however, various related experiments will need to be conducted to determine the negative effects of metal as a building material.

Honorable Mention

The Effect of Artificial Intelligence on Draws in Tic-Tac-Toe

Leo Desruelle, Williamsburg Middle School

Computer programs often have artificial intelligence systems coded within the program to give it the ability to make complex decisions. The complexity, precision, and overall intelligence of these systems affect how it handles making a decision and what results it can produce. This experiment investigates how the level of intelligence of a computer player in a game of tic-tac-toe affects the number of games that end in draws. It was hypothesized that as the intelligence increased, the number of draws would increase. Six different levels of intelligence were tested by simulating 1000 games between two computer players of the same intelligence levels, and recording the number of draws that occurred. This process was repeated ten times for each level. The results of the experiment supported my hypothesis, as the highest level of intelligence, the "master" level, had the highest average of draws out of 1000. However, while the average number of draws did increase over the course of the experiment, it did not follow a straight progression. In some levels, the number of draws actually decreased compared to the previous level. This was due to changes in the program at some levels that helped the players win the game, which decreased the number of draws for those levels.

Honorable Mention

The Effect of an Excel-based Algorithm on the Number of Calculations It Takes to Solve a Krypto Puzzle

Amy Kaplan, George H. Moody Middle School

Krypto is a somewhat obscure number puzzle generated by drawing five random integers between 1 and 25 and another random integer for the target. Krypto is solved by using the five integers to equal the target using any of the four operations, without having any negatives or non-integers in the process. The purpose of this experiment was to generate a Krypto solver in Microsoft Excel and test out strategies to the puzzle using the solver. The hypothesis for the experiment was "If two strategies are used in a programmed Krypto puzzle, then it will take fewer tries to get to a solution if two odd numbers are forced to be either added or subtracted in order to make an even number." A macro was written to randomly order the integers, randomly choose and order the operations, test for a solution, and record the number

of tries for each solution. The same puzzle was used for both strategies and the control, and it included two odd numbers, one of which was 1, three even numbers, and an even target. Strategy 1 was altered so that there would be a greater chance of making an even number. Strategy 2 function was altered so that a 1 would be either multiplied or divided at the end. The results showed that Strategy 1 was more statistically significant than Strategy 2, because its p value was 0.0011. Strategy 1 had a mean number of 110.54, while Strategy 2 had a mean of 134.89, and the control group had the most with a mean of 169.32. The hypothesis was supported because Strategy 1 had a lower mean and a lower p value. Strategy 1 made even numbers for the even target and was beneficial to solving. In contrast, Strategy 2 may have eliminated some solutions with its placement of integers even though it improved upon the control. For further study, I could introduce another similar number puzzle and test many strategies.

Honorable Mention

The Effect of Fasteners on Force to Break Apart Boxes

Andrew Logan, Tuckahoe Middle School

Which type of fasteners will hold a house together the best under hurricane force winds? What if there was a hurricane? People should have the safest construction they can. Contractors should know what fasteners are the safest and they should be using. The experimenter tested if nails, screws or hurricane clips are the strongest to build houses with. The experimenter made boxes made from real house materials and used the different types of fasteners on each box. The strength of the boxes was measured by a hydraulic jack. The hydraulic jack is a strong lifting tool that was used to pry apart the box. The hydraulic jack moves a small amount when pumped with the handle. The number of pumps it took to pry apart was recorded. The purpose of the experiment was to make houses stronger and safer for people to live in. More houses would be saved and less people would be left homeless after hurricanes. This project will prove which fastener is the strongest choice that people could use in real life on their house to protect their family and valuables.

The Effect of Gear Ratios on Rotations per Minute

Phillip Andrews, George H. Moody Middle School

The purpose of the experiment was to find the gear ratio with the highest rotations per minute and test it on a remote control car. When choosing an experiment the experimenter wanted to find something that was interesting and would help in the future. For example, spending less money on a new motor or buying different gears would save money because gears are 10 times less than a new motor. The experimenter's hypothesis was based upon prior research and wanting the car to go faster. The hypothesis was if a smaller gear ratio was used then the car will have more rotations per minute. When doing the procedure, it seemed easy to do at first until it was realized that there were many more constants than anticipated. It took a long time just to set up, be prepared to test, charge the battery, put data on the computer, and change the gear every time. Then it was tested for 3 seconds and waited for 15 seconds once one trial was over, and then after 10 trials it was to be reset for the next test. The results did increase like anticipated but not as much as expected. There was a pattern at the end of the trials; the battery started to slow down but it never lost all of its charge. In conclusion, the smaller gear ratio did have a big effect on the RPMs; the hypothesis was correct and was supported throughout the experiment. The higher gear ratios had a lower amount of RPMs and the lower gear ratios had a higher amount of RPMs.

The Effect of Windmill Blade Plastic on the Maximum Volts Created in 30 Seconds

Nick Bowers, Williamsburg Middle School

The purpose of this experiment was to test which windmill blade plastic created the most electricity. The hypothesis stated if one tests different windmill blade plastics, then the Elasto plastic blades would create the most maximum volts in 30 seconds. To test this hypothesis, a stand was constructed with the motor

protruding from the top facing outward. A voltmeter was attached to the motor, then the blade assembly was created on Tinkercad software and the models were 3D printed through a 3D printing website. Three different plastics were ordered for each level of the IV: nylon (control), Alumide, and Elasto. Experimentation began by mounting the blade assemblies onto the motor. The maximum number of volts that were seen on the voltmeter in 30 seconds was recorded with a fan blowing at 3.2 m/s (~6 mph) wind speed. There were 10 trials for each IV level. As for the results, the Elasto plastic blades created the highest average maximum volts, therefore supporting the hypothesis. The nylon plastic blades produced the lowest average maximum volts. The hardness/rigidity of the nylon and Alumide plastics were about the same, yet the Alumide, which had a significantly greater mass (31.1% more than the nylon plastic blades, and 24% more than the Elasto plastic blades), created more maximum volts. The Elasto plastic had 9.7% more mass than the nylon plastic, but created a greater amount of maximum volts. The explanation found in research stated that for large-scale wind production, flexible blades were less durable, but for small-scale wind production, tests showed that flexible blades resulted in higher energy production. This is caused by better utilization of slower, more unpredictable wind due to the flexibility. This experiment could be very important in creating small-scale wind power.

The Effect of Jetties on the Depth of a River Carlos Brown Jr., George H. Moody Middle School

In 1876 civil engineer James Buchanan Eads built a jetty at South Pass, LA. The South Pass was one of the entrances to the Mississippi River. It was constantly blocked by sand bars or sediment buildup in the mouth of the river. The sand bars limited trade and created economic and logistical problems for the river. The jetties Eads built were effective immediately proving the theory that jetties increase pressure and move sediment true. The purpose of the project is to find out if increasing the width between jetties increases the depth of the river. They were spaced at 4 cm, 6 cm, 8 cm, & 10 cm, to allow for a wide spectrum. The wooden jetties were put at their respective distances and tides were simulated with a blow dryer and the depth was measured. The results showed a small margin of difference however the 4 cm width ended in the deepest final depth. Therefore the results supported the hypothesis that if the width was decreased then depth would increase. There is a clear connection between the width and depth. The results lead to the conclusion that Eads theory on jetties is correct and that the depth of the river is increased by the decreasing of the width creating pressure. This experiment confirmed the effectiveness of jetties and the effect of width on depth.

The Effect of Cell Phone on the Amount of Radiation Emitted Lucy Deignan, Tuckahoe Middle School

The hypothesis for this experiment is: if four different types of cell phones are tested (HTC Thunderbolt, Droid Razr, iPhone 4s, Intensity II) then the Intensity II will emit the most radiation. As technology thrives, cell phones are getting more, and more popular. Although these popular devices are carried around by millions of people of all ages, many are unaware that cell phones emit radiation. The amount of radiation emitted by cellphones varies by the type of phone, what the phone is processing, the carrier, and the network connection. Many people who know about the danger of cell phones don't know that even when nothing appears to be happening, your cell phone is always receiving and processing information. The action of receiving an e-mail or a notification on an application causes the phone to emit almost as much radiation as receiving a phone call. As cell phones are getting more popular some people are starting to hear about the dangers of cell phones, but they are still not taking the proper precautions to protect themselves from the dangerous gamma rays. This experiment was to test exactly how much radiation was emitted from different types of cellphones. Each cell phone was measured while it was on but not being called, and while being called. Four trials were run for each phone. After all of the measurements were averaged, the hypothesis was not supported. The cell phone that was predicted to emit the most radiation only emitted 0.18 w/kg while on, and 0.28 w/kg while being called. The HTC Thunderbolt emitted the most radiation with 0.13 w/kg while on, and 0.48 w/kg while being called. The HTC Thunderbolt emitted the most radiation out of the cell phones tested. The purpose of this experiment is to see what type of cell phone emits the most radiation, and which type is the safest to carry around.

The Effect of the Type of Battery on its Internal Resistance Idoia Dizon, George H. Moody Middle School

When shopping for batteries, most people do not even wonder about the importance of one type of battery's internal resistance compared to another's. A battery is a device that has the ability to change chemical energy to electricity, and each type has a different starting internal resistance. The internal resistance of batteries is the voltage across the element divided by the current going through it. All batteries have some amount of internal resistance. This is because the two parts of the batteries that generate energy when connected, the anode and the cathode, are separated by a barrier that soaks up some energy before it is used. The purpose of this experiment was to determine the effect of the type of battery on its internal resistance. In the experiment, a circuit was created using a breadboard, wires, resistors, a battery holder, and two multimeters. The ten batteries per variable were attached to the circuit using the battery holder, and their voltage output, measured in volts, and their current, measured in amperes, was recorded using the two multimeters. The values were then substituted into an equation and calculated to determine the internal resistance of Alkaline, Lithium Cell, Silver Oxide, and Carbon Zinc batteries. The results supported the hypothesis that Alkaline batteries would have the lowest internal resistance compared to Lithium Cell, Carbon Zinc, and Silver Oxide batteries. The Alkaline variable had the lowest mean internal resistance of $0.0575\ \Omega$. The Silver Oxide batteries were $0.0652\ \Omega$, the Carbon Zinc batteries were $0.0685\ \Omega$, and the Lithium Cells were $0.2024\ \Omega$. These results showed that Alkaline batteries have a lower average internal resistance compared to other popular types of batteries.

The Pro's and Con's of Buying and Leasing Different Trucks

Jack Drimer, George H. Moody Middle School

There are two different options to obtain a new vehicle: buying and leasing. Buying is typically done though financing all or most of the vehicle's cost, although some buyers pay the entire amount in cash. At the end of the financing period, once the money is paid back to the bank, plus interest, the consumer owns the vehicle. An alternative to buying is leasing, where the consumer makes predetermined payments to use the car for a set period of time. However, at the conclusion of a lease the consumer usually gives the vehicle back to the dealership, although sometimes they can purchase the vehicle. The goal of this project was to research the different payment options between buying and leasing a vehicle and to compare the cost of the two options. First, the total amount of money that would be spent financing each of the trucks was calculated for two and three years with rates from Bank of Virginia. Then, the residual value of the car after two and three years was calculated and then later subtracted from the total cost of financing to simulate the consumer selling the vehicle at the end of financing. Next, the total cost of a lease over two and three years was calculated. The total cost of leasing was then compared to the cost of financing with the assumption that the vehicle could be sold for its resale value at the end of the term. It was concluded that financing is better for consumers who plan on owning the same car for a long period of time because they will not have to pay any money to own their car once the financing period concludes. However, leasing is better for consumers who want to switch between many different newer cars because they don't have to worry about selling their car at the end of financing and the monthly payments are lower. Also, the down payments in leasing are generally much less than in financing. Finally, an interview was conducted with George Adkins, sales manager of Richmond Ford, to further the study of buying and leasing in topics that may not have been captured by the comparison of dollars.

The Effect of Backpack Strap Variety on Backward Force in Newtons

Lindsay Graham, George H. Moody Middle School

Backpacks causing back pain are a large problem in school systems. New technologies, such as loadspring strap technology by Adidas, give a buffer between the straps and the back and help minimize the pain. Other backpacks, such as common 5 cm wide strapped simple backpacks, are common and were the control in the experiment. Another type of backpack, a one strapped messenger bag, is common and pulls shoulders downward more. The purpose of the experiment was to figure out which backpacks brought the least amount of force, and to figure out which is the best for backpack manufacturers to make and for children to buy. The hypothesis was, if a 5 cm wide strapped backpack, 5 cm wide one strapped messenger type backpack, and 5 cm wide "loadspring" strapped backpack are used, then the "loadspring" strapped backpack will cause the least amount of backward force for a child. In order to experiment, a model was built, mainly consisting of a wood "T" and spring that hooked onto a

metal rack. Each backpack was put onto the model 10 times for every weight put inside; 2.27, 4.54, and 6.80 kilograms. The results found showed that the messenger bag pushed with the least force by up to 3.50 Newtons. The others were very close. The control backpack was 0.66 Newtons less, but changed with the next weight. The loadspring backpack was 0.50 less in the second and with the last weight, was only a mere 0.19 Newtons. This happened and was concluded because the loadspring and control had the same general backpack design, except for the original loadspring strap. The messenger bag gave less force because it pulled down more, instead of backward and displaced in a different direction.

Green Computers: Computer Component Energy Use and Management

Ethan Hall, Thomas Jefferson Middle School

Who does not like to save money while helping the environment? The goal of this experiment was to find out what component of a computer (the independent variable) consumed the most energy (the dependent variable) to influence people to change their habits by making changes in their computer to save energy, lower their electric bill and most of all save the Earth. The hypothesis was "If the amount of energy each computer component consumes is measured, then the central processing unit (CPU) will consume the most energy." The findings supported the hypothesis that the CPU consumed the most energy. The CPU consumed over 65 more watts per hour than the monitor or printer. An interesting finding was that the CPU used less energy while in sleep mode than the printer used while in sleep mode. There were several recommendations to save energy that resulted from this experiment. First, turn off the equipment after use instead of setting the component to sleep mode. Second, energy management software (for example: Granola) could be used to help determine at what times the computer equipment uses the most energy so habits can be adapted to conserve energy and save money. Finally, since the CPU used the most energy due to the complex operations that it performed, the more programs that could be closed when not in use (for example: not set to run in the background or to continuously run when the CPU is on) the more energy saved.

The Wise Man Built his House Upon...The Effect of Type of Soil on the Stability of the Structure

Macrae Hanke, Swanson Middle School

The point of the experiment was to find out in which soil does a structure have the most stability when hit with a lacrosse ball. This helps people to know what types of soil they should and should not build on in order to be safe. The different soils were sand, topsoil, a half and half mixture of sand and topsoil, and a clay composite dug up from behind a shed in Arlington, Virginia. The hypothesis of the experiment was that if the type of soil was changed to the clay composite then the structure would be the most stable when hit with the lacrosse ball. In order to carry out the experiment, a lacrosse ball was rolled down a gutter at a balsa wood structure rooted in 4 different types of soils. The distance from the front lip of the box to the structure before and after was measured in centimeters. The measurement was then recorded on the data table. The experiment was repeated 32 times, a total of 8 for each level. The key results to the experiment were that the lacrosse ball hit the structure once and then came back to hit it again softly. In addition, the sand and topsoil mixture made the structure the most unstable, but the sand was a close second. During the days of the experiment it was very cold, so the topsoil was frozen together and had to be broken apart with a shovel. Also, the clay composite was very rocky and full of sticks. In conclusion, the clay composite proved to make the structure the most stable. However, the clay composite was full of sticks and stones because it was dug up from the ground in Virginia which the soil is very varied in what is in it. The sand and topsoil did the worst because the sand shared its very unstable traits with anything it was combined with, like topsoil.

Creative Columns

Terek Kirsch, Gildersleeve Middle School

The purpose of this experiment was to demonstrate how the cross sectional shape of a column influences the weight that the column can hold. The scientist calculated the relative strength of three different shapes; a cylinder, square, and triangle and then compared the theoretical relative strength test results. Each column was made from the same poster board construction paper, and the length and perimeter of the shape was held constant. The tests were done by loading the column with a bucket filled with water until the column buckled. This experiment tested which construction shape holds the most weight. Based

on the theory and the test results, the cylinder was the strongest of the three shapes for the constant perimeter. The square was the second strongest shape, and the weakest was the triangle. This relative strength trend was consistent with the theory, though the total difference in the tested strength and the calculated difference were not the same. What should have happened under perfect conditions was nowhere near what happened in the experiment, but in both theory and practice, the cylinder was the strongest. In conclusion the cylinder was the strongest of the three shapes for the constant perimeter. The square was the second strongest shape, and the weakest was the triangle.

The Effect of Democracy on Human Development

Anuj Kotak, George H. Moody Middle School

Since its emergence in Athens in the 5th century BCE, and prominently rising with American Independence, democracy's beneficial effect on its citizens has been debated. Democracy is a political system in which all citizens of a polity have the right to vote and participate in political and civil life. Ideal democracies protect each citizen's human rights and prosecute lawbreakers indiscriminately. The Democracy Index rates the governments of nations from zero to 10 in respect to democracy accurately by considering literacy, government issues, universal suffrage, free and fair elections, political participation of citizens, a democratic culture, and more. The Human Development Index is a composite statistic of income, education, and life expectancy at birth, and ranks countries on a scale of zero to one. The purpose of the experiment was to determine whether democracy contributes to a healthier, more literate, and more prosperous population. In this study, the four (4) levels of the Democracy Index were the levels of the IV. Twenty-five (25) random countries were selected from each level of democracy – Authoritarian Regimes (Democracy Index values from 0.00 to 3.99), Hybrid Regimes (values from 4.00 to 5.99), Flawed Democracies (values from 6.00 to 7.99), and Full Democracies (values from 8.00 to 10.00). The Human Development Index for each of these countries (100 in total) was found. The data supported the research hypothesis that as the quality of democracy increases, the human development value increases as well. One explanation for these results is that true democracy is founded "of the people, by the people, and for the people," in which citizens can decide what laws they want passed, etc. A possible improvement to this experiment would be to focus on the individual aspects of human development, such as democracy on gross domestic product per capita, literacy rates, and so on to find a possible outlier that may change these results.

The Effect of the Type of Common Building Materials on Soundproofing-cost Efficiency

Logan Lantz, George H. Moody Middle School

Sound absorption is a simple solution to conflicts such as ear trauma, annoyance, and interference with communication. The decision to use a sound-reductive material is related to the materials cost versus performance. The quality of a building material affects its cost because materials with greater performance often cost more than those with less. The purpose of this experiment was to determine the effect of the type of common building material on soundproofing-cost efficiency. The hypothesis was if the Quiet Rock is used, then the sound absorption to cost efficiency will be the greatest based upon background information of cost and relative sound absorption levels. The first step in the experiment was to place one sheet of standard drywall in a sound-reductive room where a sound source was placed in the center of the sheet, one third of a meter from the sheet on the pedestal. The decibel meter was then attached to the center of the sheet to measure the decibels of sound generated by the source. Once the sound source and meter were in the designated positions, the source generated its sound (same amount of decibels for each trial) and the meter collected the measurements. The results indicated that the mean of the efficiency of the standard drywall is the least out of the levels of the independent variables (\$0.087/dB). This mean being the lowest of the independent variables means that it possesses the greatest efficiency. The greatest mean or lowest efficiency was possessed by the wood wall paneling (\$0.684/dB). The other means for the independent variables were \$0.184/dB and \$0.569/dB by the Quiet Rock and the acoustical wall panels. The research hypothesis was not supported by the data that if the Quiet Rock is used, then the sound absorption to cost efficiency will be the greatest. It was concluded that the cost of the materials did impact the efficiency by lowering the efficiency significantly.

Compressed Air Rockets

Ferris Linde and Justin Williams, Swanson Middle School

The purpose of this experiment was to determine the perfect amount of psi of thrust pressure (psi) and the angle of trajectory needed to launch a compressed air rocket the furthest distance. The investigators hypothesized that the largest psi and a 60 degree of angle trajectory would propel the rocket the furthest distance. This experiment required a compressed air rocket kit and an open site to test the hypothesis by measuring the distance traveled. The investigators used a psi gauge to measure the psi and a protractor to measure the angle of trajectory of the rocket starting with 30 psi/60 degrees, the "Set Control". The investigators observed the rocket soar through the air and measured the average distance traveled over 10 trial launches. The tests were done for 30, 60, and 90 psi. Then rockets were launched at 30, 60, and 90 degree trajectory angles with a psi control of 60 psi. The distance was measured immediately after the landing of each trial test firing. It was correct in that 90 psi compression would cause the rocket to travel the furthest distance. The hypotheses; the rocket would travel the farthest at a 60 degree trajectory, was found to be incorrect. The experiment data demonstrated that the rocket traveled the furthest with a 30 degree angle of launch.

Engineering and Math B

First Place

The Effect of Vehicle Steering-control Systems on Autonomous Parking

Nikhil Paul, George H. Moody Middle School

Modern cars have used front wheel steering drive for lateral mobility. Typical robotic vehicles have used rear wheel differential drive for mechanical steering. In the past, all-wheel steering control systems have failed to provide a popular option due to high cost and low benefit. The purpose of this research is to explore the benefits of using three different drives (Steering, Differential, and Steering Differential Hybrid drive) on autonomous parking. Based on the distinct features of each drive, the hypothesis was that the drive with steering in the front and differential in the rear would outperform the other drives. A robot car model with steering and differential control modes and navigation sensors was built. Individual programs were developed to control the vehicle with one of three mechanical steering modes. A parking lot field was constructed for driving, parking space detection, turning, and parking. Each drive was tested with 10 individual trials and video recorded. The files were converted from video to images to extract vehicle position coordinates. The distances from final vehicle center to optimal parking position were calculated. The experiment indicated that autonomous parking was best achieved by hybrid steering-differential (mean = 4.3, SD = 1.5), followed by steering drive (mean = 8.6, SD = 3.5). The hybrid drive was statistically more accurate in parking than steering ($t = 5.047$, $DF = 18$, $p < 0.05$). These results support the hypothesis and suggest that active rear differential technology should be considered for integration with current autonomous car design strategies. The next step would be to evaluate if the same principles apply to real car designs.

Second Place

The Effect of Material Type on Sound Absorption

Philip Maruri, Tuckahoe Middle School

The objective of the experiment was to determine which type of material would be best to reduce sound levels in a building or house. The information was important to people who design, build, or live in buildings or houses because background noises were not only annoying, but the background noises

created high levels of stress and reduced concentration. High sound levels will also hurt your ears, making the range of sounds you can hear smaller. The following was hypothesized: "If different materials were tested for how much sound they absorb, then the foam board would reduce the most sound". The experimenter ran five trials for each of the materials tested which included no material (the control), carpet, foam, plywood, and sheetrock. Materials were placed between a doorway and two boxes (one on each side of the doorway). One box had the source of sound while the other had the receiver. In the experiment, sheetrock absorbed the most sound, followed by carpet, plywood, foam, and no material (in descending order). The data did not support the hypothesis since sheetrock absorbed the highest amount of sound. The results surprised the experimenter because the research made the experimenter believe that soft and uneven surfaces absorbed sound the best. Based on the data, the experimenter concluded that airy but hard materials are going to absorb the most sound.

Third Place

The Comparative Analysis of Hurricane Evacuation Systems

Yug Rao, George H. Moody Middle School

Evacuation routes are designated roadways for civilian use to vacate the danger zone in a state of emergency. Evacuation methods include contraflow, designated route, and gradual exit openings. Contraflow, or lane reversal, refers to the evacuation method when the inbound lanes on a highway are reversed to go outbound. Next, the gradual exit opening method opens the exits of an area in the most danger and then moves down in priority. In the designated route method, vehicles follow signs to specified routes. The purpose of this experiment was to research which evacuation method works best to evacuate the most number of people in the least amount of time to save their lives. Comparative studies about various evacuation methods would help government officials strategize the best plan of action and know how much time would be needed to evacuate the area. In real life, this information would be vital not only to escape the hurricane, but also to escape the storm surge, the source of about 90% of all deaths in a hurricane. It was hypothesized that if the contraflow method was used, then the traffic congestion, measured by mean vehicle speed, would be the lowest. For this experiment, the VISSIM software was used to construct a network of highways around Norfolk and Interstate 64. Simulations were run for each evacuation route system. The mean vehicle speed of the no designated route and the designated route methods were very low compared to the vehicle speeds in the gradual exit opening method and the contraflow method. The difference between the speeds of the gradual exit opening method and the contraflow method was not statistically significant. The hypothesis was not supported because the mean speed of the contraflow method was not the highest, which meant that the congestion was not the lowest. However, the contraflow method had a higher speed than that of the no designated route and designated route methods.

Honorable Mention

The Effect of Sorting Algorithm on Time Taken to Sort a List

William Parker, George H. Moody Middle School

The purpose of this experiment was to determine which type of sorting algorithm was the most efficient at sorting lists of different lengths. The insertion sort takes the lowest element in the array and puts it in a separate sub-array and removes it from the main array. The selection sort finds the smallest item in the array and swaps it into the correct position, then continues going through the array. The merge sort splits the array in half until it is a collection of single data points, and then merges them by going backwards. The quick sort divides the list into two sub-arrays based on if the numbers are greater than or less than the "pivot," the semi-random number from the array. It then repeats the process with the sub-arrays, and then merges them. The hypothesis was that if different sorting algorithms are run on differently sized lists, then the quicksort will do best on large lists and the comb sort on small lists. In order to perform this experiment, the sorting algorithms were written by the experimenter in C++, using Visual Studio 2010. A milliseconds timer was incorporated into the code, so the experimenter only had to run the program and

record the time in milliseconds it took for the program to sort the list, which was the dependent variable. Each algorithm was tested 50 times with small lists (100 numbers), 50 times with medium lists (1,000 numbers), and 50 times with large lists (10,000 numbers). The insertion sort was the slowest, followed closely by the selection sort. The quick sort was the second fastest, followed closely by the merge sort, in the middle. The comb sort was the most efficient sort. Several factors contributed to the results, including computational complexity. When n increased for $O(n^2)$ and $O(n \log n)$, it increased faster for $O(n^2)$ than for $O(n \log n)$, resulting in $O(n \log n)$ being faster.

Honorable Mention

The Effect of Trade Balance, Trade Restrictions, and Inflation on the Exchange Rate of USD versus BRIC Currencies

Taha Shaikh, George H. Moody Middle School

There are many kinds of currencies used around the world today. When comparing these currencies, one must use exchange rates to find their equilibrium. However, that exchange rate is always changing. An exchange rate between two currencies can be drastically affected in minutes. What is it that causes this randomness in exchange rates? The objective of this experiment was to determine the effect of trade balance, trade restrictions, and inflation rates on the exchange rate of the U.S. dollar compared to the currencies of Brazil, Russia, India, and China (BRIC). The hypothesis of this experiment was: If trade balance, trade restrictions, and inflation rates are applied to the exchange rate of the U.S. dollar as compared to the currencies of the BRIC countries, then inflation rates would make the largest impact on the value of the U.S. dollar. The independent variable in my experiment would be the type of economic variable that is being compared to the U.S. dollar. To perform this experiment, the data on trade restrictions, trade balance, inflation rates, and exchange rates was collected for the BRIC countries for the last 20 years. The sets of data for inflation rates, trade restrictions, and trade balance were averaged and compared to the sets of data for exchange rates, using a Pearson Product Coefficient Calculator. The set of data that had the highest correlation and lowest statistical difference was determined to be the largest determinant of the strength of the U.S. exchange rate. Trade Balance had the largest effect on exchange rates with a coefficient of 0.39. Inflation rates were shown to have the least correlation to exchange rates with a coefficient of 0.2025. This data did not support the hypothesis, because trade balance had the largest impact on exchange rates compared to inflation rates. To decrease exchange rates between countries, they must appreciate their exports to that country, eventually increasing their purchasing power in the global marketplace.

Honorable Mention

The Effect of Various Methods of Stock Analysis on Stock Performance

Sudarshan Sridharan, George H. Moody Middle School

A stock is a part of a company or corporation that is put for sale on the stock market for a set price. Buying and selling the stock will alter the stock price. A stock can be bought for a certain price, and then sold back for another price. When a stock is bought or sold, it is called trading. Stocks are traded on different exchanges depending on what the company does to make a profit. One of the largest trading exchanges is the New York Stock Exchange or commonly referred to as the NYSE. The other trading exchange is the NASDAQ for technology stocks. Trading of stocks occurs on trading floors or exchanges across the world. When referencing the different exchanges people call it the stock market. Stocks can make a lot of money for people who are successful in the stock market. However, many people are still in the dark that the stock market is a very precise science, not a guessing game where people buy stocks and then hope it goes up. This experiment can help people find out which method of stock picking is better, and which method they would like to use. The hypothesis was: If Technical Analysis and Fundamental Analysis are used to predict stock performance over a period of two weeks, then Fundamental Analysis will predict the stock performance more accurately than Technical Analysis. The stocks Apple Inc. (Ticker: AAPL), Diamond Foods(Ticker: DMND), and Netflix (Ticker: NFLX), were

chosen as the three stocks that would be monitored of the time period of two weeks because those stocks do not have any major market moving news except quarterly earnings reports. The hypothesis that Fundamental Analysis would more accurately predict the stock movement was supported when Fundamental Analysis predicted the stock movements 100% correctly, compared to Technical Analysis' 66.67% accuracy rate. Before it can be said that Fundamental Analysis is a better form of Analysis than technical analysis, more experiments like this must be conducted.

The Effect of Bridge Design on Bridge Stability Alexis Massenburg, George H. Moody Middle School

The purpose of this experiment was to determine whether or not bridge design has an effect on bridge stability. The experimenter used the two most basic bridge designs, the beam and truss bridge. It was established that the beam bridge was the weakest type of bridge, yet it was fairly similar to the truss bridge. Both bridges were supported by two horizontal beams supported by piers. It was hypothesized that if a truss bridge design was applied to the bridge, then the bridge would support the most weight. First for the procedure was to draw the top of the trapezoid (15 centimeters), the bottom of trapezoid was 18 centimeters, the sides were 7.5 centimeters, and the width was 5 centimeters apart. This was the final layout on graph paper, and then the experimenter hot glued the balsa wood pieces together. The bottom portion was made from balsa pieces, 5 centimeters long. In addition, the beam bridge was similar to an upside down truss bridge. Next, the experimenter placed two tables about the same height 2-4 meters apart. Then, each bridge was placed in-between the two tables. A ruler was placed through the bridge, and a piece of string 31 centimeters long was tied through the ruler hole. Next, a bucket was tied to the piece of string and one liter of water was added until the bridge broke. This procedure was repeated for each bridge. After all the data was put into a table, the experimenter determined the averages for each of the two bridge designs. The truss bridge design's average was 4.5 and the beam bridge design's average was 2.4. Also, the median and the mode were found as well, to add to the statistical test. According to the data, my hypothesis was supported. In other words, the truss bridge design supported more weight than the beam bridge design.

What Is the Effect on the Type of Bridge on the Amount of Weight the Bridge Can Hold? Anna Nowalk, Kenmore Middle School

In order for bridges to be safe, all of the forces acting upon them must be balanced. Forces such as tension, compression, and many others must be balanced so that the bridge stays stable. The purpose of this experiment was to see which type of bridge (made of popsicle sticks) could hold the most weight. It was hypothesized that the arch bridge would hold the most weight. The bridges were built out of popsicle sticks. Then weight was added to them until they broke. The amount of weight was measured. In two trials, the girder bridge held an average of 2.4 kg, the truss bridge held an average of 5.9 kg, the arch bridge held an average of 2.2 kg, and the suspension bridge held an average of 6.3 kg. In the end, the hypothesis was rejected.

Smartphone Brands on Speed of Locating Destinations on Google Maps Lisa Qin, George H. Moody Middle School

Operating systems are programs designed to open and run other programs on a computer system and process data. The application Google Maps contains Geo Data, which is designed to store/analyze geographic information. The purpose of this experiment was to determine which smartphone processed Geo Data faster using the Google Maps app. This experiment applied to the real world; in the future, these results could have influenced a buyer's decision when choosing a smartphone to purchase, in order to purchase the phone which processed data faster. It was hypothesized that if Google Maps was used on an iPhone 5 and Samsung Galaxy S4 to find a location, then the total amount of time needed by the iPhone would be shorter than by the Samsung smartphone. The type of smartphone was the independent variable, and the amount of time needed by the smartphones to find a location on the Google Maps app was the dependent variable. The experimenter performed the same procedure for the experiment five

times for each of the fifteen locations on Google Maps: After searching and locating each place, the amount of time needed to locate each place was measured by a stopwatch and recorded. After conducting the experiment and analyzing the data it was found that less time on average was needed to find the locations using the iPhone 5 than the Samsung Galaxy S4; the experimenter's hypothesis was supported by the data. This experiment could have been improved by expanding the variety of smartphones used, as well as testing different operating systems on the same type of smartphone. The topic of smartphones/operating systems could have been further studied through research on operating systems and their effect on the speed of processing data on not only Google Maps, but downloading videos, opening e-mails, etc. The findings of this experiment agreed with past research and findings.

The Effect of Wheel Covering on Vehicle Speed

Kevin Rao, George H. Moody Middle School

The purpose of this experiment is to determine which of three different wheel coverings could allow a vehicle to move the fastest. The hypothesis was if pneumatic tires were used, then the vehicle would travel the fastest relatively to treads and balloon tires. In order to run the experiment, one needs a Lego Mindstorms NXT, NXT 2.0, or EV3 set. If one uses the NXT set, be sure to acquire treads and pneumatic tires. If one uses the NXT 2.0 or EV3 set, be sure to acquire balloon tires. The procedure for the experiment is as follows. Construct a 4-wheeled vehicle. Program the vehicle to run for 15 seconds. Run the program at a location with constant terrain. Upon completion, record the distance from the starting point. The results of the experiment are as follows: The balloon tires had an average speed of 0.3910 meters per second. The pneumatic tires had an average speed of 0.2333 meters per second. The treads had an average speed of 0.1742 meters per second. From the given information, it is possible to conclude that balloon tires allowed the vehicle to go the fastest, thus rejecting the original hypothesis.

The Effect of Different Antenna Design on the Amplification of a Wi-Fi Signal

Prachi Sadekar, George H. Moody Middle School

Antennas are transmitting and receiving devices that can be used to amplify or radiate electromagnetic waves. Antennas are shaped differently to serve a variety of purposes. The purpose of this experiment was to determine which type of antenna amplified the Wi-Fi signal strength (dBm) the most. Based on the idea that reflector or concave antenna reflected wavelengths the best, it is believed that if concave, convex, flat and no extra antennas are used, then the group with the concave antenna will see the greatest increase in the Wi-Fi signal. Three pieces of cardboard and aluminum foil were cut out, attached to each other in perfect alignment, curved into 3 different antennas (concave, convex and flat) and placed on a wireless router which formed the bodies of the antennas. Then regular printer paper was cut out into three pieces of 10 cm x 15 cm ovals. The signal amplification was measured in dBm for each of the three antennas and without an antenna (control). The results indicated that the concave antenna amplified the Wi-Fi signal the greatest with a mean of -67.6 dBm followed by the flat antenna, convex antenna and no antenna respectively. The data supported the research hypothesis that if concave, convex, flat and no extra antenna is used, then the group receiving the concave antenna will increase the Wi-Fi the greatest. Based on the mean dBm values of the amplification of the Wi-Fi signals determined in this experiment, there appears to be a direct correlation between the curvature of the antenna and amplification of the signal. Based on the observation that the concave antenna reflects wavelengths the best, additional experiments should be done using a different reflective material and increasing the distance of measurement.

The Effect of Sail Material on Sailboat Speed

Kayla Salmon, Gunston Middle School

In competitive sailing, it is always important to look for ways to make your boat faster. A different shaped hull or sail could be the difference between winning or losing a race. The purpose of this experiment was to find out if the material of the sail affects the time it takes a sailboat to sail one meter. That is, which sail material made the boat the fastest? The materials tested were chosen based on their porosity and elasticity. The independent variables were plastic wrap, cotton, wax paper, tissue paper, and Ripstop, a

material currently used in racing sails. Sails were made of each material and attached to the boat. Then, the amount of time it took for the boat to sail one meter was recorded. The hypothesis was that Ripstop, having zero porosity and no elasticity as well as being a common sail material, would perform the best, having the shortest time and resulting in a faster sailboat. The results supported the hypothesis by showing that Ripstop sails made the boat significantly faster than when using other materials, with an average time of about 5.8 seconds. Out of all the materials, plastic wrap made the boat the slowest, with an average time of about 15.6 seconds. This experiment supported the hypothesis that Ripstop is the most effective sail out of the materials chosen. The data collected in this experiment could be used in further experiments to determine the exact qualities of a certain material in terms of its effectiveness as a sail material.

The Effect of Different Materials on Force on a Scale When a Ball is Dropped on the Scale

Seth Savage, George H. Moody Middle School

Football has been a favorite sport for many people to play and watch. Less and less people have wanted to play because of concussions. The purpose of this experiment is to lower injuries in contact sports and to study the effect of different materials on force on a scale when a ball is dropped on a scale. The experimenter's hypothesis is if six different materials were used, then polymer would protect the best against the ball because it is the only material used in an actual football helmet. The experiment started by obtaining all the materials needed. A meter tall cylinder made out of paper was placed in the center of the scale. The ball was then dropped on the scale and the reading was taken 12 times for each material. In the end polymer had the most protection with 17 pounds recorded on the scale on average with a standard deviation of 2.85. The hypothesis was that polymer would perform the best, so the experimenter's hypothesis was therefore supported.

The Effect of Varying Concentrations of Salt on the Efficiency of a Magnesium-salt Water Fuel Cell

Gurumanpreet Singh, George H. Moody Middle School

The overall efficiency of the Magnesium-Salt Water fuel cell is its ability to transform the chemical reaction between Mg and electrolyte to produce electric output. Electrolyte (salt water) concentration is the main contributor to current output. Magnesium reacts with salt water to cause an oxidation reaction thereby causing electron flow. Higher concentration of salt has the ability to increase the reaction rate and cause more electrons to flow and hence generate higher electrical power output. The purpose of this experiment was to measure the speed of the Mg-Salt Water fuel cell powered truck by varying the electrical power output of the cell using electrolyte solution of different salt concentrations. The engineering objective was to assemble the truck and the fuel cell from a kit and then power the truck from the electrical output of the cell using electrolyte of varying concentrations. The hypothesis was that if the concentration of salt is varied in the water used in a salt water fuel cell then the fuel cell efficiency will be more for higher concentrations of salt. The experiment was designed to measure the effect of the independent variable (salt concentration) on the output power produced by the fuel cell in terms of dependent variable (time taken by the truck to travel a fixed distance). The results indicated that the fuel cell power increased for salt concentrations from 5% to 25%, and it remained practically constant for salt concentrations from 25% to 50%. The engineering objectives were met, but hypothesis was proved wrong. The results suggest that Magnesium-Salt Water fuel cell power output achieved its maximum capacity at 25% salt concentration and beyond that it remained unaffected by further increase in concentration level.

Get Over It

Annabeth Stokely, Thomas Jefferson Middle School

How much weight do bridges hold? Does one type of bridge have a higher weight capacity than another? The purpose of this experiment was to find the effect of bridge design on weight capacity. The hypothesis was, if the effect of bridge design on mass capacity were tested, then the suspension bridge would hold the most mass. Two bridges of each of the six designs were built from Popsicle sticks. Strings with buckets attached were tied where the roadway would be and filled with gravel until the bridge broke. The buckets were then weighed on a scale. The girder bridge held an average of 10.4 kg; the truss bridge

held an average of 8.25 kg; the cantilever bridge held an average of 5.85 kg; the arch bridge held an average of 5.8 kg; the cable stayed bridge held an average of 4.7 kg; and the suspension bridge held an average of 3.15 kg. Overall, the girder bridge had the greatest mass capacity, and the hypothesis was rejected. Experiments like this can help engineers determine which bridge design would be the best to use.

The Effect of Delta Wing Span on Airplane Flight

John Strader, George H. Moody Middle School

The purpose of this experiment was to determine how the length of wingspan effected the flight distance of a miniature airplane. Based on his research, the experimenter hypothesized that the airplanes with wider wings would fly a farther distance than those with narrower wings. The experimenter cut seven airplanes out of balsa wood keeping everything constant except for the width of the trailing edge. A fuselage (a tongue depressor) was attached using duct tape and a penny was glued on the top of the nose to balance weight. Each plane was launched 20 times, and the data were recorded and analyzed. The experimenter observed that with the exception of the plane with a wingspan of 10 cm, the distance flown decreased with increase in wingspan. A t-test was run, and the data of the plane with a 10 cm wingspan was proven to be arrived at by error, thus confirming the experimenter's observations and rejecting the hypothesis. It was concluded that the narrower the wingspan, the farther the plane would fly.

The Effect of Longboard Deck Shape on Speed

Alexander Stuart, Tuckahoe Middle School

The objective of this experiment is to solve the problem question, "Do different shapes of longboard decks generate more speed?" The experiment was conducted using four different longboard deck shapes. The cruiser shape longboard deck, the stingray shaped longboard deck, the pintail shaped longboard deck and the drop through shaped longboard deck. The experiment took place on Hepler Road, which is a smooth paved road with a slope of 0.41° . The rider was timed going down Hepler roads slope and the distance he rode was marked. The distance and time was used to calculate the speed in meters per second. The drop through deck shape had the highest average speed out of all four decks with the cruiser shape coming in second, the pintail in third, and finally the stingray in last. If future experiments were to be conducted, they should not use a human as a method of guiding the board, and use cables or rails instead to remove human variation. Also, the experiment should be conducted indoors to remove variations of the environment.

The Effect of Different Color Lights on Distance Traveled by a Solar-powered Car

Daniel Sun, George H. Moody Middle School

Solar-powered vehicles are revolutionary vehicles that have changed the world enormously. There are many aspects, for example, colors, lighter parts, etc., that could drastically change the distance traveled by a solar-powered car. The purpose of this project was to determine how far a solar-powered car would go when exposed to different colored lights, created with different color films. The levels of the IV were blue, red, yellow, and clear. Clear was the control. Four solar-powered cars were set up under the regular sunlight on a flat surface, with their solar cells covered to prevent movement. Each solar cell had a different color see-through film attached to it. Once the timer was set and ready, the covers were taken off and the cars started to move. Once the set amount of time was up, the cars were stopped and the distances traveled were measured in centimeters. The results were against the hypothesis saying that if different color lights were tested on distance traveled by solar-powered cars, then the blue film would absorb the most heat and go the farthest. It can be concluded only that solar cells don't absorb heat, therefore making the control, which was the car without the film, the most efficient. Also, according to the data collected, the blue would be the least efficient, blocking out most of the light and therefore going the shortest distances.

The Effect of Overclocking on Core Performance

Qian Wang, Tuckahoe Middle School

Many people today are dissatisfied with the performance of their computers. They want their computers to be as fast as possible, but do not want to pay money for upgrades or buying a new computer. A way to effectively boost computer performance for free is overclocking the CPU. Overclocking is the increase in frequency, or clock rate of a component. This increases its speed at which it runs, which in turn, increases performance. The objective of this experiment was to find out how overclocking affects CPU performance. The experimenter used Cinebench to calculate the performance for a computer's CPU at different clocks to test if the hypothesis, "If the clock of the CPU is increased, then there will be a linear pattern in the increase of performance" was correct. The CPU performance increased as the clock was increased, but the hypothesis was rejected. There was not a linear pattern in the increase of performance while overclocking, instead, the performance increase gradually became smaller as the CPU was overclocked.

Environmental Science A

First Place

Utilizing Methanol-enhanced Denitrification and Macrophytic Pollutant Absorption in a Novel Multicore Nitrate Filtration System to Aid in Marine Denitrification Efforts

Colin Fenster and Jack Lohmann, Douglas S. Freeman High School

The commercial, economic, and recreational values of the Chesapeake Bay have been threatened in recent decades as rising nitrate levels have led to eutrophication of its waters, with excess algae depleting oxygen levels and devastating local ecosystems. Methanol-based denitrification has proven effective, but methanol exerts adverse effects upon the aquatic ecosystem; however, recent research has indicated the viability of C³ macrophytes in removing methanol from water, a breakthrough for the water treatment industry. The purpose of the experiment was to test the viability of a methanol-based system to remove nitrates from water while using *Ceratophyllum demersum* to absorb the methanol, negating adverse environmental impact. Deionized water treated with 1.1 mg/L of nitrate was anoxified and pumped through a system of clear PVC pipes at a volumetric flow rate of 1.8 L/hr. Spending approximately 40 minutes in the anoxic carbon-based denitrification chamber before entering the macrophytic chamber for 40 minutes, the water was then sampled, six times, for 4.5 minutes every 30 minutes. The final mean nitrate value of 0.28 mg/L was significantly lower than the starting value of 1.1 mg/L, indicating that the system was effective at reducing approximately 74.5% of nitrates present in the water. While definitive methanol testing could not be conducted due to equipment restraints, qualitative testing indicated a decrease in methanol concentration. A chi-square test indicated a significant difference between the means of the groups ($\chi^2 = 8.41 > 3.841$). The results from this experiment show that the filtration system tested has the potential to revolutionize denitrification efforts within aquatic ecosystems. The indication that such a system could be scientifically sound is in concurrence with research by Kazasi, who found methanol to be an effective initiator of nitrate-consuming bacterial growth.

Second Place

A Comprehensive Comparison of the Effectiveness of Environmentally Friendly Anti-fouling Alternatives

Ronald Cutler and John DeGaetani, Chesapeake Bay Governor's School for Marine & Environmental Science

Five newly developed environmentally-friendly treatments were researched and obtained for effectiveness testing against a control and one another on Pinewood and PVC substrates. Barnacles settling onto boats, ships, piping, and many other submerged surfaces have many harmful practical consequences. In addition, the bioaccumulation of popular but toxic copper fouling technologies is posing a threat on marine life and the ecosystem. The target species seeking prevention, barnacles in the Chesapeake bay (*Balanus improvisus* & *Balanus subalbidus*), was shown to be inhibited effectively (zero settlement) by an ivermectin compound treatment and medetomidine treatment on both substrates. The other three treatments, ultrasonic sound waves, capcaisin, and a fungus extract from *Cladosporium* sp. showed variable effectiveness on both substrates.

Third Place

The Effects of Open and Closed Systems on the Mortality of Soft Shell Crabs

Katherine French, Chesapeake Bay Governor's School for Marine & Environmental Science

Blue crabs (*Callinectes sapidus*) are a popular source of revenue within Virginia. Soft crabs, which are blue crabs in the process of shedding their exoskeletons, often experience mortality when they shed in stressful environments, making it crucial for crabbers to have controlled floats for them to shed in. The two most commonly used crab shedding systems are open and closed. Open systems pump water from a water source and are subject to weather conditions, while closed systems continuously pump the same water throughout, and water quality parameters are in a more controlled environment. In this study, data on the crab mortality in open and closed shedding systems was collected. With a p-value of 0.9523, there was no significant data collected that proved there was a difference between mortality within the open and closed systems. However, there was a significance among the number of days a crab was in a system and its mortality. There was also a significant difference of nutrient levels between the open and closed systems. By comparing the number of deaths of the crabs within each system, one can predict which system provides a better environment for soft shell crabs to survive. Lower mortality ultimately leads to higher profits for the watermen involved.

Honorable Mention

The Effect of Terrace Length on Runoff

Zephren Collinson and Justin Szczerbinski, Washington-Lee High School

Soil and land erosion is a global crisis negatively affecting billions of organisms by damaging water quality and deteriorating the amount of arable land. The purpose of this experiment was to determine the effectiveness of terracing on limiting erosion caused by water. The experiment was run by having a steady flow of water fed into a soil filled apparatus, a four sided rectangular prism, 2 x 2 x 4 ft, then measuring the amount of soil and water runoff at five and ten minute intervals. Ten trials were conducted for each of the control, 15, and 30 centimeter terraces using generic topsoil. It was hypothesized that increasing the length of the terrace would lessen the amount of runoff in a relatively linear relationship at both the five and ten minute intervals. The results after statistical data analysis were that runoff decreased from the control to the 15 cm to the 30 cm terraces in a quadratic relation in the first five minutes, but then in the second five minutes, the runoff was still less with terraces, but the 15 cm terrace had the least amount of runoff. These results did not support the hypothesis, but pointed to very interesting conclusions. It was concluded that the 30 cm terrace lost integrity when its tall back wall was eroded, while the 15 cm terrace kept integrity. This led to the conclusion that the terraces would be more effective with a retaining wall, and that an optimal terrace length for this soil type and slope grade would have been between 15 cm and 30 cm.

Honorable Mention

The Effects of Climate Change on *Lycopersicon esculentum* Yield

Sarah Eacho, Chesapeake Bay Governor's School for Marine & Environmental Science

Plants rely on a particular climate, the specific conditions of temperature, precipitation, and sunlight during an extended period of time, in which to grow and produce optimal fruit. Conditions must be optimal in order to obtain full production; however, the weather is always changing and is becoming less optimal for some plants due to climate change. Climate change affects the temperature and rainfall in a given environment. Current climate change models predict increased temperature and decreased rainfall. Because temperature and rainfall are main factors in level of production, it is important to discover how a potential change in climate will affect production. This is even more necessary due to the reliance on agriculture for food and economic stability. In order to test the effects of climate change on plant production, the environment of the tomato *Lycopersicon esculentum* was manipulated to represent climate change conditions in 2050. These conditions consisted of increased temperature and decreased rainfall. A foliar nutritional fertilizer, Awaken, was also applied as a way to determine if the negative impacts of climate change could be countered. As temperature increased, production decreased and as water amount decreased, production also decreased. Plants receiving higher temperatures produced 138 tomatoes with a total mass of 16,229.8 grams less than plants receiving current Virginia temperatures.

Plants receiving less water produced 26 tomatoes with a total mass of 7,611.71 grams less than plants receiving optimal water amounts. Plants receiving Awaken produced 26 tomatoes with a total mass of 2,565.6 grams more than plants that did not receive Awaken. A p-value was found that suggested a significant difference between the levels of water amount and yield. This suggested that water amount had an impact on tomato yield.

Honorable Mention

The Secret Life of Bees: The Future of Pollinator Habitat Restoration and Agriculture

Laura Ellis, Chesapeake Bay Governor's School for Marine & Environmental Science

Although the North American honeybee, *Apis mellifera*, continues to decline, no effective population restoration strategy exists, causing scientists to research the original habitat of the six-legged creatures. Since agriculture and honeybees have been linked for centuries, the U.S. Department of Agriculture emphasizes enhancing hedgerows, strips of vegetation between fields that are known to house and attract bees, as a viable strategy. The woody vegetation, herbaceous wildlife, and flowering plants that comprise a hedgerow acts as habitat and food for pollinators, as well as riparian buffers that stabilize soil, buffer nutrient runoff, and cool surface water temperatures. This study aimed to pilot the effectiveness of three proposed hedgerow alterations; brush piles, additional native plantings, and natural independence on restoring native and domesticated bee populations and insect biodiversity. The cost effectiveness of each alteration was compared between the three treatments. Bee populations, determined using pan traps, served as an indicator of pollinator abundance, while the location of the traps served to quantify population distribution. Trends in this study are seen that indicate planted hedgerows attract the most bees, while brush hedgerows increase insect biodiversity. In reference to spatial distribution, unaltered hedgerows showed uniform distribution at each location, brush hedgerows concentrated at the outer field perimeter, and planted hedgerows concentrated at the inner hedgerow. Widespread implementation remains the only way to see notable health differences in the Bay and insect populations. Thus, it remains important to recognize brush hedgerows as the most cost-effective, both improving bee population and insect biodiversity without any additional cost to farmers.

The Effect of Natural and Chemical Water Purification Methods on Nitrate Levels of Water

Slavina Ancheva and Tara Dolan, Washington-Lee High School

The purpose of this experiment was to research the most effective method of purification of the nitrates in water using chemical and natural methods. High nitrate levels can lead to environmental and health hazards such as abnormal reproduction of certain species. The hypothesis was that if contaminated water is present, chemical methods will be the most effective in purification. The denitrators would be the most effective method of lowering the nitrate level because it uses sulfur and aragonite to neutralize acid and supply calcium ions. From the data presented, distillation was the most effective method of purification, which does not support our hypothesis. The nitrate level remained consistent throughout while the other chemical methods (denitrators and blending) were not as effective. Therefore, the null hypothesis could be rejected according to a t-test and an ANOVA test. Results were consistent, but a better balance would give more precise results. Natural methods of purification were not effective in purifying the water. This was unexpected because clean water found in natural settings is surrounded by nitrates in natural materials, even though the water is still pure. Soil, clay, and sand all had nitrate levels of 150 and greater which are unsafe levels for drinking. Since these substances are found in the Earth, bacteria and other debris had the possibility of getting into the materials. This could have led to disruption in the results. This was a variable that was unaccounted for. If this experiment was to be repeated, more research would be done into finding how to filter out these materials to get more accurate results.

The Effect of Ocean Acidification on the Mass and Appearance of Mussel Shells

Indra Altangerel, Washington-Lee High School

The objective of this experiment was to test the effect of ocean acidification on the mass and appearance of mussel shells. Mussel shells were soaked in solutions of the pH 3, pH 5, and pH 8 (average ocean pH) for 25 days. Mass was taken of the mussel shells before being left in the varying pH solutions as well as after. Before and after pictures were also taken of the mussel shells and were used to compare the qualitative effects of varying pH, caused by ocean acidification, on the mussel shells. It was hypothesized that if the level of acidity in an ocean increases, then the mass of the mussel shells will decrease because acid will stop the carbonation of the mussel shell and cause it to break and chip away. Seven trials were done to test each pH level. A t-test was run between the mass differences of mussel shells in different pH solution. An ANOVA statistical test was done to test the statistical significance of the average mass difference of the mussel shells in different pH solutions. The calculated p-value, which was 1.80×10^{-5} , rejected the null hypothesis. The results supported the hypothesis, all the data was statistically significant and portrayed a correlation between the decrease of pH or increase of acidity in a salt water solution and the decrease of the mass of a mussel shell.

Use of Common Filtration Methods to Reduce the Effect of PPCPs on a Radish Plant

Angus Beane, Mills E. Godwin Specialty Center for Science, Math & Technology

Recent studies have shown that pharmaceuticals and personal care products (PPCPs) are prevalent in the American watershed. PPCPs include common, over-the-counter drugs; compounds found in soaps and shampoos, and chemicals in human waste. Some research has been done on the wildlife effects of PPCPs, but little has been done on filtration methods. The purpose of this study is to determine the effectiveness of common filtration methods in removing PPCPs and their effects on plant growth. The effects of PPCPs were measured using two response variables: root length and germination rate. Radishes (*Raphanus sativus*) were grown for about two weeks. Diluted solutions of varying PPCPs (acetaminophen, acetylsalicylic acid, and caffeine) and select combinations of these PPCPs were filtered using Brita filters, Filtrete filters, and coffee filters (separately). Controls for both are no chemical and no filtration. Additionally, the chemicals were set at two different concentrations, 1x and 10x the natural level. Three different ANOVAs were performed to analyze the data. It was found that acetaminophen and coffee filters increased the mean root growth length significantly (to 2.4 cm and 2.3 cm, respectively) and that a combination of acetylsalicylic acid and caffeine reduced the germination rate significantly. Literature suggests that germination rate is less affected by PPCPs while root length is more affected. Brita and Filtrete filters are ineffective in removing PPCPs because they are designed to remove hard metals. Further studies include the effects of PPCPs on cellular respiration. It is recommended that diluted water be used in all future experimentation.

Bright at Night: A Study of the Effect of Distance from an Urban Center on Ambient Light

Alice Bell, Washington-Lee High School

Many urban dwellers never see the stars. The explanation for this is simple: light pollution. The ambient light in any area has the ability to disguise the myriad constellations above. The purpose of this experiment was to investigate the effect of distance from an urban center on the ambient light measured. The hypothesis was that if the distance from an urban center is increased, then the ambient light will decrease. For this experiment, Washington DC was used as the urban center. The independent variable was the distance from Washington and the dependent variable was the amount of ambient light. On the pre-chosen night, 60 miles were traveled, with stops every 10 miles. At each stop, the ambient light was measured 20 times. The data was recorded in foot candle units (Fc) and analyzed at a later date. The mean for the first stop was 9.85 Fc and the mean for the second stop was 6.35 Fc. The mean for the third stop was 1.3 Fc. The mean for the fourth stop was 1.9 Fc and the mean for the fifth stop was 1.2 Fc. The mean for the sixth stop was 1 Fc and the mean for the seventh and final stop was 0.95 Fc. An Analysis of Variance F-test (ANOVA F-test) was conducted on all data and the results proved that there were not enough trials to show significance in the data. The ANOVA value for the first stop was 0.914, and for the second stop it was 6.381. For the third stop it was 47.918, the fourth stop it was 40.566 and the fifth stop was 49.186. For the sixth stop, the ANOVA value was 51.263 and for the seventh and final stop, the value was 51.885, making it very clear that the data was not significant in any way. For the data to gain significance, the experiment would need to be redone with an increased number of samples taken. There is a clear parallel that can be drawn between light pollution levels and ambient light levels in an area.

Effects of Electromagnetic Radiation on Insect Behavior and Colonization

Christian Blue and Shane Brooks, Chesapeake Bay Governor's School for Marine & Environmental Science

In the late 1900s, the expanding abundance of electronic-signal emitting devices gave rise to concerns over whether or not these signals were environmentally safe. Numerous scientific studies were conducted, ultimately coming to the conclusion that regulations must be placed on emissions so as not to cause harm to the surrounding environment or its organisms. This prompted the Federal Communications Commission to create a series of guidelines in an attempt to keep the strength of electronic emissions at levels deemed safe. However, there is still substantial evidence that suggests that even low-level electronic emissions can have adverse effects on biological systems. Electronic emissions have been proven to cause biological distress ranging from mild nausea to cellular damage. Also, they have been theorized to be a main cause of the phenomenon of Colony Collapse Disorder, in which several species of insects have mysteriously began to die off or vanish entirely. This study was meant to provide some evidence in support of these theories, by exposing a common species of ant, *Pogonomyrmex occidentalis*, to various forms of common electronic emissions, and noting the physical and behavioral effects of the emissions on the test subjects. Five ant colonies, with two being exposed to normal signal emissions from a small cell phone, two exposed to signal from a home Wi-Fi router, and one control exposed to only normal background radiation, were observed for five days, with multiple trials being conducted for accuracy. The average number of ants in each of three transects within the colony were noted, converted to percentages, compared to the control. Ultimately, based on the p-values calculated from a two-way ANOVA test, it can be concluded that yes, the radiation does have an effect within the treatments, albeit not in a clear, observable way. However, the unclear statistical analysis could ultimately be rectified with an increased number of trials in a future study.

The Effect of Mycorrhizae Mycelium Amount on Soil Quality

Brynn Browning, Mathematics and Science High School at Clover Hill

Fungi are extremely important parts of ecological function, decaying matter so that it may be reused in order to continually be beneficial to the environment. Mycorrhizae mycelium is a type of fungi that is not one's basic lichen or above-surface fungi. It works in a symbiotic relationship with most plant roots, improving nutrient uptake and protection against parasites, and thusly the overall health of the plant. This experiment further investigates the effect of this relationship to the soil quality around the relationship, known as the rhizosphere, and the plant health itself. In order to measure the effect, different amounts of the mycorrhizae spores were incorporated into the soil that the plants were to grow in.

Ready, Set, Recycle!

Emily Camlin, Chesapeake Bay Governor's School for Marine & Environmental Science

In recent years, the various nations of the world have not only been working on more technologically-advanced ways to conserve and recycle, but also have been studying methods on how to go about the processes and encourage people to participate. As the world grows more limited with its resources each and every day, there must be a source of control and recycling motivation. There must be something that will keep people willing and motivated to be cautious of this concept. Previous studies have shown that there are, in fact, multiple influential factors involved especially involving convenience and awareness. Set in a high school, this project attempted to measure the accuracy of previously-stated conclusions, and was followed through in individual rooms. With the addition of bins for recyclable material and an increased amount of publicity on the subject, supporting results were acquired. Steep increases in recycled waste occurred among the different experimental sectors (eventually leading to a 9-week period of having over 80% of total waste recycled) and surveys showed that more people became educated and involved in the matter. A small study such as this could provide an example for a project on a larger-scale, perhaps involving a whole town, county, or state.

Exploring the Environmental Sustainability and Efficiency of Aquaponics in Virginia in Comparison to Traditional Agriculture Systems

William Drumheller, Chesapeake Bay Governor's School for Marine & Environmental Science

Modern fossil fuel agriculture systems are large contributors to greenhouse gasses in the atmosphere. Aquaponics systems have the potential to offer numerous advantages in terms of efficient food production, while reducing such greenhouse gas emissions. This study tests the alternative of aquaponics as a cost effective and environmentally sustainable system for food production in Virginia. In this study, 12 juvenile Channel Catfish, *Ictalurus punctatus*, were grown in an aquaponic system with tomatoes, radishes, cucumbers, squash, rosemary, basil, lettuce, and green onion and their edible masses were measured. Costs were also recorded for materials and maintenance and factored into the efficiency rating of the system. There was a positive net yield in the market value of vegetables for the months of June, July, and August; however in September and October, the yield market value of the vegetables did not exceed the cost of operation. Therefore, there was a 3% gain financially due to a total electrical operating cost of \$31.90 and a higher total crop yield value of \$32.95. Based on these results, aquaponics was found to be a cost effective food production source. With further experimental attempts, aquaponics has the potential to become even more efficient and yield greater mass value, thus exceeding operating costs by a greater margin. Included in these more efficient practices would be taking advantage of warmer climate during earlier spring and summer months to maximize growth and yield while also reducing electrical maintenance costs.

Effect of Rainwater Acidities on the Growth Rate and Electrical Properties of Cherry Tomato Plants

India Eguiguren, Chesapeake Bay Governor's School for Marine & Environmental Science

The sources of elements that cause acidity in the atmosphere are numerous. Sulfur dioxide and nitrogen oxides, both very soluble in water, are gases that are two of the main contributors. Power plants, factories, volcanoes, and automobiles are some of the known emitters of these gases. Acid deposition is created when these pollutants are dissolved by water droplets or fall directly to the Earth. Besides being detrimental to human health (especially dry deposition, which causes respiratory problems when inhaled), acid rain has a negative effect on the environment as a whole. In this study, the effect of acidic water on sun-gold cherry-tomato plants was investigated. The plants were irrigated with a water pH of 3.5, 5.0, 6.5, or 8.0, and their growth rate and total fruit yield were recorded. Additionally, the electrical resistance and conductivity of each plant's stem was measured in the hope of finding a correlation between taking in acidic water and the electrical signaling taking place from cell to cell within the plant stems. The average height of plants receiving more acidic water was slightly higher than of those in the other groups. Tomato yield was highest for plants in the group receiving less acidic water (pH 6.5, equivalent to rainwater). However, the results of the electrical tests varied greatly and appeared to follow no obvious trend, and none of the statistical tests done on the collected data provided evidence that the tomato plants were negatively affected by varying acidities in irrigation water.

Survival of the Plants

Bridget Escobar, Washington-Lee High School

The purpose of this experiment was to determine which material; Aqua Globes, Jelly Marbles or Pampers Diapers, along with the control of plain soil could keep a single corn plant alive the longest in a simulated drought; a plant being considered 'dead' once it was completely withered. The hypothesis was that if Jelly Marbles, Aqua Globes and Pampers Diapers were used in corn plants, then the Jelly Marbles would be able to keep the plant alive the longest. When the first 40 plants reached 15 cm in height, they were each transferred into the 40 clear cups that were filled of the way with Jiffy Miracle Soil and the rest of the way with the specific material. They were watered for the last time and never watered or touched again while being left in direct sunlight. The plants with only soil managed to survive for an average of 6.1 days. The plants with Pamper Diapers survived for an average of 7.0 days. The plants with Aqua Globes managed to survive an average of 10.9 days without water. Those plants with jelly marbles survived an average of 15.0 days. It was inferred that materials such as Aqua Globes or Pampers Diapers would be best suited to indoor plants that are watered every once in a while. However, because they lasted the longest in a simulated drought, it was more suited to put Jelly Marbles into soil and plants that are not expecting rain for a while.

Bioremediation: Hydrocarbon Degradation by Native Microbial Populations in the Lower Chesapeake Bay

Kristen Fauber, Chesapeake Bay Governor's School for Marine & Environmental Science

This study set out to observe if environmental factors like the native microbial population and seasonal weather will have an effect on hydrocarbon degradation in sediments from shorelines in Yorktown and New Point, Virginia. Three 1-liter containers were filled with 500 ml of sediment from the intertidal zones of Yorktown Beach at Yorktown and New Point marsh nature preserve in Mathews; a control treatment was made of sterilized Quikrete Play Sand. One hundred ml of 10W30 motor oil was poured on top of the each treatment and the control. The treatment samples were left outdoors in an open air environment in the summer and winter seasons for 5 weeks and observations were made weekly. From the summer treatments, the Yorktown site had degraded the most oil, up to 1.6 ml. In the winter treatments the Yorktown site had, again, degraded the most oil, up to 26 ml. There was no difference in the amount of oil degradation between the New Point site and the control with respect to both the summer and winter treatments. In the event of a major oil spill on the York River, the best option to clean the environment would be to let the native bacteria in the Yorktown sediments biodegrade the sediments. However, in the event of an oil spill in the New Point marsh, it would not be best to let the native microbes try to degrade the hydrocarbons because they do not have capabilities to rid itself of hydrocarbons.

The Effect of Water Acidification on the Mass of *Conus inscriptus* and *Pomacea canalicus* Shells

Emily Flynn and Alyssa Luz-Ricca, Washington-Lee High School

Ocean acidification due to the buildup of carbon dioxide in the atmosphere is a problem that threatens many marine shellfish, as it lowers the pH of the ocean by reacting with carbonic acid, corroding their shells. Acidification is also present in freshwater lakes and streams, whose acidity is raised by the collection of acid rain. The experiment attempted to identify a correlation between the acidity of both saltwater and freshwater on the overall mass change of *Conus inscriptus*, the saltwater shell, and *Pomacea canalicus*, the freshwater one. The hypothesis was that if the acidity were greater, the amount of mass lost over a period of 30 days would increase. To test this hypothesis, *Conus inscriptus* shells were massed and then submerged in saltwater with different pHs varying by intervals of 0.5, and did the same for *Pomacea canalicus* with freshwater. It is important to note that the levels of pH used were not the same for both freshwater and saltwater; rather, they were scaled to the average pH of oceans and freshwater, respectively. There were five trials for each level of the control. After 30 days had passed the shells were removed from their jars and the weights were compared to the ones taken previously. According to the results of the single-factor ANOVA test performed, the null hypothesis could not be rejected, and therefore the data was inconclusive. This may be due to the other chemicals present in the water as well as human error, and it is suggested that more research be done on the subject before any conclusion is drawn.

Environmental Science B

First Place

Wood Treatment Leaching on *Festuca arundinacea* Shoots, Height, and Lateral Root Density

Nicholas Hipple, Chesapeake Bay Governor's School for Marine & Environmental Science

The United States Environmental Protection Agency (EPA) released a list of approved wood treatments in 2004, highlighting a few treatments that were determined to have been safe for surrounding plants and ground water. Four years later, this list was revised because further studies had shown that one of the chemicals, Copper Azole-Type A was not, in fact, safe for use. Chromated copper arsenicals had previously dominated the market, until the EPA found that this treatment was also not "safe." This experiment aimed to analyze just what effect one of these approved chemicals may have on the physical properties of plants around it, specifically focusing on the shoots, height, and lateral root density of the plants. To limit variables, one grass, *Festuca arundinacea*, was planted around Copper Azole-Type B treated wood, untreated wood, and in a control tray with no wood. After a week of preparation and two weeks of growth, the grass was analyzed for the number of shoots, average shoot height, and average lateral root density. Once these numbers were collected using randomly placed quadrats, they were further analyzed with One-Way ANOVA tests, all of which yielded highly significant p values. It was concluded, then, that the presence of some leaching substance from the CA-B Treated wood was negatively impacting the grass growth. Properly cataloging how leachates from wood treatments impact surrounding plants can help to justify the use of certain treatments over others, especially in crop field fencing. Furthermore, damage to the base of the food chain (primary producers) yields more adverse effects for the top of the food chain, as biological magnification begins to affect the food chain. Biological magnification is most evident in the apical predator of the food chain, which in this case, is mankind.

Second Place

Flex your Mussels: Byssus Growth of the Atlantic Ribbed Mussel, *Geukensia demissa*, on Various Substrates

Callie Morgan, Chesapeake Bay Governor's School for Marine & Environmental Science

Chesapeake Bay marsh environments have been degrading in the past years to the point of more than 60% loss of marshes. These habitats are important to the entire Bay ecosystem because of water filtration processes and flood and erosion control. Population growth directly increases development along the coasts contributing to changes in water flow and amounts of pollution affecting this fragile environment. Degradation of coastal environments is often replaced by man-made structures and many of the organisms that call the Bay home are very susceptible to these changes in their habitat. One of these marsh organisms, the Atlantic Ribbed Mussel (*Geukensia demissa*) is not only a food source, but also a cleansing force in marine ecosystems. This study looked at how man-made structures might affect Ribbed Mussels, specifically in their ability to attach byssal threads to different substrates. The experiment on these organisms and their byssal thread growth tested the effect of different substrates on the length and number of byssal threads grown. The substrates used included plastic, metal, wood, and mud. The experiment produced a significant p-value of 0.035 for length and a very significant p-value of 0.01 for the number of byssal threads. In both tests, the plastic substrate was preferred by the Atlantic Ribbed Mussel. In fact, all man-made substrates outcompeted the marsh sediment, suggesting that man-made structures may not adversely impact their attaching.

Third Place

The Effect of Laundry Load Size and Frequency on Water and Electricity Consumption

Minimizing water and energy consumption associated with automatic washing machines may provide a way to conserve the strained supplies of these resources. In the United States, laundry is one of the most significant uses of indoor water, along with showers and toilet flushing. Energy is needed to operate the washing machine; energy is also consumed with the water used because of the embedded energy required to collect, treat, distribute, and heat the water. High-efficiency front-loading washing machines can reduce water consumption by more than half compared to top loaders, which remain popular because of their lower cost. Many households tend to wash laundry many times a week. This experiment was designed to test the assumption that less frequent, full laundry loads in a top loader would conserve more water and energy than frequent small loads. The researcher hypothesized that less water and electricity would be consumed in one large load than in three small loads when washing the same mass of laundry. The experimenter washed 1.82 kilograms of laundry on the machine's small load setting and 5.46 kg of laundry on the large load setting, 10 times each. To analyze the results, the water and electricity consumption data for the small load were multiplied by three to represent the consumption that would have occurred to wash the same mass of laundry as the large load. Washing one large load in a top loader conserved more water and electricity than washing the same mass of clothes in three small loads, so the hypothesis was accepted. The average water consumption of three small loads was 2.1 times as much as the average for one large load, and the average electricity consumption was 2.8 times as much. The t-tests showed that these results are statistically significant, with $p < 0.01$ for water and electricity consumption. The hypothesis was accepted. Possible errors include measurement errors through small leaks, and varying effects of the different clothes washed. Future experiments could broaden the electricity results to embedded energy in water and electricity used by the dryer.

Honorable Mention

Corbicula fluminea: Are They Still Invaders in the Mattaponi River?

James Tyler Kelley, Chesapeake Bay Governor's School for Marine & Environmental Science

The purpose of this experiment was to observe the species *Corbicula fluminea*, and see if they should still be considered an invasive species in the Mattaponi River. Many species that are considered invasive have been missed classified; they are simply called invaders because they were introduced into the ecosystem. From the months of May to October, samples for *C. fluminea* were collected from the Mattaponi River at the Walkerton Landing site. When the *C. fluminea* were collected there were also five core sediment samples taken each time. Each clam was measured in millimeters using a Vernier Caliper, and the core samples were wet sieved and the clams found were then measured in the same manner. The results indicated that *C. fluminea* have established a stable population in the Mattaponi River environment. Other studies show high densities of juveniles in the ecosystem, but in this study the environment had a high density of adults. Based on the size frequency distribution indicating a sustained population, integration into the Mattaponi food web, and the longevity in the river; *C. fluminea* should no longer be considered invasive in the Mattaponi, but rather naturalized.

Honorable Mention

The Effect of the Concentration of Greywater (%) on the Height (cm) and Health of *Brassica rapa*

Nargilmaa Khangarid, Washington-Lee High School

The experiment conducted was the effect of the concentration of greywater (%) on the height (cm) and health of *Brassica rapa* or Wisconsin Fast Plants. The concentration levels were 0% (control), 25%, 50%, and 100%. The hypothesis formed is if different concentrations of greywater (%) are tested, then 50% greywater will have the tallest and healthiest Wisconsin Fast Plants because the concentration of detergent will be at a lower potency. In a controlled school environment the experiment was conducted for 27 days. The greywater was collected from a standard high efficiency washer. In this experiment, the Kenmore Elite High Efficiency washer was used with the eco-friendly Kirkland Ultra Clean Premium liquid

laundry detergent. Wisconsin Fast Plant seeds were planted into quads and watered on a sophisticated lighting system. As the plants grew, data was recorded and pictures were taken. Surprisingly, the general trend of the data was that as the concentration of greywater increased, the height and health increased as well. The 100% concentration group showed the most height and health. This is verified by the statistical tests by the fact that the null hypothesis was rejected for both the ANOVA test and Chi-square tests, meaning there was indeed a statistically significant difference between the distribution of height and plant parts present. The 100% group had the most average height with an average of 2.2 cm, 50% with an average of 0.47 cm, 25% with 0.16 cm, and the control with a 0.18 cm average. From this experiment, it can be inferred that greywater from a high efficiency washer is beneficial for gardening and planting. Overall, this experiment showed very unusual but very significant data.

Honorable Mention

The Relationship between Spirogyra Algae and Acidic Solutions

Adrian Matthews, Washington-Lee High School

Acid rain is a growing problem to underwater ecosystems. This experiment was designed to test how acid rain affects the alga species Spirogyra. The hypothesis was that there would be a dramatic decline in algae abundance when the plant was exposed to a pH as low as 6 because many invertebrates cannot survive in pH as low as 6. The Spirogyra was tested in solutions with four different pH levels: 4, 5, 6, and a control group of 7. To measure the alga abundance after six days, a spectrophotometer was used to determine the optical density of each sample. An ANOVA test and t-test were performed to analyze the average optical densities of all ten samples of every independent variable. It was determined that there was a significant statistical difference between the means of each pH. The data did not support the hypothesis because it suggested that Spirogyra grows best in pH 6. The greatest statistical difference occurred between the optical densities of algae in pH 5 and algae in pH 6.

The Effect of Household Medicine on the Growth of Elodea Plants

Anudari Ganbold, Washington-Lee High School

The objective of the experiment was to understand the effect of household medicine on the growth of Elodea plants. The hypothesis was that the control group, who did not receive any doses of medicine, will grow longer than the other three groups who were given various types of pills. The plants should be able to grow in its natural habitat without any interruptions, however, when the chemicals invade the environment it was believed that they will react negatively and stop growing. Afterwards, 82.5 centimeter Elodea plants were placed into their appropriate cups. Twenty plants were placed into the Tylenol, 20 into Advil, 20 more into Aspirin and finally, the last 20 were placed into the control group. Each cup holding an Elodea plant consisted of room temperature water, an appropriate pill from the group into which it belonged to and a drop of aquatic plant nutrition food. The conclusions illustrated that the plants in the Advil group grew the most in the allotted two week time frame. The next group was Aspirin, with the second best average and the control group came in third. The Tylenol group grew the least compared to the other three groups. While the average growth of the plant in each trial group was not huge, it can easily be seen that the hypothesis was not supported.

The Effect of Natural Organic Sorbents on the Sorption Rate of Motor Oil

Jordan Grimaldi, Washington-Lee High School

Every year between 1.7 and 8.8 million tons of oil are released into the ocean, and it is pertinent that eco-friendly methods are developed to clean up the oil in order to save the marine environments and wildlife. This experiment was designed to determine which natural organic sorbents (cotton, peat moss, feathers, and human hair) were the most effective in retaining the greatest amount of motor oil in an oil and water mixture. The hypothesis was if human hair is the natural organic adsorbent used, then the greatest amount of oil will be retained. For the procedure, 250 ml of each of the four sorbents (two adsorbents and

two absorbents) were placed into the oil and water mixture for two minutes with a total of ten trials for each sorbent. The remaining water and oil levels were measured and the average oil-to-water ratios were calculated. The highest average water-to-oil ratio was feathers with an average of 1.75 ml; next, hair with an average of 1.28 ml; then, peat moss with an average of 1.16 ml; lastly, cotton with an average of 1.15 ml. Therefore, the hypothesis was not supported by the data because human hair was not the most effective sorbent. The sorbent with the lowest oil-to-water ratio was the most effective; therefore, cotton was the most effective out of the four sorbents.

Soil Additives and Simulated Acid Rain on Radish Seed Growth

Kate Hardin, Mills E. Godwin Specialty Center for Science, Math & Technology

Acid rain is precipitation; just as rain, snow, or sleet, containing relatively high concentrations of acid-forming chemicals. It occurs as falling precipitation picks up sulfur dioxide and nitrogen oxides. Water is a plentiful resource and can be found almost anywhere. Typical rain water is not treated with chemicals. Radish seeds are also a plant that is easily come by. These plants germinate fairly quickly, but need a warm environment to grow, with the average temperatures being between 22 and 26 degrees Celsius. This experiment was conducted to determine if various vegetable soil additives could neutralize the pH of acid rain to help radish plants grow better. This research has the potential to aid plant growth and productivity in large cities, where there are increased amounts of pollution and less available land to grow food. As a result of utilizing vegetables as soil additives, it was hypothesized that pumpkin would be the most effective neutralizer of acid rain because pumpkin has a basic pH. The independent variables in this experiment are the types of vegetables added to the soil. The added vegetables were artichoke, cauliflower, and pumpkin. Ten gallons of rain water were collected and soil was placed into the mesh pots until the pots were $\frac{3}{4}$ full. Radish seeds were pushed down half way in the soil and watered until germination. After germination the acid rain was added to the water and the results were collected. A t-test was performed on the data to determine if the data was significant. The data for the different vegetables on the pH of rainwater and the growth of radish plants was insignificant. The results that were obtained for the control, artichoke, pumpkin, and cauliflower were most likely due to chance and error versus the independent variable. The hypothesis was not supported.

The Effect of El Niño and La Niña on the Amount of Precipitation in Quevedo, Ecuador; Tallahassee, Florida; Washington, D.C.; and Concord Maine

Gemma Harris, Washington-Lee High School

The purpose of this project was to see the effects of El Niño and La Niña on the amount of precipitation over time in different locations that progressively get farther away from one of the main points of impact of these phenomena, at Quevedo, Ecuador. The hypothesis was that if El Niño occurred, then, in comparison to years neither El Nub nor La Niña occurred, Ecuador will have much higher amounts of precipitation, Florida will have higher amounts of precipitation, the D.C. area will have slightly higher amounts of precipitation, and Maine will have the same amounts of precipitation. The second part of the hypothesis was that that if La Niña occurred, then, in comparison to years neither El Niño nor La Niña occurred, Ecuador will have much lower amounts of precipitation, Florida will have lower amounts of precipitation, the D.C. area will have slightly lower amounts of precipitation, and Maine will have the same amounts of precipitation. It was found that there was not a significant difference in the amounts of precipitation in Quevedo, Ecuador from years that neither weather phenomenon occurred to years that El Niño or La Niña occurred. This could be because there was no data available for many of the years that were analyzed, causing the data within the years that El Niño, La Niña, or neither occurred to be less consistent. There was a significant difference in the data from Tallahassee, Florida between years that El Niño occurred, years that neither El Niño nor La Niña occurred, and years that La Niña occurred. This supported the hypothesis and was similar to the findings of other research. There was not a significant difference in the data from Washington, D.C. This could be because the range of years that precipitation was measured was not very great. There was also not a significant difference in the precipitation levels of Concord, Maine. This supported the hypothesis and other research.

The Effect of Green Cleaners on the Height of *Phaesolus lunatus*

Catherine Holl, Hanover High School

The purpose of this experiment was to determine if green cleaning products had a significant effect on plant growth in the environment. It was hypothesized that if distilled water, Simple Green, Green Works, and Naturals were used in this experiment, then distilled water would have yielded the most height growth of *Phaesolus lunatus* because the lack of detrimental chemicals would have resulted in more growth of the plant. First, 60 cups were filled with soil and a *Phaesolus lunatus* seed was planted. Then the plants were watered every three days with 15 ml of either a 5.00% solution of Simple Green, Green Works, Naturals, or pure distilled water. The plants were exposed and kept under the same conditions. The total height of the plant from the soil to the top of the highest leaf was recorded after 30 days had passed. The mean height of plants watered with distilled water was 28.15 cm. The mean height of plants watered with Simple Green was 34.21 cm. The mean height of plants watered with Green Works was 37.80 cm. The mean height of plants watered with Naturals was 35.58 cm. Green Works had the highest height, however, the mean heights for all levels of the independent variable were very close, and the change was found to be insignificant. The results turned out this way because the green cleaning solutions have some biological chemicals, which increase growth when watered on plants. Green Works, Naturals, and Simple Green have these chemicals in their solutions, in relation to their average height values. Distilled water lacks these materials, and does not promote life growth as much as the solutions of green cleaners.

The Effects of Oceanographic Elements on Shark Displacement

Sara Honeycutt, Chesapeake Bay Governor's School for Marine & Environmental Science

Sharks are at risk due to human impacts and ecosystem imbalances. As a result of this shark populations are rapidly declining. Sharks are an important predator for the pelagic ocean by eating many organisms throughout the ocean and helping to maintain the population and the ecosystem. In order to do this experiment, data from the Oearch's Shark Tracking database, was collected, which included 46 different sharks and their corresponding data; these data were processed and then analyzed by performing an ANOVA. This project was used to conclude if weight, length, location, gender, or species of a shark influenced the shark's travel. It also served as an insight to shark's normal travel patterns, and helped to eliminate if the independent variables impacted the dependent variable. The data showed that there was an increase in displacement per day on the length of the shark, and a decrease in displacement per day with the weight of the shark. Data that backed the research involved taking data for 14 sharks and then converting the data into metric units, and running a statistical test, an ANOVA. Only nine sharks had enough data to include both the 24 hour displacement and the 72 hour displacement. There were many factors that were not able to be as controlled as they should have been, the factors that could have varied this study were large, but overall, the study showed that each individual shark will travel as much as it needs to in order to feed, mate, and defend itself.

The Effect of Different Algae Prevention Methods on *Microcystis aeruginosa*

Shreyas Kulkarni, Mills E. Godwin Specialty Center for Science, Math & Technology

Cyanobacteria are a large problem in today's ecosystems, making lakes too toxic for fish to live and survive in. So it was decided that this experiment would be done to see if shade on water has a better effect than water aeration on preventing cyanobacteria growth. These two methods are both eco-friendly methods and are both used in ponds and lakes today. A 0.1% solution of *Microcystis aeruginosa* and water was made. The control was no preventive method, and that was left to grow while the shade on water level of IV was placed in a box and the water aeration group was aerated with a syringe and straw every other day for two weeks. The difference in growth was measured in absorbance units by using a spectrophotometer before and after the experiment was run. It was found that the shade on water level of IV had the highest average negative difference between pre and post growth, which meant that the most blue-green algae died, which also meant more algae was prevented. A t-test was done, and two out of the three t-tests done indicated that the data was statistically significant. The data that occurred was supported by prior experiments that had found similar data. Shade might have been more effective in preventing an element for growth rather than water aeration. The results that were found could be used in finding a more eco-friendly way in preventing growth of cyanobacteria, because it was found that shade on water prevented the most; lily pads could be used for shade in ponds. Ways to extend research is to research whether controlled amounts of light could have an effect on *Microcystis aeruginosa*.

The Effect of Elevated pCO₂ on *Chaetoceros muelleri* and *Tetraselmis chuii*

Nidhi Kumar, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effects of elevated pCO₂ levels, on fluorescence, chlorophyll light absorbance and dry mass of *Chaetoceros muelleri* (CHGRA) which are diatoms and *Tetraselmis chuii* (PLY429) which are dinoflagellates. Recently, the rise in anthropogenic CO₂ has contributed to decrease in ocean pH. The study of decreasing pH from elevated CO₂ levels on marine organisms has many real world applications. Ocean acidification may affect marine food webs and could lead to significant economic changes. It was hypothesized that higher pCO₂ level would increase the fluorescence, chlorophyll a light absorbency, and dry mass ratio of the two algae. Four 4,000 ml Erlenmeyer flasks were filled with 1000 ml of artificial seawater and equal amounts of algae and two experimental treatments were aerated with pCO₂ level of 400 μ atm for a week; the two control treatments kept with no pCO₂. From the data, the control versus experimental for CHGRA and PLY429, the fluorescence decreased, CHGRA dry mass increased, and PLY429 dry mass decreased. For CHGRA, the final absorbencies decreased, while absorbencies increased for PLY429. The effect of elevated pCO₂ on fluorescence and dry mass was not statistically significant with the exception of the dry mass of CHGRA. The research hypothesis was not supported in this experiment and believed that the results of the experiment were due to the existence of two forms of Rubisco enzyme in the algae. For continued study, other marine organisms such as microalgae could be used, and the relative cell abundance could be studied.

Albedo of Arctic Surfaces

Timothy Makinen, West Potomac High School

Since the latter half of the 20th century, the understanding of the significance of Earth's poles in climate regulation has increased, prompting the studies of climate and terrestrial optics, including that of water and its several physical states. Although ice and snow are generally known to be more reflective than water, a full study that reviews the fundamental Arctic surface properties on a small scale has not yet been published. This study seeks to affirm and replicate large-scale research of Arctic ice coverage on a laboratory scale, including the effects of macroscopic levels of black carbon aerosol on ice and snow. The study compares the interaction of the visible spectrum on samples using an incandescent light. The samples were deionized samples of ice, water, and natural snow; and 20 ml snow and ice samples each with a constant amount of black carbon particles distributed evenly on the surface. The entire process featured a unique method of measuring surface reflectance by illuminating the sample. This study also features the use of an open-source photospectrometer and web-browser-based spectroscopy interface, providing the intensity values of 641 wavelengths within the visible spectrum. The research supports the hypotheses; snow and ice reflect an average 5-8 times (400-700%) more of the incoming solar flux on the incident surface than water samples, and black carbon coatings absorb an average of 48% more radiation off the ice samples and 24% more off snow samples. The data for the first hypothesis, once converted to spectral albedo values, corresponds to accepted ranges for each substance, ice and snow with average albedo readings of 0.28 and 0.39 respectively. Although the experimentation itself is simple, the data obtained holds much larger implications, illustrating the exponential relationship between retreating sea ice cover and surface warming, as well as the contributions of aerosols to the decreased surface albedo of Arctic surfaces.

The Effect of the Location of Soil in Waycroft-Woodlawn Neighborhood on the Amount of Arsenic in the Soil

Lydia Mathews, Washington-Lee High School

In order to determine the levels of arsenic in the soil of the Waycroft-Woodlawn neighborhood and whether the levels could be hazardous, an experiment was conducted. The experiment was important, as young children often play in the soil and arsenic could be unintentionally consumed. The hypothesis stated that the soil from the stream bank in the neighborhood park would have the largest amount of arsenic of the four trial groups: stream, field, playground, and backyard soil. Soil from each of the locations (the independent variable) was tested using arsenic testing kits; the amount of arsenic in milligrams per kilogram of soil was the dependent variable. The order of the testing was randomized. One

gram of soil was mixed in a test tube with the water and the various reagents before an indicator was placed in the test tube, measuring the arsenic in the gas from the reaction. The indicator's color was then matched to a test strip key to determine the levels of arsenic. Soil from the field in the park was found to have the highest mean level of arsenic at 0.005 mg/kg. The mean of the soil samples from the backyard was 0.0043 mg/kg, and both the stream and playground soil were found to contain 0.0029 mg/kg on average. The standard deviations of the stream, field, playground, and backyard soil samples were 0.0027, 0.0027, 0.0027, and 0.0034, respectively. An analysis of variance test was used to determine the test statistic and probability, finding the test statistic to be 0.93 and the probability to be 0.44. The significance of the data (although moderately significant) would likely benefit from more trials. The hypothesis was not supported as the field soil contained the highest levels of arsenic on average and that the levels of arsenic present would not be potentially hazardous to humans.

The Effect of the Age of Schools on the Dissolved Metal Content of the Drinking Water

Quincy Mendelson, Washington-Lee High School

The purpose of this experiment was to test the effect of the age of schools on the dissolved metals content of the drinking water. It was hypothesized that if the drinking water from schools that have been updated and schools that have not been updated in the past ten years is tested, then the drinking water found in schools that have not been updated in the past ten years will contain more dissolved metals. Five drinking water samples from ten different schools were tested for dissolved metal content using color coordination test strips. One drinking water sample from each school was tested for copper content using a color coordination test strip. One sample from each of the two schools with the highest average dissolved metal content in each of the two independent variable levels was tested for lead using an indicator test strip. The results were very spread out, and the dissolved metal content had a very minimal correlation with the ages of the schools. The results were overall inconclusive because the correlation between the ages of the schools and the dissolved metal contents of the water samples was not strong enough to reject the null hypothesis.

Radioactive Contamination of Terrestrial and Aquatic Vegetation

Benjamin Nickerson, Chesapeake Bay Governor's School for Marine & Environmental Science

The radioactive element thorium was introduced in the systems of both tomato plants and elodea in this experiment. The study hoped to find the effects of daily low level contamination on terrestrial and aquatic vegetation. The elodea plants were tested for total mass, total length, and radioactive uptake. The tomato plants were measured for growth, germination percentages, and radioactive uptake. Thorium appeared to have a significant effect on mass and radioactive uptake on the elodea plants. It did not have a significant effect on the total length. Thorium also did not appear to have a significant effect on the tomato plant's growth and germination percentile. However, there did appear to be a significant difference on the radioactive uptake.

Environmental Science C

First Place

The Effect of Various Ion Exchange Membranes on Generating Electricity Using a Mediator-less Microbial Fuel Cell

Catherine Pollack, Mountain Vista Governor's School

With over one billion people currently living without electricity, it has become vital to optimize an alternative energy source that is not only affordable, but is also efficient, renewable, and able to be adapted to a wide range of climates and geographies. The purpose of this experiment was to further analyze a source of alternative energy: mediator-less microbial fuel cells (MFCs), which harness the natural metabolic processes of bacteria for electricity. This experiment analyzed a specific component of MFCs: the ion exchange membrane. The null hypothesis was that all types of ion exchange membranes would produce the same amount of electricity. The alternative hypothesis was that the ion exchange membranes would produce different amounts of electricity; specifically, that if the type of membrane was changed to cellulose, more electricity would be produced. Five MFCs were run for 30 days, each using a different type of membrane, i.e., Nafion-117, cation exchange membrane, anion exchange membrane, omega polyethersulfone membrane, and a cellulose membrane. At the conclusion of the experiment, an Analysis of Variance (ANOVA) statistical test was run on both voltage and power outputs, with all trials and averages receiving a statistically significant p-value. While this resulted in the null hypothesis being rejected, the alternative hypothesis could not be supported, as it was the omega polyethersulfone membrane that produced the most electricity as opposed to the hypothesized cellulose membrane.

Second Place

Effects of Sea Lettuce (*Ulva lactuca*) Fertilizer on the Growth of Sweet Basil (*Ocimum basilicum*)

Alexandra Pitman, Chesapeake Bay Governor's School for Marine & Environmental Science

Chemical fertilizers are used in agriculture to boost crop production, but agricultural runoff is detrimental to the environment by increasing eutrophication of waterways. Organic fertilizers may decrease runoff by being better absorbed into the soil and taken up by plants rather than chemical fertilizers. Plants grown with organic fertilizers are also potentially safer for human consumption compared to those grown with high amounts of added chemicals and pesticides. The purpose of this study was to evaluate macroalgae as organic fertilizer. By removing excess algal growth from waterways for use in fertilizer, levels of eutrophication could be decreased. This experiment compared the effects of sea lettuce, *Ulva lactuca*, and Miracle-Gro on the growth of sweet basil, *Ocimum basilicum*, and the amount of nutrients each one released in water. Overall, Miracle-Gro significantly increased plant growth, but *U. lactuca* aided growth when combined with Miracle-Gro and in comparison with the control. Blended *U. lactuca* initially released more nitrates in water than did non-blended *U. lactuca*. Statistical tests showed that Miracle-Gro released significantly more phosphates in water compared to other treatments. By removing *U. lactuca* from waterways as a plant growth aid, effects of eutrophication could be reduced and the amount of chemical fertilizers used in agriculture could be potentially decreased.

Third Place

The Effect of 17 Beta-estradiol on the Sex of *Poecilia reticulata* Offspring

Elizabeth Ransone, Chesapeake Bay Governor's School for Marine & Environmental Science

In recent years, concern has arisen about the tainting of natural aquatic environments through anthropogenic means. As human populations have grown and pharmaceutical use has become more

prevalent, the concentration of sex hormones that enter bodies of water has increased around the world. These sex hormones are especially problematic because they are still potent when they are excreted from the human body and can enter local ecosystems through wastewater. This study observed the effect of enhanced environmental concentrations of 17 β -estradiol on the sex ratios of offspring of exposed fish. This study had two trials; each used a control, a low dosage treatment of 17 β -estradiol (5 nanograms per liter or 5x10⁻⁶ parts per million), and a high dosage treatment of 17 β -estradiol (15 ng/L or 1.5x10⁻⁵ ppm) in tanks with the fancy guppy, *Poecilia reticulata*. The offspring were sexed by looking at their caudal fin formation: an elongated tail was considered characteristic of a male, and a rounded tail was classified as a female. All of the control and high treatment offspring were female in the first trial. The low treatment tank in the first trial yielded a ratio of 0.75 males for every female. The second trial saw the opposite results from the first trial, as all of the low treatment offspring were male and the high treatment had a ratio of 1.75 males per female offspring. A t-test with a result of p = 0.5 found the results of the combined trials were not statistically significant. Further experimentation with a larger control population should occur before conclusions can be made about the effect of 17 β -estradiol on the sex ratio of *P. reticulata* offspring.

Honorable Mention

The Effect of Different pH Treatments on the Metabolic Rates of *Hydrilla verticillata*

Jennifer Radcliffe, Chesapeake Bay Governor's School for Marine & Environmental Science

Ecosystems are made more susceptible to invasive colonization by being stressed by factors such as global climate change, which increases atmospheric and water temperatures. In addition, aquatic ecosystems are stressed by ocean acidification, a decrease in the ocean pH caused by increased levels of CO₂ in the atmosphere. This rise in acidity is detrimental to corals and other calcifying organisms, but it may or may not have a negative impact on submerged aquatic vegetation (SAV) and its effect on freshwater organisms has not been well studied. Since its introduction to the United States in the 1950s, the aquatic invasive species, *Hydrilla verticillata*, has overrun many aquatic ecosystems, particularly in the southeastern part of the country, and has also established itself in the tributaries of the Chesapeake Bay. This study tested the respiration and production rates of *Hydrilla* under different pH conditions, in order to predict what kind of effect increasing water acidity might have on this invasive species. The apical tips of *Hydrilla* were incubated in water ranging from 8.2 to 5.7 pH units, in both the light and dark. *Hydrilla*'s metabolic rates, corrected for biomass, were computed from the change in dissolved oxygen during the incubations. The control treatment, 7.2, had both the highest respiration and production rates, followed by the most acidic and basic treatments, 5.7 and 8.2, then 6.7 and 6.2, although the difference in respiration rates was not significant. It is speculated that somewhere between 6.2 and 5.7 pH, *Hydrilla* reaches a stress threshold that forces it to go into overdrive in order to survive, possibly a survival strategy called phenotypic plasticity. Further studies would better pinpoint this threshold and may give an indication of how SAV in the Chesapeake Bay will handle stresses brought by increasing acidity or other stressful environmental conditions such as global climate change.

Honorable Mention

The Effect of Urea, Ammonia and Different Fertilizers on Rotifer Mortality

John Ryan, Hanover High School

The rationale of the experiment was that the Chesapeake Bay is currently suffering from runoff pollutants that cause an increase in algae growth, resulting in dead zones. The purpose of this experiment was to determine if pollutant salts are toxic to rotifers, and if some are more toxic than others. The title was "The Effect of Urea, Ammonia, and different fertilizers on Rotifer Mortality." The hypothesis was that if rotifers were exposed to increasing amounts of ammonia; Miracle-Gro and Scott's Turf Builder, then the amount of rotifer mortality would increase. To test the hypothesis rotifers were plated in wells with 1 ml of seawater, with algae as a food source. They were then exposed to ammonia, Miracle-Gro and Scott's Turf Builder. There were a variety of concentrations used for each type of chemical. The fertilizers where

tested at 20 ppt, 10 ppt, 5 ppt, 1 ppt, and 1 ppt. There was also an additional test done on Scott's Turf Builder at 0.05 ppt. The wells were then counted using a dissecting microscope to determine the number of live rotifers remaining in each well. When the results were analyzed, the phosphate salts were found to be the most toxic, followed by chloride salts, while acetate salts were the least toxic. Within each group the potassium cation was more toxic than its sodium counterpart. It was concluded that the combination of the potassium cation with a phosphate anion is the most toxic and caused these results. Since rotifers are a natural predator of algae, understanding how pollutants like potassium and phosphate affect rotifer survival is critical to the health of our waterways.

Honorable Mention

The Effect of Different Methods of Water Purification on Preventing the Growth of Bacteria

Thomas Sheehy and Helen Weierbach, Washington-Lee High School

The purpose of the experiment was to determine which method of water purification was most effective at preventing the growth of bacteria. It is critical to filter bacteria out of water to insure that water is safe for drinking. It was hypothesized that boiled water would allow the least amount of bacteria to survive, since the boiling water is hot enough to kill most organisms. To test the hypothesis an experiment was conducted using samples of pond water that were filtered by several methods. The methods were: boiling, a Brita charcoal filter, iodine tablets, and an emergency sand filter. Pond water was tested as the positive control and bottled Dasani water was tested as the negative control. Each sample was swabbed on Petri dishes, each level with 10 trials. Growth was observed and recorded. The mean values of each level were as follows, units in cm^2 . Bottled water had 0, Iodine Tablets with 0.4, sand filter with 1, boiled water with 1.4, charcoal filter with 2.3, and pond water with 15.2. The data showed that the bottled water had the least amount of bacteria, likely due to the company's advanced filtration methods. The boiled water had the fourth highest bacteria level, not supporting the hypothesis. Statistical analyses showed the data to be significant. The emergency sand filter reduced bacteria more effectively than predicted, while the Brita charcoal filter, sold commercially, did not.

The Effect of Carbon Dioxide Scrubbers on Car Exhaust

Amanda Orndorff, Mathematics & Science High School at Clover Hill

In this experiment, the objective was to see if it was possible to capture the carbon dioxide in car exhaust. The purpose was to find a way to prevent excess CO_2 from being released into the atmosphere and contributing to global warming. The hypothesis was if different ways to filter carbon dioxide from car exhaust were used, then sodium hydroxide would work the best. To test this, a garbage bag was attached to the tailpipe of a car, the car was started, and Bromothymol Blue indicator solution was placed in the bag and observed to determine the amount of CO_2 collected in the bag. CO_2 filters were constructed and attached to the tail pipe of the car, the exhaust was collected in a bag again, and BTB indicator solution was placed in the bag to determine if there was a large concentration of CO_2 in the exhaust. It was found that some filters can have an effect on the CO_2 levels in car exhaust but they do not completely filter out the CO_2 . The hypothesis was not supported as the sodium hydroxide filter design was more successful than the sodium hydroxide scrubbing design.

Different Soil Types on Amplitude of Transverse and Love Waves

Abhishek Penumala, Mills E. Godwin Specialty Center for Science, Math & Technology

Earthquakes are disasters that have killed thousands of people around the world. They're causing numerous environmental issues, and they're currently on the verge of becoming an uncontrollable issue. This particular study will assist in monitoring the p, s, and surface waves during an earthquake more efficiently; decrease the effect of soil liquefaction, and save precious lives and money. The purpose of this experiment was to determine the effect of different soil types on the amplitude of transverse and love waves during an earthquake. A shake table was constructed completely by hand. A MyQuake Shake

Platform was also obtained along with two accelerometers and an amplifier, and the software NI Lab View was used to monitor the waves. There was no control present in their experimentation since there is no typical soil type that is used since soil type varies with the geography of the area. The results revealed that clay soil led to less amplitude of transverse and surface waves. Two t-tests were performed, one for transverse waves and one for love waves, and it showcased that overall the data was significant for silty vs. clay soil, silty vs. sandy soil, clay vs. peaty soil, clay vs. sandy soil, and peaty vs. sandy soil. However, the data was not significant for silty vs. peaty soil for love waves. Overall, the results supported the research hypothesis and indicated the data was statistically significant. It is believed that the results are due to the physical properties of clay soil and the chemical properties of being cohesive (enables the soil particles to stick together) which helps dampen the amplitude of transverse and love waves. An improvement to this experiment would be using a more established shake table and more compatible accelerometers in order to eliminate human error and to produce the most accurate data. This particular research could lead to further studies that determine how other soil types have an effect on the phenomenon of soil liquefaction.

The Effect of Sodium Nitrate Concentration on Bioremediation of Hydrocarbons

Anirudh Prabu, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effect of sodium nitrate concentration on the bioremediation of hydrocarbons. This research can possibly help improve the efficiency of bioremediation by identifying the optimal sodium nitrate concentration for the process of bioremediation. Sodium nitrate was added to water samples from Echo Lake in Richmond, VA to make concentrations of 900 mg/l, 1800 mg/l, 2700 mg/l, and 0 mg/l of sodium nitrate. Two milliliters of oil were placed on top of an extra-deep petri dish filled with 100 ml of water and left undisturbed for seven days. The control used in this experiment was the test group that had a concentration of 0 mg/l of sodium nitrate. It was hypothesized that if 1800 mg/l of sodium nitrate is used, then the bioremediation of hydrocarbons will be most benefited. The results indicated that the 1800 mg/l test group had on average an oil slick 0.7 cm smaller and 113 less CFUs than the 900 mg/l test group, an oil slick 1.1 cm smaller and 285 more CFUs than the 2700 mg/l test group, and an oil slick 1.7 cm smaller and 575 less CFUs than the 0 mg/l test group. A t-test was performed on the data and it revealed that the data was significant for all of the levels of the independent variable. The results both supported and did not support the research hypothesis. It is believed that the results are due to the fact that sodium nitrate increases the efficiency of bioremediation up until the certain concentration when microbial inhibition is triggered. This research could lead to further studies that investigate potential additives such as enzymes which could enhance bioremediation.

The Effects of Human Development on Dune Vegetation and the Atlantic Ghost Crab (*Ocypode quadrata*)

Hannah Richardson, Chesapeake Bay Governor's School for Marine & Environmental Science

The Outer Banks are a unique system of barrier islands that are inhabited by numerous and varied plants and animals and are characterized by sandy beaches. In recent times, as construction has increased on the Outer Banks, worries have risen about the effects of this development on the myriad of wildlife, and on the tourism industry. If increased human development were to impact an organism such as the Atlantic ghost crab (*Ocypode quadrata*), or plants such as dune vegetation, the food chain of the area would be detrimentally affected, which would ultimately effect the economy of the area. This study aimed to observe if human development on the sandy beaches of the Outer Banks in North Carolina will have a significant impact on the Atlantic ghost crab within different strata on the beach front and on dune vegetation. The research was conducted in an outdoor environment which the data collection being on the beach for both the ghost crabs and vegetation. The beach was separated into three strata with data being collected and quantified in each stratum for the ghost crab data; while the plant data was only collected on the foredune, this process was repeated for the developed, Comfort Inn, and undeveloped site, New Inlet. The resulting data showed that there was statistically higher percentage of plant coverage at the undeveloped beach, as well as higher plant diversity. The undeveloped beach had a greater number of ghost crab burrows, mostly in the foredune area. This could occur because an increased human presence leads to the trampling of ghost crab burrows and vegetation, and increased pollution

could lead to harmful chemicals penetrating the sand, causing harm to the plants and also to crabs within their underground burrows. The collected data could be used to predict future effects of human development on the Outer Banks, along with any similar beaches from Rhode Island to Santa Catarina, Brazil.

Variance Attempts to Reduce the Effects of Acid Rain on Radish Plant Growth

Eleanor Ridgeway, Washington-Lee High School

This project in its present form shows the result of acid rain on radish plants and a way to eliminate effects on growing. The purpose of this experiment was to show how pollution affects plant life, and way that neutralized these effects. Some success with gardening fertilizers in area greatly affected by acid rain, eventually led to detailed experimentation. This led to the use of fertilizers as the independent variable. Acid rain, because of its acidic properties and chemicals, causes nutrients in the soil to be stripped away. Fertilizer provides short-term nutrients rapidly to those plants where nutrients have been depleted. Limestone, which is found naturally in forest soil, provides nutrients to plant life. If radish plants come in contact with acid rain for more than 15 days the plant will grow significantly less than a plant without acid rain. To help cancel the growing effects of acid rain on plants significantly, plant fertilizer should be used to replenish the soil from the nutrients that has been diminished by fertilizing the soil every 3 days. Four groups of 16 quads were created with potting soil and radish seeds with each labeled differently: control, acid rain, limestone, and fertilizer. The limestone soil was mixed with a limestone solution, and fertilizer soil mixed with a fertilizer. Every group, except the control, was watered with water at a pH level of 5, and the control group watered with a water pH of 7. It has been supported by the experiment that acid rain is detrimental to plant growth, and there was a significant difference between the control group and the group watered by acid rain. The control group performed the best and acid rain performed the least. The fertilizer eliminated almost 50% of the damage, but the limestone only had a minimal difference in height compared to the acid rain group.

The Effect of Boat Traffic on the Amount of CO₂ Dissolved in Water

Hannah Russell-Hunter, Washington-Lee High School

By the end of the century, the average acidity of the world's oceans will be 150% greater than at the beginning of the industrial era. This phenomenon is known as ocean acidification, and it is caused by a decrease in water pH. One of the causes of decrease in pH is increased levels of carbon dioxide (CO₂). The purpose of this experiment was to find out if the amount of boat traffic in an area was correlated with the amount of dissolved CO₂ in the water. The hypothesis was: "If each location is measured for CO₂, then the level of dissolved CO₂ will increase as boat traffic increases, because CO₂ exhaust created by more boats will lead to greater amounts of dissolved CO₂." The four levels of independent variable were "Control" Creek (0 boats per hour), Irish Creek (2 boats per hour), Town Creek (10 boats per hour), and the Tred Avon River (20 boats per hour). The dependent variable was the amount of dissolved CO₂ in parts per million (ppm), and it was measured using a process called titration. The data did not support the hypothesis, because the location with the highest CO₂ level was Town Creek (30.1 ppm), but it did not have the highest boat traffic. The conclusion of this experiment was that the amount of boat traffic in an area is one of the indicators of dissolved CO₂ levels, but other factors such as car traffic and businesses must be taken into account as well.

The Correlation between Water Quality, Percent of Impervious Surface in the Watershed and Population Density in the Surrounding Area to the Frequency and Diversity of Macroinvertebrates Found in the Streams of Parks Managed by the Northern Virginia Parks

Julia Simon, Wakefield High School

This purpose of this project was to study the extent to which water quality was related to surrounding population density and the percent of impervious surface in the watersheds for a diverse group of parks in Northern Virginia. The primary indicator of water quality was the frequency and diversity of macroinvertebrates found in the streams in each park. Macroinvertebrates are important indicators of water quality because they are highly affected by the chemical, biological, and physical conditions of a body of water. The specific hypothesis tested was that parks with better water quality, that were larger in size, and with lower population density in the surrounding area, are more likely to be associated with a

more diverse and larger macroinvertebrate population. This experiment was conducted by sampling the macroinvertebrate populations in four parks managed by the Northern Virginia Regional Parks Authority at locations ranging from the inner to outer suburbs. Statistical analysis was used to explore the relationship between the presence of macroinvertebrates, impervious cover, and population density. The analysis of the data collected indicated that there was a statistically significant difference between the frequency and diversity of macroinvertebrates and the percent impervious surface in the watershed, population density of the surrounding area, and size of each park's watershed. The analysis found that larger parks, surrounded by less densely populated areas and with a lower percentage of impervious surfaces in the watershed, contained a greater diversity of organisms. Future research could include sampling at additional parks as well as repeat sampling at each location.

Bio Cubes with Controlled Environments

Nicholas Sink, Southwest Virginia Governor's School

Some of the greatest problems in today's world are overpopulation, hunger, and pollution. This project may help alleviate these problems by contributing to the information needed to utilize land for agriculture and housing that was previously uninhabitable. The objective of this project was to determine the ratio of carbon dioxide producers to oxygen producers that would allow establishment of a sustainable, self-replenishing man-made environment. Three cubes containing dirt, grass, water, and crickets were constructed. The first cube contained six crickets, the second contained eight, and the third contained four. The results showed no significance difference ($p = 0.2827$) in the carbon dioxide levels of the cubes, but cube two (mean: 144.6, ± 1.6) showed significantly lower levels of oxygen than cubes one (mean: 186.8, ± 1.6), $p = 0.0001$) and three (mean: 187.6, ± 1.6), $p = 0.0001$). Cube two had the largest number of crickets so this may suggest that equilibrium is below that number of oxygen producers. Projects still need to be created in which the environments are larger and run longer so that more data can be gathered and studied.

Determining the Effect of Anthropogenic Noise on Croaker Communications in a Shallow Estuarine Environment

Samuel Spadaccini, Chesapeake Bay Governor's School for Marine & Environmental Science

Before mechanical noise was introduced into the marine environment, acoustic energy was limited to natural processes such as wave energy which is relatively quiet and periodical. In the study, ambient noise was recorded underwater using a hydrophone at various locations. The conditions defining "ambient" included no surrounding anthropogenic noise. Queen's Creek in Mathews, Virginia was chosen because it is a shallow body of water with low boating activity. Kinetic energy reverberating from the Colman Bridge in Yorktown, Virginia and from the Gwynn's Island Bridge was recorded to sample anthropogenic noise pollution. Select samples were then imported into RavenLite: Interactive Sound Analysis Software. The software digitized the sound and displayed it as an oscillogram; a graph that illustrates sound as a wavelength with amplitude on the vertical axis and time on the horizontal axis. Specific noises, both natural and anthropogenic, were isolated within the software and analyzed based on frequency and compared based on their corresponding pure tone. The three sets of data were analyzed using an ANOVA statistical test between the Coleman Bridge, the Gwynn's Island Bridge and the *Micropogonias undulatus*'s samples and a statistical difference was found. This study has helped to identify and characterize sources of anthropogenic noise pollution. Many studies have already found adverse effects of anthropogenic noise on marine organisms such as whales, but the smaller organisms in shallow, estuarine environments may also be affected by prolonged and confined anthropogenic noise pollution.

Do Plants Eat More in Large Numbers?

Christian Tinsley, Chesapeake Bay Governor's School for Marine & Environmental Science

This experiment focused on the relationship between an Aquaponics system's nitrogen assimilation and varying plant densities. The maximum nutrient uptake rate was determined for varying levels of plant density (low: 4 plants per square foot; medium: 8 plants per square foot; high: 12 plants per square foot). Data were analyzed to check for any relationships, trends, or unusual occurrences. It is predicted that the nutrient removal rate will increase linearly as plant densities are increased due to the amount of plants

that are competing for the limited amount of nutrients per cycle. By determining the maximum nutrient uptake rate at various plant densities in Aquaponics systems, the principle units of these systems could be optimized to produce the maximum production. By the end of the experiment the data was able to tell whether or not there is a certain number or ratio of plants to fish in which an Aquaponics system would be working at maximum output. This study could eventually lead to major breakthroughs in food production for third world countries. Aquaponics focuses largely on helping protect the environment as well as being a cheap and healthy way of producing food.

The Effect of Different Fuel Types on the Height and Duration of Signal Flare Flames

Savannah Williams, Gloucester High School

Potassium perchlorate is an odorless, white, powdery salt that is commonly used for its qualities as a strong oxidizer. It is found in a multitude of products, including ammunition caps, propellants, fireworks, and rocket fuel. Even roadside signal flares contain potassium perchlorate as an oxidizer, and when this washes into the groundwater, it has the potential to cause major health concerns. The purpose of this experiment was to design a flare fuel composition that used an environmentally safe, non-perchlorate oxidizer. Potassium nitrate is an equally strong oxidizer that is not toxic enough to be used in fertilizers as well as food processing, so it was hypothesized to be a viable replacement for potassium perchlorate in flare fuels. Three different potassium nitrate fuel compositions – X, Y, and Z – were compared to a store-bought Orion signal flare. One gram of each formula was placed on a glass plate in front of a scale. A strip of magnesium was used to ignite the formula. A camera recorded both the duration and the height of the resulting flame. This was repeated for a total of 3 trials for formulas X, Y, Z, and the control. The data observed from the camera showed that potassium nitrate formula Z burned equally as high as the potassium perchlorate flares, in addition to enduring almost 6 seconds longer. The hypothesis – that if the oxidizer potassium perchlorate was replaced with potassium nitrate in signal flares, then potassium nitrate would provide a viable and environmentally friendly alternative – was correct.

The Effects of Thermal Pollution on Lake Anna Waterfowl Behavior

Catherine Womack, Home-schooled

This experiment was devised to test the effects of thermal pollution on water birds. Lake Anna, Virginia was chosen to be the location of the study due to the fact that the lake supports both a cold side and a warm side heated artificially by discharge from the North Anna Nuclear Power Station. Birds were observed on both sides of the lake and compared by number and behavior (the position of the birds on or off the water); and the results were analyzed. Results showed that the number of birds on the cold side of the lake was significantly higher, while biodiversity and species richness was higher on the warm side. There was no significant difference between the number of birds on and off the water for either side. The experiment could be influenced by several factors, such as environmental differences between the two locations, time of day, and biological differences between the species observed on each side. However, the results show differences between the sides that may be a result of thermal pollution from the power plant.

The Effect of Net Porosity on Insect Presence

Xing Zhang, Mountain Vista Governor's School

Malaria is a disease that affects millions of people annually and kills over half a million. Measures taken to prevent malaria include the distribution of insecticide treated nets by various organizations. The purpose of the experiment was to test whether less expensive and pesticide-free mosquitos nets were able to achieve the same results as other studies that used expensive, insecticide treated nets for malaria prevention. The experiment included three testing conditions: a control, nylon mesh netting, and generic mosquito netting. A homemade mosquito trap was placed inside each type of physical boundary to quantify the number of mosquitos that were able to trespass the physical boundary. The three testing conditions were tested over a 2-month span, 15 days for each condition. The hypothesis was that if the holes in the physical boundary were smaller, then fewer mosquitos would be able to penetrate the physical boundary. The null hypothesis was that the size of the holes in the physical boundaries would have no effect on the number of insects captured. The control had the highest number of insects captured. The nylon mesh netting had the second highest number of insects captured. The mosquito

netting had the lowest number of insects captured. The results of the experiment supported the hypothesis and rejected the null hypothesis.

Human Behavior A

First Place

The Effects of Meditation on Focus and Concentration

Luke Hawkins, Sabot at Stony Point

The reason this experiment was chosen was because of the recent rising interest of meditation and science, and what exactly could be affected by meditation. Meditation is a religious practice as well as a helpful way to relax. From a personal experience, after meditation there is a feeling of clarity and relaxation. Meditation was then compared to the more common and recreational activity, watching television. Previous research points to meditation having positive effect on health and wellbeing. Some of these being a decrease in cortisol levels, increased focus in children with ADHD, decrease in blood pressure and heart rate, and a lower reaction to social rejection. This study measures the effects of brief mindfulness meditation on the ability to focus and concentrate as measured by time completion on the Stroop Color and the Directional Stroop tests. These scores are compared to the scores of the same participants after watching television (SpongeBob SquarePants) and 15 minutes of informal conversation. Ten middle school students who had no experience in meditation were tested. The hypothesis stated that when the participants meditated, the speed of their Stroop completion would increase, decreasing the total amount of time to take the Stroop tests. The Color Stroop test showed that the hypothesis was inconclusive, meditation decreased time compared to the control, but watching television-decreased time by a greater amount while the Directional Stroop showed that meditation resulted in a greater amount of time than the control. Future research in this topic should involve more advanced meditators as well as other measures of focus and concentration.

Second Place

Cookies: Indicators of Integrity

Cordelia Collinson, Kenmore Middle School

This project focuses on the study of students' ethical actions. It explores whether students will make morally correct choices more often in locations with adults in the area. The purpose of this experiment was to find out if students would take more cookies without payment if they did not see people in the area who could punish them. It was hypothesized that a higher number of students would pay for cookies in the cafeteria, the location with many adults, than in a minimally supervised hallway. A self-serve bake sale stand was set out into different locations, one with an increased number of authoritative figures and the other with a lesser amount of adult personnel. The overall percentage of cookies paid for in each location determined if students were more likely to pay for cookies if they believe there will be consequences. The results were that the percentage of cookies paid for in the cafeteria, the testing area with an average of nine adults, was 16.8%. The end percentage of cookies paid for in the hallway, the testing area with an average of 3.5 adults, had an ending percentage of 10.5% of cookies paid for. The hypothesis was accepted. A larger amount of students paid for cookies when more adults were in the vicinity.

Third Place

The Effect of Caffeine on Typing Speed

Vanessa Bethke, Sabot at Stony Point

Caffeine is a large part of many people's daily lives. It is the world's most consumed psychoactive drug. The average adult consumes over 220 mg of caffeine each day, and a study with seventh through ninth

grade students shows that students consume anywhere from 53 mg to 100 mg of caffeine a day. Most of the caffeine consumed by adults comes from drinking coffee or tea each morning, and for children soda is the most widely consumed caffeinated drink. The hypothesis was that after caffeine consumption a participant's words per minute would increase. The hypothesis was supported. The results were that when caffeine is consumed, there is an increase in words per minute after caffeine is consumed compared to when caffeine isn't consumed. The average increases for 110 mg being 4.11, 1.73, 2.95, and 21.09, and the average increases for 55 mg being 1.33, 1.68, 8.78, and 14.78. Also, the faster the typing speed the more errors occurred, and the greater the difference in typing speed before caffeine is consumed compared to after it is consumed. The objective of this experiment was to study the effect of average caffeine consumption on our motor skills. The experiment was conducted by having participants consume a measured amount of caffeine, and then type a timed passage.

Honorable Mention

The Effect of Color on Problem-solving Speed

Morgan Canaan, Tuckahoe Middle School

The purpose of this experiment was to use the variable of color in order to improve efficiency amongst students, office employees, and workers of any kind. It was found that by using color, emotions can be provoked that either stimulate or discourage productivity. The objective of this experiment was to isolate the color with which students solve a problem the fastest. The color with the fastest average problem-solving speed was considered the most productive color. Once this color was revealed, it was inferred that the emotions that color provoked contributed to the productivity shown within the subject. Jigsaw puzzles were chosen to represent the problem subjects were asked to solve because puzzle skills rely on logic. Fifteen female subjects within the ages of 13 and 16 were asked to complete three 16-piece jigsaw puzzles that were each a different color. The colors red, green, and white were chosen for testing because they represented a wide range of emotions. The average problem-solving time for the color red was 240.27 seconds, for the color green it was 280.4 seconds, and for the color white it was 350.73 seconds. Due to these averages it was concluded that the color red stimulates the most productivity. Research proved that red provokes an energetic, alert emotion from the human brain. As learned in this experiment, this emotion can be channeled into efficiently solving a problem and completing work. Therefore an energetic and alert environment is needed in order for one to have maximum efficiency while problem-solving.

The Effect of Different Child Resistant Caps and How User Friendly they Are

Lovell Abraham, George H. Moody Middle School

This experiment was about different child-resistant caps and their user friendliness (measured in time taken to open each cap). The purpose was to find the best child resistant cap. That way everyone would have an efficient child-resistant cap, and at the same time it would not serve as an obstacle for adults. That was determined by finding the cap between easy and hard to open. The easiness and hardness to open cap was determined by looking at the time taken to open them. The hypothesis formed was if Cap B (push down tab and turn) is used then it will take 6 seconds to open. The experiment was conducted by having 10 eight year old children open each of the four different child-resistant caps, while being timed. They each were in plain rooms, and each experiment conducted separately, to avoid cheating. All other constants (environment, lighting, tester position, age, gender, cap size, cap weight, bottle size, cap color, bottle color and bottle weight) were identified and kept the same for each experiment. After the experiment was conducted, the average time for each cap was found. The averages were graphed as a bar graph so the user-friendliness could easily be identified. The results for each trial were also charted. Finally the conclusion was formed; if Cap B (push down and turn) is used then it will take 5.8 seconds to open.

Effect of Beverage Color on Chosen Beverage

Conor Battle, Tuckahoe Middle School

Much of our taste is decided before we even taste something. Our mind chooses what we believe will taste the best based on appearance before we even taste it. Different colors (red, blue, green, yellow, and clear) were distilled in a 20 ounce bottle of Sprite, before being poured into a 3 ounce Dixie cup. It was hypothesized that if the color of a beverage was blue, then it would be chosen the most. The experiment was conducted with 15 trials of 1 person each, making 15 people tested over all. The 5 colors of drink were placed out on a table, and then the subject would pick which drink they would like to drink. They were then told not to actually drink it. The experimenter would record the number of times each drink was chosen. Blue and clear sodas both had 4 of the 15 people chose that color, making those the most chosen colors, and not supporting the hypothesis. They did not support the hypothesis, because although it was hypothesized that blue colored soda would be chosen the highest amount of times, clear soda was not included. These results show that blue soda and clear soda are the most chosen colors for sodas among young consumers.

Effect of Chewing Mint Gum on Test Score

Callie Borges, Tuckahoe Middle School

The problem question, "Does chewing mint flavored gum, while studying for and taking a test, help concentration that can provide a better test score?" was put to test. The experimenter's hypothesis was, if a person chewed mint gum while studying for and taking a test, then they will get a higher score on the test than a person not chewing gum while studying for and taking the test. The experimenter set up a power point consisting of three slides of 20 pictures. During each trial, the experimenter would show ten people, five people chewing gum and the other five were not, one slide of 20 pictures that they could memorize for 30 seconds. After those 30 seconds, the slide would go away and the people would write the names of as many pictures that they could remember in one minute. For the next two trials the experimenter would do the same thing but with a different slide of pictures. After all testing, the scores of everyone's papers were collected and the final scores were determined. The experimenter's hypothesis was proven, but the average score of the people who chewed gum was only a little bit higher than the score of those who did not chew gum during the experiment. Further testing would be needed to really determine if chewing mint gum while taking a test helps get a better test score than not chewing any gum.

The Effect of Color of Cupcake and Icing on Preference

Willoughby Clark, Tuckahoe Middle School

The hypothesis for this experiment was: if vanilla cupcakes were dyed and baked, then the cupcake dyed red would be chosen more by humans than white, blue, and green dyed cupcakes. Cupcakes are a popular dessert favorite around the world. Bakeries compete to have the best looking food to attract more customers, because customers may come to buy the best looking cupcakes. They all want the perfect color. This experiment tested the levels of the independent variable to see which color was most preferred by humans. There were eight people tested. Each participant was shown four different colored cupcakes to see which was most chosen. There was one white cupcake, one red, one blue, and one green tested. The experiment was run and results were recorded. Overall, the hypothesis was not supported. The red cupcakes were not chosen at all and the white were chosen the most. White cupcakes were the most preferred in this experiment.

The Effect of Size of Container on Food Selection of Adolescents between the Ages of Ten and Thirteen

Caroline Davis, George H. Moody Middle School

During this experiment, the purpose was to determine which plate size would be chosen most out of the three choices. It was hypothesized that if the six-inch plate was provided, it would be chosen significantly more than the eight and ten-inch plates even though food quantity would be constant amongst the three sizes of plates. In order to discover which plate size would be chosen most, 42 adolescents between the ages of 10 and 13 were taken separately into a room and asked to choose a plate from the choices

provided. Each plate was the same brand, color, and design and contained one cup of rotini pasta. As each subject selected a plate, the data was recorded. Out of the 42 subjects that participated, it was recorded that 17 chose the six-inch plate. The eight-inch plate was chosen 14 times, and the ten-inch plate was chosen 11 times. As hypothesized, the six-inch plate was chosen more often than the eight and ten-inch plates.

The Effect of Age on Work Ethic

Morgan Doll, Tuckahoe Middle School

Work ethic is a necessary part of life for all ages, but especially for adults who provide for their families. Subjects in this study completed the Multidimensional Work Ethic Profile, which consists of seven major classifications of work ethic. These classifications are hard work, self-reliance, leisure, centrality of work, morals and ethics, delayed gratification, and wasted time. The hypothesis of the experiment was, if the age group of the subjects is 11-14 years old, then they will score with less work ethic than the subjects who are 40-55 years old, and it was proven correct. The questionnaire was presented in a Likert scale where “strongly disagree” was weighted with one point and “strongly agree” was weighted with five points. The students scored lower than the adults on all classifications of work ethic except hard work and delay of gratification. The students and adults scored the same on the morality and ethics classification. The experiment was conducted to see if work ethic is lower in middle school students than in adults, which could potentially make it harder for them to get a job in the future. Today there is an intense amount of competition for jobs, and because the hypothesis was proven correct, it is shown that middle-school students need to change their attitudes about work.

Priming Effect

Bridget Fitzpatrick, Kenmore Middle School

Commercials, billboards, and advertisements can affect our perception of the world by priming us to see objects or problems from a specific viewpoint. How much priming alters our perception is unknown. The purpose of this experiment was to determine the effects of priming through visual perception after reading designed text. Participants read one of three different text paragraphs and then look at the same image to see if their visual perception of the image was influenced by the text paragraphs. The results from the experiment showed little influence from the priming on the participants, however, in other studies, priming was shown to have a great effect on the participants. The possible reason for the difference in results from this experiment versus other experiments is that the chosen reading text for this experiment was not effective in priming participants' visual perception.

Highlighting versus Writing

Maya Gorton, Gildersleeve Middle School

The Highlighting vs. Writing project was done to find out which type of studying habit helped students remember 20 different words the best. Thirty students (15 girls and 15 boys) were placed into three groups (after having permission slips signed) with an even amount of girls and boys in each. The first group was the reading group. The students had two minutes to study 20 words that were shown on a smart board. After that they had a two minute break to answer “All About Me” questions that were basically used to distract the students. Afterwards they had two minutes to recall as many words as they remembered on a sheet of paper. The second group was the highlighting group. To study the words, students were given a sheet of paper with 20 of the same words that the first group had, plus another 10 bonus words. They had two minutes to highlight and study the 20 words they saw on the board. Afterwards they did the “All About Me” questions and the test like the first group did. The last group was the writing group. The students in this group were given a sheet of paper and then had two minutes to write down and study the 20 same words as the first two groups. Once the two minutes were up, the students also did the “All About Me” questions and the test like the first and second group. The reading group had the most words remembered with an average of 9.9. The highlighting group had the second amount of words memorized with an average of 7.8, and the writing group came in third with an average of 7.7. The conclusion was the reading group remembered the most words.

The Effect of Age of Girl on Body Image Perception of Self

Brenda Hayes, Orchard House School

This experiment tested the effect of the age of a girl on her body image perception of herself. This project further investigates when girls begin to feel self-conscious about themselves. The hypothesis stated that older girls would have the worst body image because they would have been influenced by media for a longer period of time. A survey was created then sent out to 80 girls in total: 20 girls in each class of 5th, 6th, 7th, or 8th grade. The results showed that the 5th graders had the best body image and the 7th graders had the worst body image. This proved the hypothesis that older girls would have a worse body image than younger girls.

The Effect of Color on Color Seen First

Tyler Hendricks, Tuckahoe Middle School

The objective of this experiment was to reveal which color out of the four colors offered would be seen first. The experimenter approached the experiment by first researching the subject online and with academic journals, and then formed the hypothesis that if different colors are placed on a table, then red will be seen first. Next the experimenter designed the experiment by choosing which colors to use and deciding what order to place them in each trial. Then a few days before the experiment permission slips were handed out to the test participants. The experiment was then conducted on the set date. Once the results were gathered the experimenter examined the results to form a conclusion. The key results of the experiment were that red was chosen the most out of blue, black, white, and red. The experimenter concluded that the hypothesis was supported by the data from the experiment and red was chosen the most times of the colors offered.

The Effect of Different Types of Gluten Substitute on Preferred Taste

Ashley Hennerberger, George H. Moody Middle School

Celiac disease (or celiac sprue) is an immune system reaction induced by sensitivity to gluten proteins such as gliadins. This disease is caused by an improper lining of the intestines. In a person with celiac, his/her intestines are not lined to allow proper nutrients through and therefore allow improper nutrients through such as gluten. The purpose of this experiment was to see if different types of gluten and gluten-free flours when baked into cookies had a great effect on preferred taste. The five flours used were all-purpose (gluten) flour, almond flour, coconut flour, Trader Joe's gluten-free baking mix, and Namaste Foods Perfect Flour Blend. The hypothesis stated was if coconut flour with xanthan gum (bacteria from corn sugar like gluten) is used as a gluten substitute in a cookie recipe, then it will have the highest ranks from participants. The cookies were baked (some with xanthan gum) and then set out to cool and bagged. The process was repeated for every type of flour (50 cookies each) and then distributed to the participants. The participants were then given a survey that had cookies labeled A – E on it. The participants were asked to number the cookies 1 (best) – 5 (worst) on taste. The results showed that the almond flour baked cookie received the highest ratings. The mean value for each flour was: all-purpose flour, 2.60; almond, 2.07; coconut, 4.36; Trader Joe's mix, 2.60; and Perfect Flour Blend, 3.38. The regular and Trader Joe's flour both had the same average rating. This shows that both flours are comparable to each other and are just as tasty. In conclusion, the almond cookie got the highest rating because of its texture, but this also showed that there are many tasty gluten-free options available.

Effect of a Priming Comment on Perception

Josephine Holland, Tuckahoe Middle School

Is a person's perception of a documentary influenced by an expert's opinion? According to this study it is. The experimenter wondered whether the expert's testimonial actually made a difference in how people viewed a product, and so the study, "Effect of a Priming Comment on Perception," was performed. The study was done on 38 students, ages 10-13. The independent variable was the type of expert's opinion (a positive opinion, a negative opinion, no comment). The dependent variable was the student's perception of the documentary (good, bad, so-so, etc.). The hypothesis was if the experimenter gives students 3 priming comments (positive, negative, no comment), then the group of students with the positive comment will have the most positive viewpoint. The students received slips of paper that contained 5

basic facts (producer, location, and so on) about the documentary “The Hobart Shakespeareans.” About a third of the students got a positive comment at the top of their page (experts say this was an amazing documentary). Another third got a negative comment at the top (experts say this documentary was horrible), and the remaining third received no comment. After students read all of their paper (including comment and basic facts), part the film “The Hobart Shakespeareans” was shown. Then students took an online survey about their opinion of the documentary. The students rated the documentary on a scale of 1-10 on how interesting it was (one was not very interesting, ten was very interesting), check boxed comments that they thought applied to the documentary, then had the option of free writing any thoughts they had about the documentary. Overall, the hypothesis was not accepted. Surprisingly, the no comment group had the most positive reaction to the documentary. The negative comment appeared to have a large impact on how the participants viewed the video and the positive comment did seem to have a significant difference in the viewpoint with the check-boxing and notes/comments section.

Effect of Chewing Gum on Concentration

Lamia Kaiser, Kenmore Middle School

The effect of chewing gum was chosen to work on because the scientist was curious on the topic. The independent variable is chewing gum and dependent variable is timing how long each student takes to complete a worksheet with chewing and not chewing gum. It was hypothesized that if people chew gum while doing worksheet #2 they'll be able to get more correct answers than not chewing gum with worksheet #1. Participants were given 2 worksheets, worksheet #1 and #2. The participants chewed gum while doing worksheet #1 and did not chew gum while doing worksheet #2. The average amount of correct answers on worksheet #1 (2/3 mix-up 1) was 23 out of 25. The average amount of correct answers for worksheet #2 (subtraction) was 25 out of 25. The hypothesis was accepted because people were able to get more correct answers and finished faster with chewing gum than without chewing gum.

The Effect of Different Types of Verbal Communication on Inattentional Blindness

Ryan Keough, George H. Moody Middle School

The origins of human speech are unknown to us. Even though it may seem that speaking is the most important part of communication, listening is the other vital part in the process. From model to model, the invention of the telephone has made its way from the classic telephone to modern, portable cellular phones. If various forms of communication were used during a driving video, then it is believed that talking to a person while using a hand-held cell phone or hands-free-cell phone will cause the participant to find less street sign poles than talking to a person sitting next to him/her or having no conversation, but will have similar results to each other. This research can benefit society by demonstrating the harm that certain types of verbal communication can cause while driving. In preparation for the experiment, a 30 second video and a 3 minute video were created using a Nikon Coolpix L120 camera to record what a passenger would see driving around the Bridgeview subdivision near Nuckols and Springfield Roads in Glen Allen, Virginia. Participants using hand-held devices had a mean that was approximately 3.9% higher than those that used any other form of communication. Hand-held users, however, had the largest standard deviation, 3.9. Following after them is passenger with 2.9, and hands-free with 2.4. At the bottom is the control with a standard deviation of 0.9. Since the participants who used handheld devices performed better than all the others, the hypothesis was not supported. This is not in agreement with similar research, saying that hand-held cell phones were more distracting than nothing. Additional experiments could also examine whether males or females perform better in a dual task environment. The experiment could be improved by increasing the number of street signs in the video, or increasing the length of the video, in order to test their memory even further.

The Effect of Teaching Form on Learning

Zoë Kinnard, Tuckahoe Middle School

The objective of the experiment was to find which teaching style (video narration or article) is more effective when teaching middle school students. Twenty-nine test subjects participated in the experiment. Ten subjects, labeled Group I, watched/listened to a video narration and took a ten question test. Another ten, Group II, read an article. The last group of nine test subjects was the control group, Group III. This group took the test without prior teaching. The test's questions were based on an article on oak trees, and

the questions were in random order. The video narration was a recording of the experimenter's voice reading the article aloud, along with photographs of *Quercus alba*, oak trees. The final results of this experiment showed that the experimenter's hypothesis, if students are exposed to the same subject matter about *Quercus alba* trees, one in the form of a video and the other in the form of an article, then they will learn more effectively through reading the article, was proven to be incorrect. The experiment showed that in actuality middle school students were taught more effectively through video narration. This experiment was successful because it answered the problem question: which form of information is more accurate when teaching middle school students (watching and listening to a video narration or reading independently)?

The Effect of Image on Donations

Teja Kinney, Tuckahoe Middle School

Charity is a generous action of donation to aid the poor, ill, or helpless. This concept is extremely important in today's unbalanced world, where much of the population is either extremely rich or extremely poor. Many people feel that it is the duty of the rich to help the poor and others unable to help themselves. Charities give this opportunity. Depending on what each charity promotes, some sort of image will most often be shown. So what type of picture causes the most people to donate? Six cups were placed in front of six pictures (a rose, construction worker, family, tornado devastation, child, and green landscape). Each participant was given a token and told to choose the picture to which he or she would most likely donate to if it were a charity. The participants then filled out a brief survey containing questions regarding the reasons they chose the picture they did and various personal preferences. The experimenter's hypothesis was: if people see a picture of a child associated with a charity, they will be more likely to donate to this charity than to one which shows a different picture. The hypothesis was accepted. Ten people donated their token to the picture of the child, nine to the tornado devastation, and one to the family. The other pictures received zero tokens.

Human Behavior B

First Place

The Effect of Birth Order on Educational Achievement

Rachel Zhao, George H. Moody Middle School

Birth order refers to people's position in the sequence of their siblings. The effect of birth order on personality and accomplishment has captivated the attention of researchers for decades and continues to fascinate researchers, parents, educators, and the general public. Most of the research findings so far have been in favor of first born children as more driven and successful. However, this claim lacks empirical support and is repeatedly challenged by researchers. The purpose of this experiment is to add more valid data to the findings by repeating some of the previous experiments with a focus on the effect of birth order on educational achievement. The hypothesis of the experiment is that if individuals were first born, they would most likely receive a higher educational degree than later born. Prior to the experiment, a survey including questions regarding the subject's birth order (IV) and the highest educational degree received (DV) was created with Survey Monkey. Invitations were emailed to friends, family members, neighborhood directories, and social media such as Facebook, WebChat, etc. A total of 212 responses were received. The survey results demonstrated that first born children were more prone towards achieving graduate degrees followed by last born and then middle born: 58% of the first born obtained a master's or doctorate degree, while only 35% of the middle born and 46% of the last born received master's or doctorate degree. The findings did support the hypothesis of the experiment and were consistent with similar research in that first born had higher academic achievement than later born. The experiment can definitely be improved by diversifying the survey sample. This research only examined the relationship between birth order and the educational achievement. Future studies can include the role of social economic status and family size on educational achievement.

Second Place

The Effect of Age Range on Mnemonic-aided Short Term Memory Improvement

Yashodhara Varma, George H. Moody Middle School

The experimenter wanted to find out how age, learning, and memory correlate. The purpose of this experiment was to find the effect of age range on mnemonic-aided short term memory improvement. The hypothesis was "If the short-term memory improvement of people from the ages of 30-40 is tested with and without a mnemonic, the average short-term memory improvement [of that group] will be greater than that of any other 10-year age range between 10 and 80. The experimenter asked for each test subject to write the subject's age and gender. The experimenter showed a test subject a list of 10 words for 20 seconds. After 40 seconds, the experimenter asked and recorded how many of the words the test subject remembered. The experimenter repeated the above procedure with the same list of words and a mnemonic for that list. The experimenter then subtracted the number of words remembered prior from the number of words remembered with the mnemonic-aided short term memory [to find the mnemonic-aided short term memory improvement]. The experimenter saw a general downward trend on the effect of age range on mnemonic-aided short term memory improvement. The improvement peaked at the age range of 20. An outlier was the age range of 60 because the age range had the same mnemonic-aided short term memory improvement as the 10 years old age range. This shows that a mnemonic is an effective memory improvement tool for all age ranges, but the experimenter would recommend the age ranges of 10-30 and 60 use mnemonics for the greatest mnemonic-aided short term memory improvement.

Third Place

The Effect of Food Color on the Perception of Taste

Emma Mewborn, George H. Moody Middle School

Research has shown a complex relationship between human taste perception and food color. The visual stimulus of food color is so strong that humans will report a flavor perception matching the food color while actually disregarding the food's true flavor. The purpose of this experiment was to determine the effect of cupcake icing color on the subject's perception of the cupcake's taste. It is hypothesized that if the color of a food item is changed, then the human taster will perceive its flavor as having also changed. In this investigation, the different colors of cupcake icing was the independent variable. The human research subject's perception of cupcake flavor was the dependent variable. Subjects sampled three identically flavored cupcakes, one with white icing, one with pink icing, and one with yellow icing. They were then asked to complete survey questions about the cupcakes. The results of the survey indicated that 48 percent of the respondents were influenced by the color of the icing of the cupcake, even though the cupcakes were all flavored identically. Only 12% of the survey respondents correctly perceived that the cupcakes were all flavored the same. The strongest association reported was white icing and vanilla flavor. The next strongest association was pink icing and strawberry flavor. Based upon responses recorded in this research, food color seems to play a significant factor in human taste perception.

Honorable Mention

Effect of Shooting Sleeves on Shot Percentage

Scott Moss, Tuckahoe Middle School

The experiment run was the effect of different shooting sleeves on shot percentage. This experiment was conducted due to the popular trend of shooting sleeves in the game of basketball. It was run by having 9 test subjects shoot 10 shots for each level of the IV. The levels of the IV were no shooting sleeve, one normal sleeve on the shooters dominant arm, two shooting sleeves (one on each arm), and a padded sleeve on the shooters dominant arm. The results for this did not support the hypothesis, if different shooting sleeves are used then, a shooter will have the best percentage with one shooting sleeve on. The most successful shooting sleeve was the padded shooting sleeve. However, the padded was the most successful, the double shooting sleeve was a close second and one shooting sleeve was not that much worse. This showed that shooting sleeves are effective and the most effective one is the padded shooting sleeve. This leads a basketball player to the idea that they should wear a sleeve, and for the best results to wear a padded sleeve.

Honorable Mention

The Effect of Gender on the Short-term Memory of Humans

Reona Pereira, George H. Moody Middle School

Memory, without it we wouldn't be able to score well on tests, recognize faces or names, we wouldn't know who we are; without memory, the human brain is almost useless. It might not occur to many people that we need memory for everything, because it's the key to helping us learn and pick up new things that would help us survive. There are two types of memory, short term and long term; long term memories are easier to access and remain in our brains longer while short term memories are smaller and can be lost with the passing of time or distraction. So what about gender differences in memory? Females and males are very different yet similar; they behave differently, think differently, look differently, but does one gender have a better memory than the other? The purpose of this experiment was to determine the effect of gender on the short term memory of a human being. Thirty people were gathered, as a control, 15 were girls. Both groups had 2 minutes to memorize 10 random faces with first names and then had 1.5 minutes to look at another stack with the same faces and recite who is who. They were then given a percentage based on the number of faces they got right. The mean for the girls was 84.6666% and the mean for the boys was 84%. A t-test was done and that showed that there was no difference in the data

between the girls and boys because the p-value was above 0.05. The results did not support the hypothesis that the females would have better scores than the males on the short-term memory test because there was no difference in the data for the groups. The results would have been more accurate if the participants were given less time to memorize the faces because none of the scores were below 50%.

Honorable Mention

The Effect of the Levels of Distractions on a Person's Ability to Recall Factual Characteristics of an Intruder

Megan Sundberg, George H. Moody Middle School

The hypothesis of this experiment was that a person with no distraction, or the control group, should have scored the highest on the characteristics of the intruder quiz. A person completing the written questions would be the most distracted and therefore have the lowest score on the quiz. Five volunteers entered a quiet room at a time, for the control group, participants were asked to sit silently for a minute as, unknowing to them, an intruder walked in the room for 30 seconds, and then left. After the minute was over and the intruder had left the room, participants were given a sheet of paper that asked for the approximate height, weight, age, clothing, etc. of the intruder. This was then repeated two more times for the verbal questioning and the written questioning. The quizzes were graded based on a predetermined answer key. The results of the experiment supported the hypothesis on the basis of the average test scores in each group decreased as the level of distraction increased. The experiment also showed that humans can in fact be distracted while doing the simplest task, even though the person may think the task affects their ability to think and react to circumstances they are faced with in everyday life.

The Effect of Different Forms of Entertainment on the Number of Calories Burnt during Workout

Medha Majety, George H. Moody Middle School

Calorie, a unit of energy, is frequently referenced along with energy gained or energy burnt. It was originally discovered by Nicholas Clément. Calorie is a unit of heat, or thermal energy. Calories are gained when consuming food. Calories can be burnt while exercising, walking, or any other form which requires kinetic energy or motion. Entertainment can stimulate a person to burn more calories. There are many forms of entertainment such as books, movies, and music. The purpose of the experiment was to find out which form of entertainment engaged the participant to burn the most calories. Each participant worked out for 5 minutes while listening to music, watching a movie, and reading a book. They also worked out for 5 minutes with no disturbances (control). There were 2 minute intervals after each 5 minutes elapsed. To reduce human error, 10 trials were conducted which meant there were 10 participants. The number of calories burnt by each participant was recorded. The results contradicted the hypothesis. The hypothesis was: If movies are watched, then the person will burn the most number of calories during the workout. The results showed that participants burnt the most calories while listening to music. People also burnt many calories with the control compared to movies, and books. This experiment could help with a great epidemic, obesity. Obesity starts with the constant lack of motion. The experiment provides data of the best way to work out. One can work out listening to music, reading a book, or watching a movie and not know which one really enhances workout. The results will show how one maximizes calories burnt while listening to music.

Effect of Grade Level on Password Security

Amalendu Manoj, George H. Moody Middle School

Password security is becoming an increasingly common topic in society. With technology becoming the inevitable future, it is becoming imperative to the safety of all of the rising generation to be aware of both the positive and negative potential the world of social media offers. Since losing the password to just one

account can cause a trail of more breaches to occur after it, this experiment tackled the question at its roots- teenagers. Teenagers are the demographic newest to social networking, making them the most vulnerable online and offline. For this reason, the purpose of this experiment was to test the effect of grade level on password security. To conduct this experiment, 3 different levels of the independent variable were tested (6th grade students, 7th grade students and 8th grade students) and each level contained 20 people. Each person was given an anonymous survey with 2 basic questions on them: what their grade level was and if they tend to use similar passwords for all online accounts. The answers were taken and put into a column and pie chart. The results clearly indicated that not as many 6th graders use similar passwords when compared to 7th and 8th graders. It showed that 7th and 8th graders varied by a very slim margin of only 5% or one person. Also, the hypothesis which suggested that 8th graders would have the most people using the same or similar passwords and 6th graders would have the least was supported by the results. However, aside from the numerical data these results also have a strong real world application. The data set, as a whole, suggests that adding lessons about online etiquette and making smart choices with online accounts is favorable. Since so many teenagers use online accounts and take the potential they have lightly, there should be an eye opener for them since technology is the inevitable future we are all heading towards.

The Effect of Environment on Timed Testing

Amelia Martin, Gunston Middle School

It was known that many students listen to music while studying or doing homework, but it was wondered does the music actually help your concentration or does it draw your attention away from your work and decreased the quality of the assignment? This project tested how student time varied when distractions were happening around the student. The student's attention was tested in 5 different situations, the lights on, lights off, television playing, familiar music playing, and unfamiliar music playing. The student took a short test and was timed. The hypothesis stated that familiar music would cause the student to do better on the test and that unfamiliar music would cause times to be slower for the test completion. The results of the experiment supported the hypothesis: the fastest average time was with familiar music playing at 46.95 seconds. The slowest time was with unfamiliar music playing, the average time was 55.15 seconds. Lights on, lights off, and television on did not dramatically affect the time. Average times were within 1 second of each other. This project stated that listening to music you know enhanced the quality of work.

Effect of Color on Memorization

Elizabeth Mauck, Tuckahoe Middle School

Memory is something that we use every day in and out of school. An experiment was undertaken to see if color would aid people in the act of memorization. Different colors (blue, green, and red which are main colors seen in the retina) were tested to see which would help individuals most in the act of memorization. It was hypothesized that blue would allow people to memorize the best. The experiment was completed by typing fragments containing 9 letters and numbers in different colored (black, blue, green, and red) texts and recording how many characters the participant being tested got correct. The experiment was done at the kitchen table of a residence. The test participant was asked to flip over a piece of paper containing a fragment in the identified independent variable. They had 15 seconds to memorize the fragment and then the sheet of paper would be taken away when they were then asked to repeat to the experimenter what they read in the order they read it. This was repeated with the other levels. There were 9 repeated trials. Data collected was quantitative as it was the number of characters said correctly. The hypothesis was not supported as it was found that the color green aided best in memorization with a mean of 7.9 characters correct out of 9. It was also found that the colors black and blue both equally helped the least in memorization with an average of 5.6 characters correct out of 9. Based on findings in the research, it should be added that further experimentation should be done to test lighting on effects of memorization as well.

The Effect of Gender on Most Effective Learning Style

Lauren McKelvey, Tuckahoe Middle School

The hypothesis tested in this experiment was that if males and females were tested to see which gender was affected the most by a learning style then male and female subjects would have different

preferences: the males would prefer the kinesthetic style and the females would prefer the auditory style. Every year, educational opportunities are expanded in schools and the curriculum gets more difficult. Knowing the best and worst ways to learn and teach can assist teachers, students, and coaches in their daily lives. Using the results of this experiment and other similar ones, studying for tests and learning new material could become as easy as reciting the alphabet! In this experiment, the first step was to compile a list of common household items for subjects to memorize. After three sets of the same 15 items were found and 30 similar items were written down or recorded, the experimenter set all of the items, papers, and audio recording to begin testing. Then, the experimenter put up dividers between the items and put out a previously made answer sheet. The experimenter let the subjects try to memorize one set of items for a minute and three seconds (the length of the audio recording). When the time was up the experimenter told the subjects to either flip over the paper with the words or put a cloth sheet over the items so they could no longer see them, and write down as many items as they could remember. After the testing was concluded, the results showed that 6 out of the 10 female subjects preferred the kinesthetic style alone, 1 out of the 10 preferred a mix of kinesthetic and visual, and 3 out of the 10 preferred visual. It also showed that 8 out of the 10 male test subjects preferred the kinesthetic learning style, 1 out of the 10 preferred a mix of kinesthetic and visual, and one preferred the visual style. Overall, both the male and female subjects did the best using the kinesthetic learning style, proving that the hypothesis was partly accepted and partly rejected.

The Effect of Color on the Probability of Choosing a Candy

Katerina Moss, George H. Moody Middle School

Choice is a very deceiving topic. The researcher wanted to dig deeper into the mind and find out about some things that affect a human's choice. The purpose of this experiment was to observe if the female species is more attracted to the bright and vibrant colored candies as opposed to the dark and dull colored ones. The researcher used color of candy wrapping as the independent variable in the experiment. The dependent variable was the probability of a female picking the color (%). If a researcher used royal blue, yellow, forest green, black, and white wrapped candies, then the yellow will be chosen most often. This is inferred because of the many background studies showing that women will most likely choose brighter colors on the warm side of the color scale, rather than the dark and less vibrant colors on the cool side. To begin the experiment, the researcher set up all the candies on an empty, open table in their house. The candies were arranged in a repeating pattern: blue, white, green, yellow, and black. This pattern was kept the same during the entire experiment. Ten female testing subjects all aged between 7 and 14 were told, "Choose one candy of your choice. They are all the same flavor, just wrapped differently". The researcher recorded which colored candy each girl chose. Of the 30 people that were asked to choose a candy, 24 chose the blue one, 8 participants chose the yellow candy, 2 chose black, 4 chose white, and green was chosen 2 times. When asked to pick a candy, blue was the most popular choice that was picked among girls aged 7-14. Clearly yellow was chosen less than blue because only 8 girls picked it, unlike the 24 that picked blue. This statement proves that the hypothesis was not supported.

The Effect of Music on Reaction Time

Nicholas Richter, Tuckahoe Middle School

The purpose of this experiment was to determine if different types of music can affect reaction time with light stimuli. The experimenter determined this through an experiment using different types of music including pop music, rap music, rock music, alternative music and no music, for the control. The experimenter found out from other sources that folk music can often increase reaction speed, and also that it is sometimes suggested to not listen to music at all to increase reaction speed. The experimenter's hypothesis is that if alternative music was played, then the subjects would have the fastest reaction time. The experimenter tested ten subjects with ages ranging from 13 to 16. The experimenter sat all subjects down at a table one at a time in the same location. They were tested using each of the levels of the independent variable for each trial. There were three trials in the experiment. Surprisingly, the faster paced rock music had the fastest reaction time overall from the averages of the three trials. The experimenter's hypothesis was wrong and alternative music was not the music with the fastest reaction times. Pop was the music with the second fastest reaction times. Alternative was the music with the third

fastest reaction time. Rap music was the music that had the fourth fastest reaction times and the control, which is no music, had the slowest reaction times. This is why the experimenter believes that if one is looking to increase reaction time, then one should listen to music.

Perception of Time

Neeka Samimi, Kenmore Middle School

Time perception is how much time one thinks has passed. Time perception among adolescents was tested in this experiment. The purpose of the experiment was to find out how the activity one is engaged in affects time perception. It was hypothesized that an enjoyable activity would seem to go by faster than the actual elapsed time, and that a neutral or unenjoyable activity would seem to go by slower than the actual elapsed time. Subjects went through three different activities: an activity designed to be enjoyable, a neutral activity, and an activity designed to be unenjoyable. The subjects then gave their estimates for how long they did each activity. The results showed that when engaged in an enjoyable activity, adolescents typically think that the amount of elapsed time is less than the actual elapsed time. The hypothesis was partially accepted.

The Effect of Noise on Concentration

Hallie Sitison, Tuckahoe Middle School

This experiment was conducted for the purpose of finding out if noise affects how a student does on a task, and if so which type is most or least affective. The experimenter used the program iTunes on a MacBook Pro to play the noise while students matched colored cards to their corresponding color. The test subjects were instructed to put in head phones, and once they heard music to start the timer and then match the cards to their corresponding colors. In the case of no music, they were instructed to start when they heard the beep. When they finished placing all of the cards in the right place they were told to stop the timer and wait for the next independent variable. The experimenter could improve this experiment by adding additional trials. If the experimenter were to conduct this experiment again, she would also make sure that there were the same number of males and females for this might make results more accurate. No noise (took an average of 26.298 seconds for subjects to match all of the colored cards) and classroom noise (took an average of 23.646 seconds for subjects to match all of the colored cards) were so close that there was no scientific significance to the data.

How Well Do You Know your Colors?

Mignote Tadesse, Kenmore Middle School

The Stroop effect is the result that occurs when a person tries to read the color of a word that represents a different word (the word red written in blue ink). Clinical psychologists find the Stroop effect/test useful because they can use it to see how well kids with schizophrenia and other mental disabilities develop on their attention and focus. The purpose of this experiment is to find out the effect of reading the Stroop test on 7th grade students. The scientists' hypothesis stated that when a person reads the Stroop test they will hesitate, and make errors thus taking the subjects a longer time to read the incongruent test. The scientist made sure that all of the participants read Test #1 and #2 out loud while being timed. The average for the incongruent test (the word red written in blue ink), was 49.58 seconds and the median was 45.85 seconds. The average for the congruent test where the words and colors matched was 14.29 seconds with a median of 13.55 seconds. All participants took more time reading the test with non-matching colors and words. The researcher accepted the hypothesis. The subjects hesitated, got frustrated, and made errors. With many trials conducted by the scientist, the results suggested that the result of the Stroop effect makes the reader have a more difficult and somewhat stressful time reading the Stroop test.

The Effect of the Mode of Learning on Number of Correct Answers

Hazel Thurston, Kenmore Middle School

This paper is for scholarly purposes. It includes a detailed description of Howard Gardner's eight modes of learning and which mode is most effective on middle school age students. This paper will disclose how students learn the best, and will explain the cognitive thinking process of adolescents. The experiment

will suggest that students learn the best by reading material for their own, rather than have a teacher or peer present information. The hypothesis was accepted. The experiment will test upon Howard Gardner's theories, and expand upon the sensory memory of students.

The Effect of Type of Music on Work Performance

Lane Van Lenten, Tuckahoe Middle School

The hypothesis for this experiment was: if different styles of music (None, Classical, Techno, and Pop) were played, then Classical music would stimulate the mind and help the subject complete math problems more quickly. In all companies, it is important to ensure employee performance is kept at an optimal level, and many companies strive to ensure that they keep their working environment enjoyable and comfortable for employees. Some companies have started playing music in their workplaces in order to do this. Does music really help though? This experiment tests which type of music helps work performance. There were 27 trials run. Music was played while subjects answered as many math questions as they could in a 3 minute timespan. Measurements were calculated and recorded. After averaging the scores of all the participants, the hypothesis was not supported. Playing no music helped the subjects taking the test.

The Effect of the Sport Played on Reaction Time of Girls Ages 11-13

Avani Venkatesh, George H. Moody Middle School

Reaction time is how fast the human body responds to change in stimulus. Reaction time is certainly an easily affected variable. The two types of reaction time are simple reaction time and choice reaction time. The purpose of this experiment was to see if the sport played by the subject affects the subject's reaction time. The experiment was done by dropping a ruler through the subject's fingers and seeing how fast they could catch it. The experiment was done with 40 subjects who were all females between the ages of 11 and 13. There were 10 subjects for each level of independent variable. The different sports tested for the levels of the independent variable were soccer, swimming, basketball, and the control group was no sport. The hypothesis of the researcher was "if the simple reaction time of basketball players, soccer players, swimmers, and subjects who play no sport is tested, then the basketball players will have the fastest reaction time." The researcher's hypothesis was not supported by the data and results. The results show that soccer players have the fastest reaction time, and subjects who played no sport have the slowest reaction time. The researcher concluded that this was because of how the ability of a fast reaction time was needed to play soccer.

The Effect of Music on Heart Rate

Sami Wells, Sabot at Stony Point

Music can make people laugh, cry, or even stand up and fight, but does it affect the beating of the heart? Heart rate is an indicator of physical and mental well-being as well as being a measurable function of the body. This experiment was designed to discover if music has an effect on heart rate. The hypothesis for this experiment is that heart rate will be affected by the tempo of the music played. Ten participants ranging in age from 10 to 71 were selected for testing. They were tested individually using four different selections of music with either slow or fast tempos. After each song was played, the heart rate was recorded for each participant. The results of this study have shown change in heart rate from the control group while participants listened to music. The tempo of the music affects heart rate. It was found that both fast and slow music affected heart rate. Fast music was found to speed up heart rate in each event. Slow music was found to affect heart rate but the reason for the varied change from the control in the results was unclear. After the fast song #2, the mean change of heart rate dropped more during the slow song than it did when there was no fast song before it. Although the tempo of the music was found to affect heart rate in this study, further research is necessary with a greater number of participants.

Microbiology and Cell Biology

First Place

The Effect of Nitrogen and Phosphorus on Oleaginous Microalgae Productivity

Eric Teichner, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effects of nitrogen and phosphorus wastewater nutrients on the lipid productivity, dissolved oxygen content, and biomass yield of microalgal strains *Chlorella sp.* and *Nannochloropsis sp.* Recently, it was determined algal biofuels can be possibly cultured in a wastewater medium due to its high levels of elemental nutrients nitrogen and phosphorus, possibly reducing economic costs. Further efforts are needed in strain selection of microalgae to be cultured in nutrient-rich wastewater or inexpensive fertilizer. Common algal strains *Nannochloropsis sp.* and *Chlorella sp.* were studied to determine any possible effects. Both algal strains were exposed to standard nutrient contents, which acted as a control, and relatively high levels of nitrogen and phosphorus to simulate amounts present in wastewater. It was hypothesized that if *Chlorella sp.* is exposed to levels of nitrogen and phosphorus, then it will have the highest growth after its respective growing period, amount of lipids present, and amount of dissolved oxygen. This is based on previous experiments where *Chlorella sp.* had the both the highest biomass and lipid productivities under optimal experimental conditions. The results revealed that nitrogen and phosphorus had a positive effect on the turbidity and dissolved oxygen while decreasing the lipid productivities by an average of 36.5%. Specifically, *Nannochloropsis sp.*, had overall higher values for all dependent variables. A t-test performed on the data revealed that the data were significant at almost all levels of independent variable (IV). The results not did support the research hypothesis based on the data collected. It is believed that under nutrient limiting conditions the cells deposited fatty acids in a triacylglycerol pathway. Future research should focus on optimizing lipid production under these stressed conditions using genetic engineering or different algal strains/parameters.

Second Place

Ultraviolet Radiation on Bacterial Inhibition in Lake Anna Water Cultures

Pranay Nuvvala, Mills E. Godwin Specialty Center for Science, Math & Technology

With the planned implementation of new pipes drawing water from Lake Anna, it is important to determine the sensitivity of aqueous bacteria to ultraviolet radiation sterilization. The purpose of this experiment was to determine the difference in bacterial inhibition between samples obtained from various locations and exposed to various wavelengths of ultraviolet radiation. The water was collected from Lake Anna and was collected from the north, east, and west shores at a depth of six meters. The bacteria samples were then cultured and subject to both 302 nm (UVB) and 360 nm (UVA) light. It was hypothesized if the bacteria from the northern shore at six meters of depth were exposed to 302-nanometer ultraviolet light for 30 minutes, it would result in the highest amount of bacterial cell growth inhibition. The northern shore was covered by a dense canopy and thus, the bacteria would be more sensitive to light. The 302 nm light has a shorter wavelength, and thus more energy, therefore making it more effective in breaking bonds in the bacteria's genome. To perform this experiment, an R2a agar solution was created and pouring into petri dishes. From a 1 ml concentration, 20 colonies from each level were isolated and streaked onto a new plate in a grid, with 20 streaks on each plate for each level. Some plates were irradiated with 302 nm of UV light for 30 minutes and the others with 360 nm of UV light for 30 minutes. The plates were then incubated at 37 degrees Celsius. The growth of bacteria was recorded and a chi-square test of independence was run and the calculated chi value was lower than the table chi, thus the null hypothesis was not rejected. Accidental puncturing of agar during plating may have skewed the data. Further study could include testing for the possibility of bacterial protection mechanisms such as the utilization of the RecA gene.

Third Place

Antimicrobial Properties of Green Tea Polyphenols on *Escherichia coli* K-12

Kevin Zhan, Mills E. Godwin Specialty Center for Science, Math & Technology

This experiment was done to investigate the antimicrobial properties of green tea polyphenols on *Escherichia coli* K-12. With the increasing use of chemical antimicrobials, many strains of bacteria have become antibiotic-resistant, thus prompting research in finding a natural alternative, like green tea. It was hypothesized that if polyphenols from green tea exhibited antibacterial properties, then it would have targeted certain components of a bacteria cell in order to kill it. For the paper disc test, six concentrations of green tea extract were used: 0 mg/ml (control) 0.004 mg/ml, 0.04 mg/ml, 0.4 mg/ml, 4 mg/ml, and 40 mg/ml. Ampicillin and kanamycin served as positive controls. These samples were then incubated and the area of the zone of inhibition that formed was measured. For the liquid culture test, three different amounts of the 40 mg/ml solution were used: 0 ml (control), 0.5 ml, and 0.05 ml. The samples were incubated and had their absorbance measured with a spectrophotometer. The results from the paper disc test indicated that zones of inhibition were formed and their area increased when the concentration increased. In the liquid culture test, the increasing amount of the green tea extract appeared to not inhibit bacterial growth. A t-test was performed and revealed that the data was both significant and not significant. The paper disc results supported the hypothesis while the liquid culture test did not. One discrepancy factor was that it was not possible to determine what was responsible for the inhibition of bacteria growth. Further studies may investigate how different bacterial strains respond to green tea polyphenols.

Honorable Mention

The Effects of Spices on Inhibiting Growth of *Escherichia coli*

Mark Feinberg, Washington-Lee High School

The purpose of this experiment was to determine the effects of garlic, onion, allspice, oregano, black pepper, and lemon juice on inhibiting the growth of *Escherichia coli*, a potentially lethal bacterium. The hypothesis of the experiment was that if these spices are applied to a nutrient agar medium containing *E. coli*, and the zones of inhibition are compared, then the medium containing a combination of all six spices will have the largest zone of inhibition, because garlic, onion, allspice, and oregano separately have been found to be the most powerful anti-bacterial spices, and black pepper and lemon juice, the most frequently used spices worldwide, are effective synergists in the destruction of bacteria. Although the hypothesis was not supported, there were statistically significant results for the garlic, lemon juice, and the combination -- they were all effective in inhibiting the growth of *E. coli*. Garlic powder had the largest average zone of inhibition, the combination was second, and the lemon juice third. There was a statistically significant difference between the means of each of these groups. The results were likely affected by the form of the spices used and the test method. It is also possible that spices with no zone of inhibition were contaminated during processing. The experiment could be improved by trying different brands of spices, different bottles within the same brand, and different forms of spices. Various spice combinations should be tested to determine whether they work synergistically or antagonistically. Further studies should be conducted on food, rather than on isolated microbes cultured in a medium.

Honorable Mention

Effects of Self-tanner Component, Dihydroxyacetone, on Human Cells

Elissa Fink, Southwest Virginia Governor's School

Current controversies in society include the effects of excess sun exposure and the resulting risks of skin cancer. Many people have turned to self-tanners for melanin coloration. Concern has been raised

pertaining to the possible risks from Dihydroxyacetone (DHA), a chemical found in self-tanners. It reacts with free amino groups of proteins in skin to create pigmentation, and could possibly interact with DNA and cause apoptosis. This study aimed to explore the effects DHA has on cultured human cell lines, specifically looking for apoptosis. HCT116 cell lines were treated with 1 mM, 10 mM, or 100 mM of DHA for 24 hours. In other experiments, cells were treated with 1 mM and 100 mM DHA solutions for 1 hour before harvesting. Supernatants containing the cells' proteins were collected and analyzed with a Bradford assay for protein quantification. Results were compared to a Bovine Serum Albumin (BSA) standard curve to obtain protein concentration. Supernatants were analyzed by Western blotting. Proteins were resolved by SDS-PAGE in a 10% gel. The proteins from the gel were transferred to a PVDF membrane and blocked with 5% skim milk. A PARP antibody and secondary antibody, HRP conjugating α -Rabbit, were used. The membrane was developed onto x-ray film. Exposure times of 2 and 4 minutes produced the clearest Western blot image. Samples of 24 hr/10 mM and 24 hr/100 mM showed the 89 kDa cleavage of the PARP antibody which indicates cellular apoptosis. This pilot study shows that the normal concentration of DHA found in self-tanners, 10 mM, damages cells. Future studies could include testing the expression of a house-keeping gene as β -tubulin to confirm equal levels of total protein. This study begins investigating the safety of DHA. Results could affect consumers and an entire industry that produce and sell the products. The common belief that self-tanners are safer than tanning with sunlight could be reversed.

Honorable Mention

The Effect of Different Kinds of Light on the Productivity of Baker's Yeast

Natalie Heckman, Washington-Lee High School

This experiment was performed to discover the effect of different types of light (no light, infrared light, UV light and white/regular light) on yeast. This knowledge would help bakers to know where (under what type of light) to store their yeast. From the research done previous to this experiment it has shown that most bakers store their yeast in places with no light to eliminate the effect of light. Additionally it was also shown that UV light might have a positive effect on the yeast and make it have a higher productivity rate. This experiment was conducted by leaving yeast under the certain type of light for 24 hours. Then the yeast was put in a bottle with warm water and sugar, and a balloon was put on top. The balloon was left to fill up with carbon dioxide for a specific amount of time. After that the balloon was used to find the volume by measuring the displacement. This experiment was repeated for all the variables. The hypothesis for this experiment was that the yeast would be the most productive in no light over all the other types of light, which was true. Also, it was thought that the regular or white light would have had the worst effect, but in reality, it was the second best. No light had the best results with the largest mean and the lowest standard deviation. The least successful one was infrared light. The experiment has indicated that a place with no light is best to keep yeast at the highest productivity rate. The second most productive light for the yeast was white or regular light, and the one after that was UV light.

The Effect of Various Natural Preservatives on the Shelf Life of Gluten-free Bread

Bradley Atkinson, Mathematics & Science High School at Clover Hill

This project used natural preservatives to extend the shelf life of gluten-free bread. This could save money for people with allergies to gluten. Many people complain that gluten-free bread is really expensive, and that it has a short shelf life. So, by extending the shelf life, this project could save those people money by reducing waste. This project used honey and vitamin C powder to extend the shelf life of gluten-free bread. To do this, the preservatives were mixed with two bread mixes, one for each preservative. After the bread was baked, each loaf was cut into 30 slices. Then, the amount of days it took for each slice of bread to mold was measured. There was also a control loaf with no preservatives added to it. This loaf followed the same procedure, except for the adding of a preservative. The results were that the bread with the vitamin C powder in it lasted the longest. The bread with honey added to it

lasted fewer days than the bread with vitamin C powder, and the bread that lasted the least amount of days was the control loaf. This was based off of the average amount of days that the breads lasted.

The Effects of Concentrations of Silver Nanoparticles and Bleach on Bacterial Yield

Andrea Gayle, Chesapeake Bay Governor's School for Marine & Environmental Science

Silver nanoparticles are non-toxic particles that control bacterial growth, they can be used as an effective bactericidal material, and have increased in demand in various health industries. They are incorporated into various wound dressings and sprays to assist in proper sanitization and healing. Household bleach also assists in these areas but can bring about many harmful health effects that can cause respiratory problems if inhaled, and burns in the gastrointestinal tract if ingested. The purpose of this study is to locate an acceptable standard of bactericidal material that is safe and effective for use in the health industry that replaces common household bleach. The study was conducted by applying three concentrations of colloidal silver and bleach onto agar plates and measuring percent coverage of bacteria remaining on the plate. All controls, positive and negative, produced results of which were intended, which were no bacteria growth for negative controls, and significant growth for positive controls. For the concentrations of colloidal silver with the addition of supernatant, the highest concentration of colloidal silver had an average bacterial surface area of 16.32% and a standard deviation of 34.04, and the lowest concentration of colloidal silver had an average surface area of 5.06% and a standard deviation of 7.56. With the addition of supernatant to bleach, the highest concentration of bleach had an average surface area of 0.24% and a standard deviation of 0.53, and the lowest concentration of bleach had an average surface area of 1.44% and a standard deviation of 1.99. The statistical analysis conducted suggested that there was no significant difference between colloidal silver and bleach or the three concentrations on bacterial yield. Therefore, because there were signs of inhibition from colloidal silver, it may be considered a substitute for bleach in various health industries.

The Effect of Time on Bacteria Growth in Open Bottles of Water

Desire' Kan, Washington-Lee High School

The objective of this experiment was to determine the effect of time on bacteria grown in an open bottle of water. It was hypothesized that a bottled water open for five days would have the most bacteria grown, due to the amount of the bacteria would have to reproduce compared to the amount of time the other trials had. It was also hypothesized that the control (zero days) would have the least amount of bacteria grown. Five days before testing, ten bottles were opened and a sip was taken from the bottle. This was repeated three days before, one day before, and on the day of testing. After precautions steps were taken, sampling was taken from each bottle. After a 48 hour period, data was collected and the data analysis consisted of calculating the mean, standard deviation, bar graphs and an ANOVA statistical test. The statistical test showed that there was not a statistically significant difference between the quality of water in a bottle that was open for five days and a bottle open for one day, three days or zero days. Since there was no statistical significance, additional research could be conducted to gather additional data to test the hypothesis again.

The Effect of Microwave Radiation on Water Purification

Parth Kotak, Maggie L. Walker Governor's School for Government and International Studies

The purpose of this experiment is to determine whether microwave radiation is a viable method for purifying water to drink. This experiment has real world application in areas where clean water is not easily accessible, or is often contaminated with micro-organisms. Since *E. coli* is similar to the bacteria responsible for cholera (*V. cholerae*; both are gram-negative, similar shape, environment, etc.), a rugged representation of other aquatic bacteria, and safer to handle, they were chosen for this experiment. The *E. coli* were exposed to microwave radiation at 50 °C, 75 °C, 100 °C, and no radiation (the control). Their growth after 11 hours was measured via light scattering in a spectrophotometer. It was hypothesized that if *E. coli* was exposed to different amounts of radiation, then the more exposure they receive, the higher the mortality rate will be. The rationale behind this hypothesis was that high doses of microwave radiation,

albeit being unionizing, are harmful to cells. The mean absorbance rate for the control data was 1.978 AUs; at 50 °C, the rate was 1.581 AUs; at 75 °C the absorbance was 1.579 AUs; at 100 °C, the rate was 1.598 AUs. Using advanced statistics, the data was proven to be statistically normal, the post-radiation growth lower than the control, and the levels of the IV were shown to be statistically indifferent, meaning the radiation did have a positive impact, but no discernable difference between 50 °C, 75 °C, and 100 °C. However, none of temperatures killed enough bacteria to make the solutions drinkable. The levels of the IV may not have varied due to the time between trials, the higher boiling point of LB broth (which would not have killed as many *E. coli*), the light absorbed in the spectrophotometer, and the functionality of the microwave system. One possible follow-up to this experiment would be to test on other water-based organisms such as *Daphnia magna* in a similar procedure, and to enhance the effect of microwaves.

The Effect of Disinfecting Cloths on Reducing the Amount of Bacteria in Clarinet Barrels

Emilee Kowalewski, Mathematics & Science High School at Clover Hill

The purpose of this experiment was to investigate whether or not cleaning rags used on clarinets could be treated with disinfectant to sanitize the instrument after playing. Musical instruments are played all around the world, and as they are constantly shared and played they're lacking in proper hygiene. As these instruments are being deprived of proper maintenance, they are becoming harvesters of bacteria and germ growth. It was hypothesized that treating cotton cloths with 91% isopropyl alcohol would reduce the amount of bacteria in the barrel of a clarinet, and the null hypothesis was that the alcohol would have no effect on the amount of bacteria. Clarinets were treated with different methods of common instruments care. The differences in bacteria before and after each test were recorded to determine the most effective way to clean the interior of a clarinet. The alcohol on average resulted in a higher percent decrease in bacteria than the cleaning method without disinfectant. Therefore, the hypothesis was proven correct.

The Effect of Juice and Penicillin on *Bacillus subtilis*

Kelley Lee, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to see if fruit juice had an effect on the inhibition zone of Penicillin on *Bacillus subtilis*. Many people drink juice while they are ill and on medications. A research hypothesis was formulated stated that if juice is added to penicillin then, orange juice will increase the inhibition zone of penicillin the most on *Bacillus subtilis*. Forty-five plates plated with *Bacillus subtilis* were tested for each of the levels of the independent variable and the control. Fifteen were tested with apple juice, 15 were tested for orange, and 15 were tested for the control. The inhibition zones were then measured 24 hours later. The levels of the independent variable were apple and orange juice and the control was the addition of no juice. A t-test was performed on the data and the results showed that the data was not statistically significant for apple juice versus the control, orange versus apple juice, and orange juice versus apple juice. It is believed that the results are due to the minimal growth on some of the agar plates creating outliers. Improvements include administering more juice on the Penicillin disk and making sure each plate is plated with enough bacteria. This research could lead to further studies that investigate drug and juice interaction with the human body.

The Effect of Common Household Substances on the Growth of *S. epidermidis* Bacteria

Erik Paletzki, Washington-Lee High School

The objective of this study was to determine the impact of common household substances on the growth of the bacterium *S. epidermidis*. It was hypothesized that hydrogen peroxide would perform the best, because it has been historically used to neutralize bacteria. The common household substances tested were white vinegar, rosemary oil, used to represent the rosemary plant, and hydrogen peroxide. To measure the bacteria neutralizing ability of each substance, the bacteria were applied to 20 Petri dishes. For each neutralizing substance small punches of filter paper were soaked with the substance and applied to five of the bacteria laden Petri dishes. Nothing was applied to the filter paper used on the control plates. Next, the Petri dishes were placed in an incubator for 48 hours, after which the size of the zone of inhibition was measured and the data was analyzed. The results showed that all of the

substances were able to kill the bacteria. Hydrogen peroxide outperformed the other substances, preventing colonies from forming on all of its plates. The Petri dishes treated with rosemary oil were able to prevent bacterial growth on most of the plates. Vinegar showed very minimal growth on most plates. These results supported the hypothesis.

Mutations Matter: Genetic Mutations of Parkinson's Disease and Schizophrenia

Kyra Parker, T. C. Williams High School

Genetic mutations affect many people worldwide, but the functions of the mutations vary. The lack of dopamine is one of the main causes for Parkinson's disease, but is also found in the treatments for Schizophrenia. The purpose of this experiment was to look at the respective genetic mutations of Parkinson's disease and Schizophrenia. In Parkinson's disease the gene mutation looked at was PINK1 and in Schizophrenia the gene looked at was NPAS3. The genomes of ten individuals were observed on the National Center of Biochemistry Information database. The effect of the mutation was identified by the change in the codon sequence and the resulting amino acid. In the PINK1 and NPAS3 genes some amino acids changed to nonpolar, polar uncharged or even negatively charged amino acids, and sometimes to a stop codon. In Parkinson's disease, the results were clearer because seven out of the ten people tested amino acids changed to a nonpolar amino acid or did not change at all. Nonpolar amino acids are hydrophilic, causing proteins to twist into useful shapes that are important for cellular membranes. With these changes it cannot only disrupt the cellular membrane, but also the tasks of the proteins and cells. In Parkinson's disease, the results varied between the individuals. Better understandings of the mutations will help make better treatments for people with the diseases.

The Effect of Anthocyanins on UV-B Radiation against *S. cerevisiae*

Pranav Ravichandran, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the protective role of anthocyanins against UV-B radiation. Anthocyanins have served as natural deterrent to help plants against ultraviolet radiation. This protective effect can be applied to applicants such as sunscreen to protect humans from the sun's harmful rays. *Saccharomyces cerevisiae*, baker's yeast, was subjected to either 40 minutes or 80 minutes of UV-B radiation. After 24 hours, the final absorbance readings were found using a spectrophotometer. The initial readings were subtracted from the final readings to find the difference. The control was 0 minutes of exposure. A hypothesis was formulated that if the yeast with strawberry extract was exposed to 80 minutes of UV-B radiation, then the yeast would grow the most. The results showed that the 40 minutes of exposure caused the yeast to grow more than the control and 80 minute group. A t-test was performed on the data and it showed that the data was significant for the control versus the 40 minute group, control versus 80 minute group, and the 40 minute group versus the 80 minute group. However, the data collected did not support the hypothesis. The most probable reason for the data received was that the anthocyanins influenced the response to the radiation. This research could be furthered by studying different pigments' protective role against ultraviolet radiation.

The Effect of Natural Antimicrobials on *Escherichia coli*

Alexandra Webster, Washington-Lee High School

The purpose of this experiment was to evaluate the effect of the natural antimicrobial essential oils *Cinnamomum cassia blume*, *Origanum compactum*, and *Melaleuca alternifolia* on *Escherichia coli*, and compare the results against those of chemical disinfectants. The hypothesis was that if *C. cassia* was used, then the most *E. coli* would be killed because *C. cassia* had a suitable method of killing bacteria, namely reducing cellular adenosine triphosphate (ATP) levels and damaging the membrane. Additionally it was hypothesized that the natural antimicrobials would be more effective than the chemicals. To start the experiment, 20 Petri dishes were inoculated with *E. coli*. Paper disks soaked in the antimicrobial substance were added to the bacteria on the Petri dish, and after the plates were incubated the diameter of the zone of inhibition was measured. Different than hypothesized, *O. compactum* performed the best with a mean zone of inhibition of 4.14 cm. It killed the cells by inducing membrane damage and making ultrastructural alterations to the organelles of a cell. Not far behind was *C. cassia*, with a mean zone of

inhibition of 3.72 cm. It was effective because it depleted the cells of energy and was toxic to the cell membrane. Finally, *M. alternifolia* had a mean zone of inhibition of 2.75 cm, and killed the cells by disrupting the membrane. All of the natural antimicrobials performed significantly better than any of the chemical disinfectants, with Lysol, Windex, and Clorox producing diameter measures of 1.31 cm, 1.27 cm, and 0.58 cm, respectively. Both the oregano oil and cinnamon oil had diameter averages around three times longer than the best performing chemical disinfectant, meaning they are around three times more effective. In conclusion, this experiment found that natural antimicrobials are viable bactericides.

Medicine and Health

First Place

Ferrous Sulfate, Sweetening and Flavoring Agent Interaction in Dysgeusia Perception

Sydney Fain, Southwest Virginia Governor's School

Alternative sweetening agents and their corresponding benefits have been disputed in the field of food science, in regard to their contribution to obesity and reduction in nutritional value. Dysgeusia, or perception of metallic taste, is a common symptom associated with chemotherapy, antibiotics, pregnancy, and iron supplements. Since these treatments are deemed the most effective options for the alleviation of adverse medical conditions, pharmaceutical and consumer industries widely investigate the treatment of side-effects such as dysgeusia. This study aimed to determine whether a ferrous sulfate additive would in conjunction with vanilla extract enhance the sweetness perception of an alternative sweetening agent, and if, in turn, the metallic taste would be lessened. Human test subjects were given samples with equivalent concentrations of ferrous sulfide, vanilla extract and sweetening agents (sucrose, sucralose, saccharin, acesulfame potassium, honey), and prompted to score each sample with regard to the intensity of the attribute of interest (sweetness, vanilla, dysgeusia). Samples significantly varied with regard to each attribute of interest (sweetness $p = < 0.0001$ +/- 0.12617, vanilla $p = < 0.0001$ +/- 0.14207, metallic $p = < 0.0001$ +/- 0.15194), with a sweetener showing an emphasis of desired flavors with an increase in iron composition in addition to the preliminary indication of a masking effect, contributing to the perception of ideal sweetening methods to offset chemotherapy and chronic illness side effects while also introducing the possibility to preventative measures. The data were collected using a five point Likert scale and statistically analyzed using ANOVA, Student's T and Tukey HSD tests. The study's findings are applicable to the beverage industry as a way to reduce excess consumption of sweetening agents and motivate the inclusion of vitamin and mineral supplements. Data are also applicable to the medical field as a remedy for common medical conditions that prompt a lingering metallic taste such as pregnancy and chemotherapy treatment.

Second Place

Gain in the Brain: The Effect of Tumeric Concentration on Planarian Learning Rate

Juliana Bain and Deboshree Das, Thomas Jefferson High School for Science & Technology

Neurodegenerative disorders may be possible to cure with the help of *Curcuma longa*, a common kitchen ingredient, also known as turmeric. The purpose of this experiment was to determine the effect of turmeric on the learning rate of *Schmidtea mediterranea*, known by most as planaria. The major finding was that as turmeric concentration increased, the bubble blasts until reactions ceased decreased, which means that the learning rates of the planaria increased. Since turmeric increases learning rate of planaria, it is plausible to suspect that turmeric may have similar effects on other organisms, insofar as they share basic neurological building blocks.

Third Place

Investigating a Synergy of Raloxifene and S-equol to Create a Novel Chemopreventive Treatment for Breast Cancer

Jake Cui and John Han, Thomas Jefferson High School for Science & Technology

Every year over 200,000 women are diagnosed with breast cancer in the United States. Breast cancer is the uncontrolled growth and invasion of abnormal cells in mammary tissue that eventually leads to the destruction of healthy cells. Some high-risk women opt to take chemopreventive therapy to reduce

carcinogenesis risks. Research and experimentation was performed on raloxifene, a chemopreventive drug. Raloxifene antagonizes estrogen receptor alpha (ER- α) in order to prevent transcription of cellular growth-inducing genes. The purpose of this experiment was to improve raloxifene's efficiency and noncancerous cell viability. A synergetic treatment combining raloxifene and s-equol, a metabolite produced through soy (a common Chinese medical supplement) pre-consumption which blocks estrogen receptor beta, was created. It was hypothesized that the synergistic treatment would induce a significant increase in apoptotic efficacy against MCF-7 breast cancer cells and a decrease in 2BS noncancerous cell death. MTT viability assays, Annexin tests, and morphological analyses were conducted to confirm. Against MCF-7 cells, 15 μ M of synergy induced apoptosis around 700% more efficiently compared to 80 μ M of raloxifene. The synergy also reduced 2BS cell death by 10% compared to raloxifene. The results from this study indicated that the raloxifene/s-equol synergy significantly improved raloxifene's apoptotic ability against breast cancer cells while mitigating harm against noncancerous cells. This treatment may warrant future studies in chemoprevention for breast cancer.

Honorable Mention

Comparison of Nasal Smears among Allergic Rhinitis and Cold

Arisa Kano, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to compare the nasal smears of allergic rhinitis, cold, and control subjects. The symptoms for cold and allergic rhinitis are sometimes similar, which leads individuals to visit the doctor for a cold when they might have allergy symptoms instead. Nasal smears of allergic rhinitis, cold, and control subjects were viewed using a BX41 light microscope and pictures of the cells were taken from the microscope. After pictures were taken, the cells within the nasal smears were identified and counted. The control in the experiment was the nasal smear of a person in a good physical condition. The hypothesis studied was if the nasal smears of allergic rhinitis subjects were studied under the microscope, then more eosinophils would be present than in cold subjects. Results revealed that more eosinophils were counted in the nasal smear of allergic rhinitis subjects and more neutrophils were counted in the nasal smear of cold subjects. A t-test showed that the data was not significant with the exception of epithelial counts for cold versus control, neutrophil counts for allergy versus control, and cold versus control. Results support the research hypothesis and obtained match theories that eosinophils are abundant within allergic reactions and that neutrophils are abundant due to viral load.

Honorable Mention

The Association of Different Lifestyles on BMI Percentiles in Adolescents

Jennifer Lin, Douglas S. Freeman High School

Obesity is a rising health epidemic and is one of the most common disorders crossing from childhood to adulthood. Its multivariable causes still challenge society today. The purpose of this research was to determine if certain lifestyle choices were associated with overweight and obesity in adolescents. Ninety local high school students participated in this study. A lifestyle questionnaire, based on the frequency of preference for healthy/unhealthy foods, breakfast and snacking habits, physical activities, sedentary lifestyles, and sleep patterns, was filled to obtain the research data. The Body Mass Index (BMI) percentiles were calculated based on self-reported age, height, and weight, and were classified into 4 body weight groups: underweight, normal weight, overweight, and obese. The results indicated that most participants (73.3%) were normal weight, while 13.3% were overweight, 7.8% were obese, and 5.6% were underweight. Other main findings were that overweight and obese students consumed significantly more fast foods than underweight or normal weight students, obese students drank more sweetened soda and beverages than the other groups of students, overweight students skipped more breakfast and ate less fruits/vegetables than normal weight students, and a higher percentage of obese students spent at least 2 hours per day watching TV or playing video games than lean (combined underweight /normal weight students) or overweight students. However, there was no significant difference for any dietary habits between the underweight and normal weight groups, and there was also no significant difference

among BMI weight groups in association to snacking, frequency of physical activities, sleep durations, or bedtimes. Finally, gender was also associated with BMI weight status, as there were more normal weight female students than males, and males had more overweight and underweight students than females.

Honorable Mention

The Effect of Curcumin on Intestinal Barrier Function

Sneha Reddy, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of the experiment was to investigate the effect of curcumin on reducing gut derived LPS infiltration into the bloodstream by preventing the disruption of the intestinal barrier. Recently, low grade inflammatory diseases such as Type-2 Diabetes and atherosclerosis have become more widespread throughout our nation. This inflammation is mainly caused by the release of LPS (lipopolysaccharide) from the gram negative bacteria that are present in the intestines. With high fat diets, intestinal permeability increases causing the release of LPS into the circulation triggering a dysfunctional barrier function. Twelve curcumin pre-treated caco-2 epithelial cells were grown in trans wells and were split in to LPS and no LPS added sub sections. The effect of no curcumin on LPS and no LPS sub sections acted as the negative control producing significant results and justifying the study of curcumin on LPS reduction. It was hypothesized that if curcumin was used then it would reduce LPS infiltration into the bloodstream thus preventing the degradation of the intestinal barrier. A t-test was performed at a 0.01 level of significance and the results were revealed as non-significant between the LPS and no LPS sub sections. The research hypothesis was supported along with null hypothesis in saying that there is no significant difference between the LPS and no LPS levels in the presence of curcumin. This research could lead to further studies that investigate the effects of optimal natural antibiotic dosage, plasma LPS levels, and cytokine releases due to high-fat diet induced inflammatory diseases.

Perceptions of Teenage Athletes on Anterior Cruciate Ligament Safety

Victoria Agud, Southwest Virginia Governor's School

Anterior Cruciate Ligament (ACL) of the knee joint must be functional in order for an athlete to perform. If it gets damaged, an athlete will be out of his or her sport for a minimum of 6 months for treatment. In many cases, the ACL cannot be repaired in order for the athlete to continue a high level of competitiveness. This seems to be an issue in many contact sports. The main issue with athletes and their ACLs is that most athletes are completely unaware of their ACLs and how easily they can tear this ligament. In an effort to try to change this oversight, a survey was created and given out to high school athletes from the researcher's schools. In order to do this, a sample size of 32 was taken in an effort to try and see if this survey would change athletes' awareness of ACLs. The researcher compared the change in opinions by exposing the athletes to potentially new information. The researcher then calculated the data using a Proportion Test and found out that not many of the athletes that were spoken to, or who took the survey, were aware of their ACLs, let alone that they could tear it. Ultimately, the results failed to reject the hypothesis because the evidence shows that this survey helped make athletes, from the home school and its neighboring counties, more aware of their ACLs. This data shows that watching instructional videos did raise awareness of ACL safety. Therefore, education in student training should utilize similar methods in the future. If this survey did not have the impact that it did, new information regarding the ACL would have to be gathered. Future research should investigate ACL safety because ACL injuries are very significant, especially in football and other high contact sports.

The Effect of Zinc Oxide and Octyl Salicylate on Blocking Ultraviolet Radiation

Isabel Arnade and Lydia Cawley, Washington-Lee High School

This project was created with the purpose of determining which concentration of active ingredients was most effective at blocking sunlight. This experiment tested one physical ingredient, zinc oxide, and one chemical ingredient, octyl salicylate, both found in sunscreens. It was hypothesized that the highest concentration of zinc oxide and octyl salicylate (8%) of the alcohol-glycerin solution would result in the lowest UV index reading on the meter. The data was found by placing a UV index meter under a glass pane, which was covered with a solution containing the concentrated active ingredients. The readings were recorded and the mean was found. As expected, the control, 0 grams of the active ingredient, produced the highest UV index reading with an average reading of 5 for both zinc oxide and octyl salicylate. Two percent (1 gram) of the active ingredient produced the highest UV reading for both experimental groups, with an average of 3.4 for zinc oxide and 3.8 for octyl salicylate. The experimental groups warranted decreasing UV index readings with increased concentrations, demonstrating a trend in the data. As hypothesized, the 8% (4 grams) concentration had the lowest UV index for both solutions. Zinc oxide had an average of 1.0 and octyl salicylate produced an average reading of 1.6. The low readings indicated that the ingredients blocked UV radiation, therefore better keeping exposure low and if applied would better decrease the risk of sunburns and cell restructuring caused by radiation. The experiment met its objectives as it was able to effectively obtain data in response to the question. The hypothesis, that the 8% concentration would have the lowest UV reading, was supported. Overall, the experiment answered the question of which concentration of the alcohol-glycerin solution would result in the lowest UV reading and provided consistent data.

The Effect of Athleticism on Caloric and Fat Consumption

Minna Blotner, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine if there was any relation between participation in organized physical activities and nutritional choices amongst high school students. Recent studies have been conducted comparing the different uses of macromolecules for energy during athletics, but no comparisons have been recorded comparing athletes to non-athletes in regards to their meal choices. About 50 students, randomly selected from a high school environment, were given a questionnaire concerning their caloric consumption for a typical day and their athletic backgrounds. There was no control for this experiment, since there was no standard athletic background to compare participants. It was hypothesized that if students were involved in athletics, then their overall caloric consumption (kilocalories, or k/cal) would be higher, but their fat intake in grams (g) would be lower. The results revealed that there was a difference between participation and the dependent variables. Nevertheless, the results did not fully support the research hypothesis, as the student athletes had higher fat consumptions than non-athletes. T-tests were conducted and revealed that there was a statistically significant difference. It was believed that these results were obtained due to the fact that since athletes were consuming more food, more fat could possibly be consumed. Even if they made the same nutritional choices as non-athletes, since athletes on average consumed more quantities of food, they would have higher fat consumptions. For continued study, the caloric intake could be examined amongst athletes during their active and non-active seasons to see if athlete nutritional choices change when they are inactive.

The Effect of Caffeine versus Energy Drinks on *Daphnia magna* Heart Rate

Allision Cuesta, Washington-Lee High School

Caffeine is a natural alkaloid methylxanthine, which acts as a cardiac stimulant, diuretic, and smooth muscle relaxant. Consuming large doses over a long period of time can cause potential health risks including osteoporosis and cardiac issues. Common additives to energy drinks, in addition to caffeine, are vitamin B6, which helps make hormones that improve mood, and sweeteners including high fructose corn syrup and aspartame. *Daphnia magna* are microscopic crustaceans that circulate hemoglobin, an oxygen carrying protein through an open circulatory system. The purpose of this experiment was to test if there were any chemicals in energy drinks that had synergetic effects with caffeine. It was hypothesized that *Daphnia magna* immersed in the Rockstar Zero Carb drink would have the highest heart rates due to the high caffeine concentration and added chemicals. *Daphnia magna* were tested in caffeine solutions proportional to the caffeine content in Diet Coke, Monster Energy Drink, and Rockstar Zero Carb Energy Drink, as well as those drinks. An ANOVA test showed significant results, and 2 sample t-tests were done

with the control and each independent variable level. T-tests between the heart rate averages of the control and the Monster Energy Drink and Diet Coke variable levels showed significant, however these averages were significantly lower than the control average. In conclusion, while some of the data was significant, it did not support the hypothesis. Rockstar Energy Drink had similar average heart rates to the caffeine solutions and control. Improvements that could be made to this experiment would be to run more trials to decrease the standard deviation. Another improvement would be to use bicarbonate strips to test carbonation levels in energy drinks before testing, which possibly caused the lower heart rates in *Daphnia magna*.

The Effects of Mirror Therapy on Performance of Physical Therapy

Catherine Grant, Blacksburg High School

The purpose was to look at the influence of mirror therapy on lower quarter functional movement as noted by the Lateral Step Down Test. For the procedure, all participants (n = 21) tested with the Lateral Step Down test. Participants were split into two groups: Mirror group (n = 11) and Control (non-mirror) group (n = 10). Participants performed the Step Down exercise and the star excursion exercise for 30 repetitions each exercise. Participants were tested again with the Lateral Step Down test. The data showed the mean population scores improved from 2.8 to 1.9 by a difference of 0.9 points. The control group initially tested to give a mean value of 3.2 and standard deviation of 1.398412. The control group improved 41% and resulted with a mean score of 1.9 and standard deviation of 0.567646. The mirror group originally tested to give a mean value of 2.4 and standard deviation of 1.577621. The mirror group improved 21% and resulted with a mean score of 1.9 and standard deviation of 0.737865. In conclusion, all subjects improved in scores over time with practice. Mirror therapy had no significant effect on the performance of the Lateral Step Down test.

The Effect of Detoxification of the Gastrointestinal Tract by Way of Veterinary Homotoxicology on the Healing of Chronic Disease and Allergies in Canines

Allison Herrity, Washington-Lee High School

A major purpose of the intestine is to create a barrier in order to keep toxins from being absorbed into the bloodstream. When harmful bacteria in the gastrointestinal tract create small perforations in the lining of the intestines, allowing toxins to enter the bloodstream, it is known as Dysbiosis or Leaky Gut Syndrome. The leading cause of Dysbiosis is antibiotic overuse. Antibiotics wipe out not only the harmful bacteria in the GI tract, but also the helpful bacteria. Harmful bacteria are building up resistance to common antibiotics, and it is throwing the bacterial microbiome way off balance. This project offers an alternative to antibiotic use, known as homotoxicology. Homotoxicology uses natural homeopathic remedies and metabolizing enzyme complexes to purge the GI tract of harmful bacteria, while allowing the healthy bacteria to remain. The microbiome is then reestablished through the introduction of a healthy diet and herbal supplements, promoting wellness and healing throughout the intestines.

The Effect of Antacids on Heartburn

Laura Smith, Washington-Lee High School

During this experiment different antacids were tested to evaluate effectiveness in neutralizing heartburn. It was hypothesized that if different antacids were tested then Gaviscon would be the most effective. Muriatic acid was used to simulate heartburn; it has a pH of one. Twelve different test tubes containing the same amount of acid had 20 drops of antacid placed inside. The pH of the acid after the antacid was put in was measured and averaged to determine the most effective. This process was repeated for each antacid test. The results show that Roloids was most effective in neutralizing the acid. This experiment was completed over the course of two days and took many initial trials to make sure that the experiment could be completed mostly without flaws.

The Cytotoxic Effects of Bromelain and Papain on Breast Cancer MCF-7 Cells and HN12 Head and Neck Cancer Cells

Cancer is rapidly becoming one of the leading causes of death around the world. It is often treated using chemotherapy, which kills rapidly dividing cells by interfering with cellular activity during specific phases of the cell growth cycle. However, chemotherapy also kills healthy cells, which is the reason as to why severe side effects, such as loss of digestive tract lining, bone marrow cells, and destruction of hair follicles develop. The purpose of this experiment is to compare the cytotoxic effects of bromelain and papain on breast cancer MCF-7 and head and neck HN12 cancer cells. There were eight different concentrations of bromelain and papain that were used on both the MCF-7 and HN12 cells: 10 micrograms/ml, 20 micrograms/ml, 50 micrograms/ml, 100 micrograms/ml, 200 micrograms/ml, 500 micrograms/ml, and 1000 micrograms/ml. In addition to those concentrations, a control of 0 micrograms/ml concentration was used on both cell lines as well to analyze whether or not the enzymes made a difference. It was hypothesized that the 1000 micrograms/ml concentration of the bromelain will show the greatest cytotoxic effect on the cells. The effectiveness of the enzymes was determined by using an assay that measured absorbency. The cytotoxic effects of bromelain and papain were measured by using a Colorimetric WST-1 based assay. This assay is used to analyze cytotoxic compounds such as anti-cancer drugs and other pharmaceutical compounds. It analyzes 96-well plates and contains a microplate (ELISA) reader with a filter wavelength of 420 to measure absorbance. The more cells in a well, the higher the absorbance. The results revealed that papain had more significant results than bromelain, and multiple t-tests were done on the data to reveal that certain concentrations also seemed to produce more significant data than others. Although significant, it is believed that most of the results are due chance rather than the independent variable. This research could lead to further studies that investigate the likelihood of a natural anti-cancer drug being created.

Mathematics, Statistics and Computer Science

First Place

Human-cockroach Interfacing: μ -rhythms Control *Gromphadorhina portentosa* utilizing Electroencephalography

Jonathan Towne, Thomas Jefferson High School for Science & Technology

Specific human synaptic activity produces small voltage oscillations at frequencies ranging from 8 to 13 Hertz called μ -rhythms. This study expands the functionality of recording and processing μ -rhythms using electroencephalography (EEG) coupled with a fast Fourier transform (FFT) coded in LabView; these techniques were used by the experimenters for differentiation of directional thought patterns. Data acquisition with EEG was developed in this project to record “left” and “right” thought patterns for the purpose of improving existing signal processing and creating an interface between a human and *Gromphadorhina portentosa* (Madagascar Hissing Cockroach; *G. portentosa*). By means of FFT, oscillations recorded from the C3 and C4 electrodes indicated the frequencies produced by the left and right sides of the motor cortex. When μ -rhythms were identified, the hemisphere of origination was indicated by an infrared signal sent to an implanted receiver in *G. portentosa*. Depending on the signal, the circuit would force the cockroach to turn left or right. Accuracy with which the cockroach turned greater than 300 in the desired direction, calculated as successful turns divided by total attempts, was recorded. Acquired data identified a statistically significant increase in the accuracy of the two-part human-cockroach interface (human brain-computer link and the computer-cockroach link). This study successfully developed a human-cockroach interface.

Second Place

The Effect of Cellular Interactions on Cancer using Game Theory

Mihir Paithane, Mills E. Godwin Specialty Center for Science, Math & Technology

Cancer tumors progress through the spread of invasive or malignant cells causing normal cells to decrease in proportions. The main reason for these phenotypes are genetic mutations, but surrounding cells and even microenvironments add to the inclination towards a certain phenotype. Game theory is a series of mathematical analyses that allow for the prediction of situations based on the outcomes of interactions between “players” or components in the situation. The game theory can be applied to biological situations in the sense that they can attempt to predict the proportions of the phenotypes of cells after biological. The purpose of this experiment was to determine if interactions between cells had an effect on the phenotypic outcome of later generations using the game theory. In this experiment, game theory was used to assess the interactions between three cell phenotypes usually found in cancer. The three defined cells were autonomous growth cells (AG), invasive and motile malignant cells (MAI), and cells that performed anaerobic glycolysis (GEP). Preset variables were applied in a game theory payoff matrix to better understand the fitness costs of each of the three cell interactions with one another. Based on this payoff matrix, analytical equations were deduced that allowed for the analysis of the proportion of autonomous growth cells and malignant cells in a tumor. It was found that the malignant phenotype was more likely to appear in a tumor that contained high amounts of the phenotype of glycolytic cells. Inversely, autonomous growth cells were seen to decrease as the increase of glycolytic cell phenotypes was exhibited. This experiment could be elaborated on by increasing the number of phenotypes that interact within a tumor to add more applicable results to the real world as real tumors contain multiple cellular phenotypes.

Third Place

Benford's Law

Michelle Howard, Washington-Lee High School

Benford's law is a statistical theory in which the leading digit of the values in a set of data follow the probability frequencies as follows: 1: 30.1%; 2: 17.6 % 3: 12.5%; 4: 9.7%; 5: 7.9%; 6: 6.7%; 7: 5.8%; 8: 5.1%; 9: 4.6%, meaning the leading digit of the number 1 shows up 30.1% of the time, etc. The purpose of the experiment was to determine the validity of Benford's Law and to determine which sets of data followed the exponential curve of the law. A computer program, made in the programming language of Python, was created in order to have sets of data inputted, and to output the frequencies of the numbers 1-9 as the leading digit. The hypothesis was that data sets that were distributed across multiple orders of magnitude fit the theory of Benford. An order of magnitude is a range of numbers with a fixed ratio. Orders of magnitude are often rounded to the nearest 10. After testing several sets of data including "Arlington Public School ID's" and "Heights of mountains around the world," to name two, a conclusion that was in accordance with the hypothesis was reached. In order for data sets to fall under the theory of Benford, the data sets must be large, distributed across more than two orders of magnitude, and must not have predisposed limitations to their leading digits. Benford's Law has many important practical uses in everyday life. Benford's Law could be used, most importantly, to detect account expenses fraud. Mark Nigrini recently researched a topic in which a fraudster wrote numerous checks to himself just below \$100,000. This caused the numbers 7, 8, and 9 to have very high frequencies when compared to Benford's probabilities. Therefore, the graph, when compared to Benford's curve, was skewed.

Honorable Mention

Comparing Vehicle Accident Variables' Effects on Drivers, Younger versus Older

Alexis Brown, Southwest Virginia Governor's School

Motor vehicle accidents are one of the leading causes of death for teenagers. Many states have adopted graduated licensing programs in effort to reduce the number of fatalities. The steps of this system involve a learner's permit, a restricted intermediate license, and a full-privileged license. The purpose of this study is to compare the effects of several motor vehicle accident variables on younger drivers vs. older drivers to provide evidence if the programs are beneficial. Variables examined were the age of driver and passenger, vehicle type (passenger cars, pickup/passenger trucks, vans), severity of crash (fatal, injury, property damage), occupant type (driver, passenger), and gender. Data were gathered from the 2012 Virginia Crash Facts, 2011 NHTSA (National Highway Traffic Safety Administration), the Census Bureau, and the IIHS (Insurance Institute for Highway Safety). Analysis was completed in JMP software and involved seven Chi Square Tests, one for each variable with occupant type and gender separated by fatal or injury. Passenger cars carried a higher level for both groups. Also in both, significance increased as crash severity decreased. The number of 16-20 year old passengers injured or killed was higher than 16-20 drivers while the older group exhibited the opposite result. Gender seemed to play a very little role, although males had slightly more fatalities across both age ranges. Most notable was the large increase when drivers traveled with peer passengers. Each age range demonstrated this upsurge, but the 13-19 year old group had the highest significance. The findings of this study supply evidence to support graduated licensing systems, specifically their passenger limits. Perhaps more states should adopt similar legislature to help protect young drivers and others on the roads.

Honorable Mention

The Effect of Median Household Income on Standards of Learning (SOL) Passing Rates in Virginia

Spencer Philips, Washington-Lee High School

In this statistical analysis project, the objective was to find out if median household income has an effect on the average passing rates of the English and Mathematics Standards of Learning test (SOL), a statewide government accountability test conducted in the state of Virginia. In prior studies conducted by experts in the field of education, it has been often believed that the amount of money a household has

can lead to better test scores and higher passing rates, but it is unclear to what extent. That is the purpose of this experiment. There are 130 school districts in the state of Virginia, which all happen to be counties, and all of the SOL passing rates are available for each district on the Virginia Department of Education website. Math passing rates and English passing rates which were averaged together, because public opinion polls show they are the two most important subjects for students. To make it easier to see if income did have an impact on passing rates, trials were set up into income brackets. The brackets were \$24,000 - \$49,000; \$49,001 - \$74,000; \$74,001 - \$99,000; and \$99,001 - \$124,000. Due to the prior research stating that higher income leads to higher test scores, the hypothesis was: "If a county in which the median household income is \$99,001 - \$124,000 (highest bracket in the state) per year, then the SOL pass rate in that county will be higher than other counties in Virginia with lower median annual household incomes." The results were consistent with the hypothesis. As each income bracket increased in the amount of income, so did the passing rates. The hypothesis was supported, and students in districts that had a median household income of \$99,001 - \$124,000 had the highest passing rate in the state, with 82.75% of students passing. The state average SOL passing rate was 69.1%.

Honorable Mention

Quantitative Easing's Effect on Price Returns and Volatility of S&P 500

David Qin, Mills E. Godwin Specialty Center for Science, Math & Technology

In response to the recession, the Federal Reserve in 2008 began to inject billions of dollars into the financial market by buying back government bonds, known as Quantitative Easing (QE). The purpose of this study was to determine QE's effect on the U.S. stock market, specifically, the price returns and volatility of S&P 500, the index tracking the stocks of five hundred major U.S. companies. It was hypothesized that at the two levels of the IV (with and without the presence of QE), S&P 500 would display higher returns and less volatility with QE. The price returns and volatility were measured using the index tickers SPY and VIX, respectively. First, weekly data of SPY was downloaded from YahooFinance, covering the periods of 10/24/05–10/27/08 (without QE), 11/25/08 - 4/25/08 (QE 1), 11/3/10 - 6/2/11 (QE 2), and 9/13/12 - 9/13/13 (QE 3). Then, means, variances, and number of experimental units were calculated, and a t-test was done on the two sets of data (non-QE vs. QE 1, 2, 3) to determine the significance of QE's effect on S&P 500 price returns. This same procedure of downloading weekly data (of the same ranges, representing the same time) was repeated with the ticker VIX, and the same calculations as before (including t-test; with vs. without QE) were performed to identify QE's effect on volatility. The results revealed that QE positively impacted S&P 500 price returns while decreasing its volatility, both significantly. The null hypothesis (that QE has no effect on price returns or volatility) was therefore rejected while the research hypothesis was supported. It is believed that the results may be due to the fact that the Fed's buying back of securities leads to increased availability of spending money in the economy (interest rates low, so investors borrow more), which could be used for investment in the stock market. Additionally, anticipated increase in money supply could lessen investment uncertainty, resulting in decreased volatility in the financial market. Further studies could examine correlations between other economic indicators and stock price return.

The Effect of Education Level and Location on Income

Spencer Culbertson and Joseph Gordon, Deep Run High School

It is commonly believed that higher education leads to a higher income level. It is also, but less commonly, considered that living in different places with the same type of education can yield different incomes. The purpose of this investigation was to compare different income levels and different residencies to discover how they compare. The hypothesis of this investigation was if an individual lives in a state with a greater population, then their education will be worth more. This investigation was conducted by looking at the results from the Census Bureau. The mean incomes by education level and by state were looked at. The states included Virginia, Oklahoma, New York, Illinois, Florida, and California. The education levels that were examined were high school graduate, bachelor's degree, and

advanced degree. The results showed that the advanced degree would allow for the greatest average income across the country. This is in agreement with the hypothesis. The data also showed that the highest average income was in California. This is also in agreement with the hypothesis, because California is a state with a large population. A t-test was done to determine the significance of the results. The null hypothesis was rejected for the aspect of the hypothesis about higher education equating to greater income. Although the null hypothesis was accepted for the aspect about different states yielding more income. The difference in income by each state was insignificant to the investigation.

A Regulatory Algorithm Based on Microeconomics for use in Cryptocurrencies

Matthew Retchin, Mills E. Godwin Specialty Center for Science, Math & Technology

Bitcoin, the first cryptographically secure peer-to-peer electronic cash system (a cryptocurrency), was created primarily in order to facilitate reliable transactions between two parties without the use of existing traditional financial institutions. Unfortunately, Bitcoin suffers from both volatility and a fundamental tendency towards deflation. In order to address these problems, we are introducing an alternative cryptocurrency design that promotes price stability and economic equilibrium in the network by utilizing the established economic principle of supply and demand. Additionally, by using a genetic algorithm targeting a specific exchange rate price, nodes may efficiently adapt to economic fluctuations by continuously producing a new evolutionarily improved minting algorithm. This process takes place after the network aggregates and analyzes objectively determinable economic variables, those of supply and demand. We are proposing a decentralized, self-regulating cryptocurrency that algorithmically adjusts the minting process with supply and demand and autonomously tests algorithms in order to ensure consistent and dependable economic conditions. Use of similar procedures would enable policymakers to implement more objective monetary policy.

The Effect of Sport and City on the Home Game Advantage

Andrew Roy, Washington-Lee High School

Finding factors that affect the outcome of sporting events is very important. In Las Vegas, bettors put colossal sums on their skills to predict the outcome of games. The purpose was to find how much stock should be placed in home advantage based on several game-specific factors. In this experiment, the independent variables were sport and city. The MLB, NFL, NBA, and NHL were the leagues used, and the nine cities with one team in all four leagues were used. Three city factors were examined: city population, median household income, and game attendance. The hypothesis was as follows: if the cities vary in many ways and the NFL, NBA, MLB, and NHL are viewed, then home advantage will be more significant in higher city factor values, and more significant in the NBA and NFL than in the MLB and NHL, respectively. All statistics were gathered through means, a Two-Variable t-test, and a Matched-Pairs t-test. The data rejected and supported parts of the hypothesis. After statistical analysis was run, the results stated: attendance has a direct, significantly positive effect on home game advantage, population has a small effect, and there is essentially no correlation with median household income. By sport, the descending order was: NBA, NFL, NHL, and MLB. The order of the first two supported the hypothesis, but the last two were narrowly incorrect. This means that home game advantage is significant; the extent is based on these factors. However, clearly there is difference at home versus on the road.

Physics

First Place

The Effect of Greenhouse Shape on the Greenhouse Performance

Swapnil Pande, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effect of greenhouse shape on its performance. The hypothesis was that an offset-triangle greenhouse would yield the best performance. Growing plants in greenhouses can extend their growing season because the greenhouse can maintain the necessary conditions for a longer time. Developing a mathematical model is an inexpensive and fast way for design and analysis compared to experimentation to determine the best shape. The levels of the independent variable were an even-triangle greenhouse, offset-triangle greenhouse, and a dome-shaped greenhouse. The dependent variable was the ambient greenhouse temperature. A mathematical model was developed by calculating the heat transfer parameters and incident solar radiation for a given location, season, and shape. A computer program was developed in the C language to calculate the sun angles, sun load, heat transfer parameters, and to solve the system of differential equations using the fourth order Runge-Kutta numerical method. The offset-triangle greenhouse performed the best with the highest ambient temperature in the winter and the lowest temperature in the summer. The performance of dome and even-triangle greenhouses was comparable. In general, the standard deviations were low. The maximum temperatures achieved by the greenhouses were statistically significant and not significant depending on the shape and season. The data collected supports the hypothesis. One source of error in the analysis may be that this greenhouse model does not account for plants in the greenhouse. This experiment could be extended to test the greenhouse shapes in different locations.

Second Place

The Effect of Different Permanent Magnets on Ferrofluid Reactivity

Goutham Thiagarajan, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the impact of the different permanent magnets on the reactivity of a ferrofluid. Ferrofluids are liquids that are capable of becoming strongly magnetized in the presence of a magnetic field, but they cannot retain this magnetization. Due to a possession of high magnetic susceptibility, ferrofluids should be applied to benefit society. Different permanent magnets were chosen to test the reactivity of a ferrofluid. Thirty milliliters of ferrofluid were exposed to vertical magnetic fields from a neodymium magnet, a samarium-cobalt magnet, a ceramic magnet, and Alnico magnet 25 times respectively. The ensuing reaction to the magnetic fields produced gradients in the fluid, which were counted. There was no control in this experiment. It was hypothesized that neodymium magnets would affect the composition of the ferrofluid more dynamically than the samarium-cobalt, the Alnico, or the ceramic magnet. The results revealed that when exposed to neodymium magnets, the ferrofluid had, on average, 27 more visible projections than those from Alnico, 23 more than ceramic, and 12 more than samarium-cobalt. Six t-tests were performed on the data and the data was revealed to be statistically significant for all comparisons between the experimental groups. The results supported the research hypothesis. For future improvement, the amount of ferrofluid can be lowered and the size of the magnet can be kept more constant. This research can lead to further studies that investigate the possible medical applications of ferrofluids, such as in experimental cancer treatment.

Third Place

The Effect of Wavelength on the Voltage/temperature Relationship in Silicon Photo-voltaic Cells

Shannon Khurana, Mountain Vista Governor's School

The objective of this research was to determine if specific wavelengths (colors) of light have a significant impact on the slope of voltage/temperature relationship in silicon photovoltaics (solar cells). Factors such as temperature, light intensity, and electromagnetic (light) energy affect the amount of voltage a solar panel can retain to create electrical power. Voltage capacities in solar panels exist in relationship to temperature. Results indicate there is no significant difference in the voltage/temperature relationship in silicon solar cells based on wavelength. This result supports the null hypothesis that if different wavelengths of lights are exposed to a silicon photovoltaic cell, then there will not be a significant difference between the slopes of the voltage/temperature relationships.

Honorable Mention

The Effect of the Percentage of Sawdust to Water in Pykrete on the Time it Takes to Melt, its Strength upon Impact and its Buoyant Force

Bridget Hart, Yorktown High School

The purpose of this project was to find the effect of the ratio of sawdust to water in a block of pykrete on the time it takes to melt, the strength upon impact, and the buoyant force. Pykrete is a mixture of sawdust and water frozen solid created during World War II in hopes of building an aircraft carrier out of ice. The hypothesis for the melt test was if the amount of sawdust increased, then the time it takes to melt would increase. The hypothesis for the strength test was if the amount of sawdust increased, the mass after being dropped would be larger. The hypothesis for the buoyant force test was if the amount of sawdust increased, the buoyant force would also increase. To test the hypotheses, the pykrete was made. All blocks were 20 grams; the ratio of sawdust to water varied depending on the level. The levels were 0% sawdust, 5% sawdust, 10% sawdust, 15% sawdust, and 20% sawdust, all by weight. Once all the blocks were made and frozen, the three tests were conducted. To test how long the pykrete took to melt, the blocks were arranged on a wire rack and a timer was started. The time was recorded when a block no longer contained solid water. To test the strength upon impact, a drop test was conducted. The largest piece of each pykrete block after being dropped was measured for mass. To test the buoyant force, an Archimedes can was constructed to measure the amount of water displaced when a pykrete block is placed in the water. The data was collected for each test. The hypotheses for both the melt test and the strength test were accepted by the data. The 15% sawdust, 85% water mixture had the highest melt time and the highest mass after being dropped. For both tests there was only a statistically significant difference between the levels that contained sawdust and the one that did not; there was no significant difference between any of the levels that had sawdust. The hypothesis for the buoyant force test was rejected by the data. The 0% sawdust mixture had the greatest buoyant force. There was not a statistically significant difference for any levels in the buoyant force test. The 15% sawdust, 85% water mixture would be the best choice for use as building material because of its slow melt rate, strength, and low buoyant force. In future studies, it would be interesting to test pykrete against other common ship building materials for different desirable properties and characteristics. Another project would be to find practical uses for pykrete in the modern world.

Honorable Mention

The Effect of Changing the Cant Angle of a Winglet on the Lift-to-drag Ratio

Shivam Mehta, Mountain Vista Governor's School

This experiment was performed to determine which canted of a winglet would produce the greatest lift-to-drag ratio. The winglets were created using the program OpenVSP version 2.2.5, and were tested in the virtual wind tunnel program Project Falcon. An airplane with no winglets, winglets canted at 0 degrees, winglets canted at 15 degrees, and winglets canted at 30 degrees were tested. The null hypothesis was there would be no difference in the lift-to-drag ratio between the winglets canted differently, while the alternative hypothesis was that the winglet canted at 15 degrees would produce the highest lift-to-drag ratio. The null hypothesis was rejected and the alternative hypothesis was not supported. An Analysis of

Variance (ANOVA) test was performed which yielded a value so small which determined all of the data was statistically significant.

The Effect of Various Temperature Ranges of Copper Piping on Magnetic Field Strength

Joseph Baker, Mathematics & Science High School at Clover Hill

This experiment was conducted to test the Curie-Weiss law and to determine what temperature ranges have the strongest magnetic fields. In order to test the Curie-Weiss law a magnetized ball bearing was dropped through copper piping heated to different temperature ranges. While this was done a stopwatch was utilized to record precisely how long it took for the ball bearing to fall through the pipe and hit the surface underneath. The magnetic ball bearing being dropped through the copper pipe with the colder range had the slowest (best) results with it taking an average of 1.15 seconds to fall through. In this experiment the hotter range had the fastest (worst) results with it taking an average of 0.65 seconds to fall through the pipe. The control group, which consisted of a room temperature pipe, had an average of 0.92 seconds to fall through. It is concluded from the results that the “cold” temperature proved to strengthen the ball bearing’s magnetic fields the best, the “hot” temperature had the weakest magnetic fields, while the control was right in the middle of the two. The results of this experiment support that the Curie-Weiss law is true. In fact, discovered here, magnetic fields can be strengthened by colder temperatures and weakened by hotter temperatures. The findings here hold numerous implications for the transportation industry as well as the theme park industry, and they could hold the key for enhancing safety in the future.

Does the Frequency of a Wine Glass Halve when the Liquid Inside Doubles?

Steven Bluestein, Washington-Lee High School

Benjamin Franklin’s glass armonica was an enchanting instrument. They were too soft to hear, but with today’s amplification technologies, they could be used more. This project, which has to do with it, was done to test if the amount of liquid in a wine glass would proportionally affect the frequency of the sound made from playing the glass. This has to do with Benjamin Franklin’s glass armonica. The problem was how doubling the liquid inside a wine glass affects the frequency. The hypothesis was that when there was more liquid, than the frequency would be lower. The method for this experiment was to measure water into a glass, play it, dump it out, and repeat. Each of the four measurements were tested 25 times. The four measurements used were 1/3 cup, 2/3 cup, 1 cup, and 4/3 cups. The independent variable was the amount of liquid in the glass. The dependent variable was the frequency of the note. The results were very conclusive. The results were put through regular statistical tests, but also an ANOVA F-Test. The means for the trials were 564.72 hertz (hz), 536.56, 464.75, and 374.46, from lowest amount to highest. The standard deviations for each of the trials, in the same way, are 1.34, 4.44, 8.78, and 9.71. The range was similarly skewed. The p-value was much less than 0.05, which is what it needed to be statistically significant. The hypothesis was not accepted. This experiment showed that by doubling the amount of liquid, the frequency does not respond proportionally. It might respond, however, to the percent of the glass filled.

The Effect of Different Colored Filters on Photograph Contrast

Elizabeth Boycourt, Mathematics & Science High School at Clover Hill

The purpose of this experiment was to determine if colored filters really did change the contrast in black and white prints. The original hypothesis was if a number 3 colored filter was applied to a photograph, then the best contrast would be achieved. To complete this experiment, a roll of black and white 100 ISO film was taken in an area already containing decent contrast. The film was then hand rolled in a light proof black bag and placed inside a light safe developing tank. The roll of film was processed using standard developing chemicals, and left to dry for 24 hours. After the film was cut into negative strips, it was prepped to make black and white prints. Inside the dark room, filters were added to the enlarger head, and 18 total prints were created; 3 at each level of the IV. The results determined that the number 3 filter created perfect contrast, as defined by true black, true white and good greys being present in the print. The 0, 1, and 5 filters all did equally poorly, creating either under contrasted or over contrasted prints.

Filters 2 and 4 did not obtain perfect contrast, but were only slightly too dark or too light. The principal conclusions are that the number 3 filter created the best contrast with the specific constants of the experiment.

How Does Foot Position on the Soccer Ball Affect the Distance the Ball Travels?

Nicholas Conklu, Washington-Lee High School

The purpose of this project was to find the best foot position on the soccer ball for maximum distance. There were four different techniques of kicking the soccer ball that were tested, namely; distal one-third, instep technique, outside of the foot, and on the laces. If soccer players know which kicking technique is more effective it can increase the chances of successful a performance. The hypothesis stated that the use of the distal one-third of your foot making contact with the ball will result in the ball traveling the farthest. At the beginning of every trial, pictures were taken of the foot position on the ball. All of the kicks started at one end of the field. Each kick was videotaped with the technique recorded due to the randomized order of foot positions. Observations were made on how far the soccer ball travels and data measurements were recorded in a table. Average distance of each foot position was determined and analyzed. Distal one-third average: 35.10 meters, instep technique average: 28.42 meters, outside (of foot) average: 32.88 meters, and laces (of foot): 35.65 meters. The kicking technique with the highest average distance rate was the laces (of foot). Even though the distal one-third foot position average was only 0.55 meters below the laces technique the data collected did not support the hypothesis made at the beginning of the experiment.

The Effect of the Number of Dominoes on the Time it Takes to Fall Down

Lauren Hancock, Hanover High School

The purpose of this experiment was to determine if the number of dominoes within the same length affects the time it takes for the line of dominoes to fall. In the experiment, the different levels of independent variables were 20 dominoes, 30 dominoes, and 40 dominoes. They were lined up equally distant apart on a track that had a built in meter stick on it and took up 60 centimeters in length. The dominoes were then knocked down by a ring stand-like structure. Two photogates were attached to the track and were connected to a computer with software. As the dominoes fell, the photogates were able to calculate the amount of time it took for the line to fall. The results showed on average, it took 0.306 seconds for 40 dominoes to fall within 60 centimeters, 0.648 seconds for 30 dominoes to fall, and 0.876 seconds for 20 dominoes to fall. So, as the number of dominoes increased within 60 centimeters, the time it took for them to fall decreased. The more compacted the dominoes were, the less time it took for the dominoes to fall. This is because there was less space in between each domino, therefore it took less time for one to fall and knock down the one in front of it. The further apart the dominoes were from each other, the more time it took for them to fall because there is more space in between the dominoes, so it took longer for each one to collapse.

The Effect of Type of Insulating Material on the Temperature of Water after Five Minutes

Justin Hollett, Mathematics & Science High School at Clover Hill

In this experiment, an effort was made to show what household material could make the best insulator. This was done by doing a series of trials using two beakers, a graduated cylinder, cotton balls, sand, water, air, soil, sawdust, a pot, boiling water, oven mitts, two thermometers, a pipe coupler, Styrofoam discs, and a stopwatch. One of the beakers, which was a smaller 250 ml beaker, was placed on top of the pipe coupler in the bigger beaker, which was a 1000 ml beaker. The space in between the beakers was filled with one of the insulators. Boiling water was poured into the 250 ml beaker, and a Styrofoam disc was placed on top of that beaker. The thermometers were put into the disc, and after 5 minutes of recording the temperature each minute, the water was poured out and the insulator disposed of. Key results from this experiment were that water performed the worst at insulating water, and was therefore used to t-test everything against. Also, cotton balls performed the best out of all of the materials. It was concluded from this experiment that the hypothesis, which stated that sand would keep the water the hottest and water would let it become the coldest was partially supported.

Comparison between Frictional Coefficient in Water and Dry Ice

Eric Keener, Mountain Vista Governor's School

The purpose of the experiment presented in this report is to discover which of the two compounds, solid carbon dioxide and solid water, has a lower coefficient of kinetic friction. The null hypothesis was that the coefficient of dry ice will be lower than that of water ice, and the alternate hypothesis was that the coefficient of water ice will be lower than dry ice. The two substances were obtained in large quantities and slid across a regulated surface at a controlled and constant temperature. The time for each compound to come to rest was recorded and used to determine the coefficient of friction through the use of kinematic equations and other physics formulae. The data showed that solid carbon dioxide had a significantly lower coefficient of kinetic friction than solid water. After performing a paired t-test, it was concluded that the null hypothesis was supported.

The Effect of Time on Variable Star RR Lac

Sydney Mabry, Deep Run High School

Everything that we have discovered in the universe runs on time. Cepheid variable stars, stars that change in magnitude, are time-keepers, as they are very accurate and rarely vary from their cycle. The purpose of this experiment was to figure out if the star RR Lac was a variable star. The hypothesis for this investigation was, "If RR Lacerta is a variable star, then its period will be 7 days." A telescope was set up with a 50 mm eyepiece. RR Lac was found, and its magnitude was compared with non-variable stars. A non-linear graph was made to show all 20 points of RR Lac's magnitude. Rather than using a t-test, a one-variance test was used. RR Lac was compared against a regular star with a constant magnitude. The null hypothesis was that RR Lac had the same variance as the constant star. The one-variance test proved this was incorrect, so RR Lac is a variable star. Excel was used to make a graph of a folded period of RR Lac. A folded chart is like a clock; where a clock starts again at 12, a folded chart will start over at the estimated period in days. For example, if the estimated period is 8 days, a sample taken on day 11 would fold to day 3. The chart took the points of RR Lac's magnitude depending on the period chosen, and placed them on the folded chart according to what day they were viewed. The chart would change if the period of RR Lac was changed. In order to estimate the light curve of the folded chart, non-linear regression was used. The process of non-linear regression was repeated for many different periods of RR Lac. The numbers with the least amount of error tended to be in the 6-7 days range. The number with the least amount of error was 6.9, since it had an error of 0.95. Therefore, RR Lac had a period of 6.9 days.

The Effect of Temperature on the Amount of Weight a Magnet Can Hold

Isabel Ruff, Washington-Lee High School

This experiment focuses on temperature and how it affects magnets. It tested the amount of weight a magnet could hold after being put in different conditions for certain amounts of time. It was testing to see if magnets were significantly affected after being in a certain condition and should be avoided. The magnet used was a 3-lb (1.361 kg) horseshoe magnet and it was placed in a freezer, a pot of boiling water, and left in the room. It was then attached to a bucket and weight was put in it until the bucket fell because the magnet couldn't hold the weight anymore. Then, the magnet was put back into the fridge, boiling water, or left out in the air for five minutes until the process was repeated again. The result turned out to be very similar. There wasn't a significant difference between the averages of the data for each variable. The data was also a little random, without a lot of clustering. Even so, the data was very similar for every variable and the trials. Even though there wasn't much of a difference, the magnet performed best after sitting out in room temperature (17.778 °C) and performed the worst after being put in the freezer (-17.778 °C). It seemed that magnets should be kept in a medium temperature, so that they may perform the best. It is expected that the results will become more drastic if the temperatures are made more extreme. If another experiment is done, it would make sense to focus on either warmer or colder temperatures using different increments. This project impacts people because it helps alert them to the effect that the weather can have on the performance of magnets.

The Effect of Different Kinds of Soundproofing Materials on the Number of Decibels

Thomas Salotti and William Wallace, Washington-Lee High School

The purpose of this experiment was to determine the effect of different kinds of soundproofing materials on the number of decibels. The hypothesis used to test the purpose was, "If soundproofing materials are tested then soundproofing foam board will allow the fewest number of decibels to be heard." The hypothesis was tested by using three different soundproofing materials: egg cartons, blankets, and acoustic foam. The three materials were cut into individual squares and selected in random order for testing. The squares were placed one at a time on the open face of a wooden box. The background noise was measured using a sound meter (in decibels). Then, a sound was played from inside the box using an iPhone 4S. The total decibels was recorded, and subtracted by the background noise level to find the effect of each soundproofing material. Although the data was shown to be statistically insignificant based on an Analysis of Variance Test, the soundproofing material with the greatest mean difference was the egg carton. The hypothesis was not supported by these results. There were several errors in the procedure that could have negatively affected the experiment. One being the area around the testing site had fluctuations in the number of decibels (background noise), causing the control to change at various points throughout the experiment.

Searching for Pulsars among Interference and Cosmic Background Radiation

Emily Schulman, T. C. Williams High School

In this project, the researcher analyzed 137 pointings which each contained 34 plots of data. These plots were retrieved from the Pulsar Search Collaboratory's database. The goal was to find rapidly rotating radio sources called pulsars. Four parts of each plot were analyzed to identify if the plot contained a pulsar. If a plot did not contain a pulsar then it had to be identified as radio frequency interference (RFI) or cosmic background radiation. If a plot contained a pulsar then the Australia Telescope National Facility pulsar database was searched to see if the pulsar had been discovered or not. If not, then Drs. Lorimer and McLaughlin were contacted via email and the candidate was either put on a list of candidates to observe or put into one of the prior categories. Of the 137 pointings analyzed, 28% plots contained RFI, 72% contained cosmic background radiation, and 0.06% contained pulsar candidates. No known pulsars were observed.

Light: Is It a Particle or a Wave?

Benjamin Stanley, Washington-Lee High School

The purpose of the project was to determine whether light is a wave or a particle. This problem could be tested by creating a slit in a piece of paper, about needle sized, shining a laser through said slit, and recording the pattern of light on the wall behind. Then, a second slit was created, almost exactly the same spot as the first one yet not touching, and a laser was shone through both of them simultaneously. If a diffraction pattern, or a spread of the light occurred, light was therefore a wave (Young's Double Slit Experiment). Whether light was a wave or particle was determined by the diffraction pattern seen on the wall behind the slits. A diffraction pattern occurred when the laser was shone through the first slit. When the laser was shone through the second slit, the diffraction pattern grew in size, so the light from the two slits benefited each other (constructive interference) which is a property of a wave. The experiment was repeated due to the small potential movements of the laser during the experiment. When positioned correctly and securely using a mount, the laser shone through the slit the same way and produced the same pattern, yet appeared to be slightly larger. An explanation for this would be that the more accurate position of the laser granted it to move through the slit with more precision, therefore causing more light to go through the slit, producing a larger diffraction pattern. This experiment determines light is in fact a wave, however other experiments have been performed proving that light exhibits particle characteristics too, leading to the wave-duality of light theory.

The Effect of Mass of a Primary Body on Distortion of a Secondary Body due to Tidal Force

Sarah Steele, Clover Hill High School

This project investigated the precise measures of the effects of the tidal force produced by one body on another body. These results were computed using mathematical formulas and a simple Python routine.

The independent variable (IV) was the mass of the primary body, and the dependent variable (DV) was the height of the bulge on the secondary as a result of tidal force. The levels of the independent variable ranged from 1×10^{10} kg to 100×10^{10} kg, with 0×10^{10} kg acting as the control. It was hypothesized that as the mass of the primary increased, the effects of tidal force on the secondary would become more pronounced. This hypothesis was supported by the results, which increased in the form of a consistent arithmetic progression as the mass increased. It was concluded that as the mass increased by 1×10^{10} , the height of the bulge on the secondary increased by 0.445 meters (0.000445 kilometers).

The Effects of the Arch of the Back on the Creation of Topspin

Tamia Walker-Atwater, Chesapeake Bay Governor's School for Marine & Environmental Science

This study was used to find the optimal arch of a tennis player's back to create the most topspin. Topspin is the fast forward spinning motion on a ball caused by friction, making a ball bounce lower. After conducting a series of three different trials, each done in an indoor tennis court, a total of 61 different data points were collected. Based on the linear regression ran on these points, a p-value of 1.10406×10^{-3} was given. This p-value shows that there was significance between the arch of a player's back and the amount of topspin created when conducting a tennis serve. Other data collected shows that there was a height increase of the ball after initial impact of 0.762 meters for every degree that the arch of a player's back decreased. This was thought to be true because with an increased arch, a player is bending back more allowing them more time to watch the ball. With this increased eye contact with the ball the player has more time to adjust posture, therefore making better contact with the ball.

The Effects of Soccer Ball Panels on Distance Traveled

Taylor Webb, Chesapeake Bay Governor's School for Marine & Environmental Science

Since the first soccer ball constructed in Stirling Castle in 1570, it has been modified over and over again. These changes often require changing the number of panels that cover the surface of the sphere or the ball, therefore altering the shape slightly. Due to the alterations to these panels, this study was used to show if the number of panels on a soccer ball had an effect on how far the ball would travel, as if it was passed in a game. A wooden mechanism, that mimicked a passing action, was used on three different balls, each with a different number of panels. Beginning with the 20-paneled ball, an average of 277.3 centimeter distance was found. The 24-paneled ball had an average of 288.6 centimeters traveled and the 36-paneled ball had an average distance of 284.8 centimeters. The relationship was for every panel there would be a change of 0.29 centimeters. After running a linear regression on the data that was collected, the p-value came out to be 0.14, which showed that the number of panels did not significantly affect the distance that the ball traveled, since there was more variability among the individual levels than between the different levels. Therefore, the number of panels does not impact the distance that the ball travels. This lead to the conclusion that all soccer balls, regardless of the number of panels that it has will not make passing in soccer and therefore, any soccer ball can be used internationally.

The Effect of Different Focusing Methods on Determining the Critical Focus Zone of a Telescope

Emily Wroblewski, Mathematics & Science High School at Clover Hill

In this experiment, different focusing methods such as the Bahtinov Mask, STI Knife- Edge Focuser, Hoodman Eyepiece, and manually focusing the camera, were used to produce the best critical focus zone of a telescope, in the shortest amount of time. Astronomy as a whole is a very complex science, especially when imagining deep space objects is involved. Many astronomers have difficulty finding which particular focusing method to use in order to create the best image quality possible, without spending unnecessary time that could be used for imaging. To help resolve this issue that all astronomers face, the experiment was conducted. To conduct the experiment, first, all the required materials were gathered, such as the focusing methods, the telescope, etc. Then each focusing method was tested and 25, 10-second images were taken. Finally, for each focusing method the outside temperature, sensor temperature, half-flux diameter, and the full width at half maximum were recorded in degrees Celsius and arc seconds. After these steps were repeated for each focusing method, graphs and charts were constructed to help see the final result. The mean of the FWHM (full width at half maximum) using the STI Focusing Method was 3.27 arc seconds. The mean of the HFD (half- flux diameter) using the STI

Focusing Method was 10.28 arc seconds. The hypothesis of the experiment was supported that the STI Focusing Method would have the best critical focus zone regarding the HFD and the FWHM.

Plant Sciences and Microbiology A

First Place

The Effect of EDTA on the Ciliary Reversal of *P. caudatum*

Alison Bekenstein, George H. Moody Middle School

In *P. caudatum*, ciliary reversal is the function where the cell changes its direction of ciliary beating and reverses its direction of swimming. Ciliary reversal can only occur with the presence of intracellular Ca^{2+} . Adding EDTA to the swimming medium can change the cilia beat frequency, prevent ciliary reversal, and damage CaM. The purpose of this experiment was to determine how EDTA would affect the ciliary reversal in *P. caudatum*. Based on similar research which stated that EDTA inhibits Ca^{2+} entry to the cell and prevents ciliary reversal, it is believed that if there is 10 mM of EDTA in the swimming medium then *P. caudatum* will have a lower percentage of ciliary reversal. *P. caudatum* were tested with 125 μL of 10 mM of EDTA and without EDTA. For one minute, the total number of *P. caudatum* that encountered the wall of the well and the number that reversed ciliary beat when encountering the wall were counted using the app Click Counter. There were 10 repeated trials. *P. caudatum* that received 10 mM EDTA had a lower percentage of ciliary reversal with a mean percentage of 17.9%. The *P. caudatum* that did not receive EDTA displayed ciliary reversal with a mean percentage of 40.2%. The data supported the hypothesis that if there was 10 mM of EDTA in the swimming medium, then *P. caudatum* will have a lower percentage of ciliary reversal. This experiment reveals that EDTA forms a stable compound with extracellular Ca^{2+} which prevents Ca^{2+} entry into the cell, therefore preventing ciliary reversal. The *P. caudatum* that received EDTA exhibited less ciliary reversal because EDTA damaged calmodulin, prevented Ca^{2+} from entering the cell, and changed the overall behavior of the cilia.

Second Place

The Effect of pH on the Rate of Composting

Nikhil Chandravel, Tuckahoe Middle School

The objective of this experiment was to study the effect of pH on the rate of decomposition of compost. The hypothesis was, "If vinegar (pH of 2.2), tap water (pH of 7.0), and milk of magnesia (pH of 10.5), were added to three different composts, then the compost with the acidic or neutral medium will generate more complete/usable compost faster than the compost with the alkaline medium." An experiment was conducted to test the hypothesis, in which a set amount of organic matter was put in a plastic container, and then assigned liquids were added. The composts were regularly aerated and shaken well, and the rate of decomposition was observed qualitatively every week for a period of six weeks. The result at the end of six weeks indicated that the decomposition with the neutral medium was the fastest and the acidic medium was slower than expected. The rate of decomposition in the alkaline medium was faster than the acidic medium, but it was slower than the neutral medium. The experimental results suggested that the neutral pH was optimal for facilitating the composting process.

Third Place

The Effect of the Amount of Nitrogen Fertilizer on the Production of Vitamin C

Raghda Labban, George H. Moody Middle School

The purpose for conducting this experiment was to see how the amount of nitrogen fertilizer affects the production of Vitamin C in tomato plants. Fertilizers have been overused to increase fruit yield without thinking about their effect on the fruit's nutritional value and the environment. Overuse of fertilizers has a

harmful effect on bodies of water and increases the cost of food. The hypothesis for this experiment was that if the amount of nitrogen fertilizer is increased, then the production of vitamin C will decrease. Three tomato plants were grown in one AeroGarden using a low level of nitrogen fertilizer and three additional plants in another AeroGarden using a high level of nitrogen fertilizer. When the plants matured ten tomatoes were harvested from each AeroGarden and analyzed them for vitamin C by titration with potassium iodate. The AeroGarden with more fertilizer produced bigger plants and denser leaves than the AeroGarden with less fertilizer. Vitamin C concentrations in tomatoes grown with low fertilizer averaged 0.2294 milligrams per gram of fruit, whereas Vitamin C concentrations in tomatoes grown with high fertilizer averaged 0.1772 milligrams per gram of fruit. Using less fertilizer resulted in 23% more vitamin C production. Due to the results of the experiment, a conclusion was made saying that when smaller amounts of nitrogen fertilizer are added to plants, the fruits produced contain greater amounts of vitamin C compared to plants fed large amounts of nitrogen fertilizer.

Honorable Mention

The Effect of Allelopathic Nuts on Germination of Weeds

Skylar Brodowski, Gunston Middle School

The intention for most common herbicides is to kill the undesirable weeds, and hopefully not harm the intended plants. It is the goal of many gardeners to find herbicides that strike the right balance. This experiment tested the effect of various allelopathic nut solutions (i.e., acorn, chestnut, hickory, walnut, and water as control) on several types of weeds (i.e., liriopse, plantain, crabgrass, and grass as the second control). The goal was to find the effect of a nut's allelopathy on various plants' germination. Twenty trials were tested using petri dishes that were lined with a filter paper circle. Each paper circle was soaked in water that the nuts were previously soaked in for 24 hours. There were five paper circles for each nut, and one paper circle of each nut had one type of the five weed seeds put inside it. In all total, 200 seeds were used. The seeds were grown and watered normally, using the specific type of nut-soaked water group that the paper circle was soaked in. The results showed that the acorn and walnut worked as fairly good natural herbicides, as both slowed all of the different weeds' germination. The acorn average germination rates were 0.3 Liriopse seeds, 2.7 Plantain seeds, 0.3 Crabgrass seeds and, 0.3 Grass seeds. The averages for the walnut were 0.2 Liriopse seeds, 0.4 Plantain seeds, 0.6 Crabgrass seeds and, 0.4 Grass seeds. The results of the experiment can be used to identify promising natural herbicides that could be used to slow the germination of certain weeds.

Honorable Mention

The Effect of Different Materials on Pine Wood Rotting

Jaideep Damle, George H. Moody Middle School

Wood is the most commonly used building material in the United States. It is always exposed to the elements and is susceptible to rot and decay. Rot is caused by water and moisture seeping into wood creating an environment for fungi to grow and thrive. Therefore, wood has to be protected against water seepage by protective coatings. The purpose of this experiment was to find out which coating, among paint, wood stain, wood varnish, and plastic wrap, would protect wood the best from moisture seepage and absorption. Based on the research about the properties of each coating, a hypothesis was formed: If paint, wood stain, wood varnish, and plastic wrap are used as a covering/coating for wood that is placed in water, then the wood with the wood stain on it will absorb the least amount of water. Four different coatings were tested against a control group of wood samples that was left uncoated. They were each put into tubs that contained 600 ml of water, and kept at room temperature for five weeks. Readings were taken every week of the five week period. The increase in the weight of the wood samples was recorded as a measure of water absorption. The results showed that the varnish coated wood group gained the least amount of weight since the experiment started. The conclusion was that out of the four coatings, varnish worked best.

Honorable Mention

The Effect of Different Fertilizer Components on *Elodea* Height Change

Mohini Johri, George H. Moody Middle School

One of the greatest factors contributing to the eutrophication, the growth of algae in bodies of freshwater, is runoff from fertilizer. Phosphorus content from fertilizer runoff is shown to control the productivity in the lake. *Elodea* is an extremely common aquarium plant found throughout North America, primarily in bodies of freshwater. Fertilizer has a harmful impact on the *elodea* in a freshwater environment if used in excess. Based on the research, it was hypothesized that if the fertilizer most highly concentrated in phosphorus was added to the jar of *elodea* and water, then it would have the greatest effect on the change in height of the *elodea*. The purpose of this experiment was to determine the effect of different fertilizer components on the change in height of *elodea*. Ten *elodea* plants were designated to each group of the independent variable; Group A (Azalea Camellia Rhododendron, highest in nitrogen), Group B (Miracle-Gro Bloom Booster, highest in phosphorus), and Group C (Miracle-Gro Tomato Plant Food, highest in potassium), and Group D (control; no fertilizer). The height of each plant was measured every day for 20 days with a centimeter ruler. There was a decrease in height of all groups of the independent variable. Group D, the control, lost 2.92 centimeters in plant height, while Group B decreased by 7.07 centimeters, while the values of C and D lay in between these two. The outcome of the experiment supports the hypothesis that the fertilizer with the highest concentration of phosphorus (Group B) has the greatest effect on the change in the height of the *elodea*. These results display that phosphorus was the main limiting nutrient in the experiment. Future research with more trials over extended periods of time in a better simulation of the freshwater environment will establish greater understanding of the correlation.

The Effect of Water pH on Plant Growth

Madeleine Beauvais, Gunston Middle School

The purpose of this experiment was to examine the effects of differing pH levels on the growth of Queen Sophia Marigolds. Five levels of independent variables were chosen. They were the pH of the water given to each set of Marigold plants. The pHs were 5.0, 6.0, 7.0 (the control), 7.5, and 8.0. The dependent variable was the height of the plants and the number of live plants out of 10 seeds per flat. It was hypothesized that if the pH of the water was between 5.8 and 7.0, the plants would grow faster, and more of them would grow and stay alive. The experimental procedure included the changing of the pH per liter of water, giving 100 ml of water per day to each flat. Each of which was filled $\frac{1}{5}$ with low quality potting soil. The data was recorded on a per-day basis, which included the number of live plants and the average height of the plants. At the conclusion of the experiment, it was found that the hypothesis was not supported. The data showed that the plants with the lowest pH stayed alive for the shortest amount of time, even though they sprouted the fastest. This project could be improved by testing more levels of pH, or having more trials. In the future, this project could be used to inform people about taking care of our environment, and the effect of acid rain on plants because Marigold plants are medium hardy plants; they are not overly resistant to a change in pH, but they are not as sensitive or fragile as other plants.

What is the Effect of Purification/filtration Method on the Amount of Bacteria Left in Stream Water?

Anne Bell, Thomas Jefferson Middle School

Hikers were always looking for the most effective method of removing bacteria from water, but which method was the most effective? This project investigated three different methods of removing bacteria from stream water, and it measured the change in water bacteria. The water was tested using a Brita® water filter (for a standard kitchen water pitcher), chlorine-dioxide drops, and iodine tablets, and bacteria

growth was measured after 3 days and 5 days. The hypothesis was that if water was purified with the chlorine dioxide drops, then the lowest percentage of bacteria would grow in the Petri dish. The experimental results did not support the hypothesis, but in fact the control group had the lowest amount of bacteria after both 3 days and 5 days. The experiment showed that a standard water filter may not be an effective method for removing bacteria from water.

The Effect of Bananas on How Quickly Fruit Rots

Caroline Berger, Kenmore Middle School

Ethylene is a hormone produced by growing fruit that causes fruit to ripen, and it is produced by bananas in the form of a gas even after harvesting. The purpose of this experiment was to find if different kinds of fruits are paired with bananas, which fruit would rot the fastest. The hypothesis was that of all the fruits tested (pears, apples, and oranges), if a pear was paired with a banana, it would rot the fastest. Four of each type of fruit were placed in plastic bags along with four bananas per bag, stored in an environment with a constant temperature, and measured over a course of two weeks. Control bags without bananas were prepared as well. However, none of the fruits rotted enough to show a clear result. By using a different storage method, future experimentation may yield more defined results.

The Effect of Oil Location on the Majestic Giant Pansy Plant's Change in Height

Lady Greer Corral, George H. Moody Middle School

The purpose of this experiment was to discover the most effective location of oil on the height of a pansy. Oil spills frequently occur around the United States. In these oil spills, the plants around the spill often die off. This experiment required pansies to be exposed to motor oil on different locations of the plant: oil on the soil, on the leaves, on the petals, and no oil as the control. Five milliliters of oil was taken and poured on the designated area along with 50 ml of water poured directly on the soil. Twenty-four hours after the latest oiling and watering, the height of each plant was taken to see whether or not the plant grew, shrunk, or stayed the same. The process of oiling, watering, and measuring continued for 3 weeks. It was hypothesized that the group with oil located on the soil would have the greatest height difference compared to the other locations. On average, oil poured on the leaves was shown to decrease in height the most at 0.47 cm, while the least decrease in height was the control at 11.4 cm. At the end of the experiment, the data observed did not support the research hypothesis. It was believed that the overwatering of the plants caused the oil to settle along the surface of the water and not reach the roots. With the oil not implanted into the system of the plant, the maximum damage was not done, unlike the oil on the leaves and petals. Also, different factors of the experiment were thought to cause interferences with the growth of the plants. Factors like amount of sunlight and the use of the same cup for oil and water. After oiling the plants, some oil could have lingered on the cup, thus pouring extra oil or less oil for each plant. Not only that, but when watering the control, oil particles might have been left on the surface of the cup allowing oil to pass and reach the plant. Sunlight affected the results of the experiment because each plant did not receive equal amounts of sunlight, providing other plants with an advantage. These factors possibly affect the growth of each plant.

The Effect of Surface Runoff Pollution on Algae Growth

Nidhi Desai, George H. Moody Middle School

Lakes, ponds, rivers, and oceans are all filled with microscopic organisms. Humans create the excess of those microscopic organisms through pollution. The main purpose was to show the public that if different amounts of fertilizer are used to represent surface runoff pollution, then which one would have the most amount of algae growth? If there was a maximum amount of algae growth, then the fertilizer was most effective in increasing the amount of algae. The more amounts of nutrients there are, the more algae will grow. Therefore, the hypothesis for the experiment was, if algae are placed in different concentrations of fertilizer, then the higher the concentration, the more algae will grow. Procedures taken for the experiment were straightforward. As follows, 40 glass containers were labeled with the amount of fertilizer that would be in each container. The experimenter then poured fresh pond water (200 ml) into each container, later adding each independent variable. The containers were placed under a growing light for approximately a

week in a sterile laboratory. When the week was over, there were algal blooms grown. Next, data was collected by counting and recording the amount of bacterial colonies grown. After the algal blooms had been grown and recorded, the experimenter disposed of them properly in the laboratory. When the algal blooms were grown and recorded, the results came in that the pond water with 15% fertilizer was the most efficient in growing algae. The hypothesis was proved because the highest concentration grew the most algae. The other independent variables grew accordingly to the experimenter's hypothesis as well.

The Effect of Different Pitches of Laughter on Plant Growth

Samuel Gerardi, Kenmore Middle School

For quite a while, it has been thought that music helps plants grow. This project examines how the pitch of sound affects plant growth. The purpose of the experiment was to find out what pitch of laughter causes plants to grow the fastest. Research was done by the scientist about the topic. Sound is caused through vibrations and frequency, or pitch, affects those vibrations. The higher the pitch, the more vibrations there are. In a past experiment, it was suggested that plants benefit from these vibrations. The scientists hypothesized if recorded pitched laughter is played to groups of parsley plants, then the parsley plants exposed to high pitched laughter will have the highest rate of growth. The plants were split into groups and placed in a confined area. High, medium, and low pitched laughter were played for their respective groups, one group at a time, for 8 days. The plants were measured for difference in height at the beginning of the experiment, 4 days in, and on the 8th day. The results were high pitched laughter stimulated the most growth and the control stimulated the least growth. Below high pitched laughter was medium pitched, then low pitched laughter. The hypothesis was accepted.

The Effect of the Amount of Ascorbic Acid Given to a Yellow Carnation on Lifespan

Mano Harada, George H. Moody Middle School

Free radicals have an odd number of electrons and therefore steal electrons from other substances. This leads to the altering of the substance's structure and function. Rather than causing aging, some free radicals may prove useful. A recent study done by Siegfried Hekimi and Wen Yang shows that worms that produced high levels of free radicals lived longer than normal worms and worms given antioxidants. Hekimi speculates that oxidants act as a signal in the worms' bodies to help repair cellular damage. The purpose of this experiment was to determine the effect of the amount of ascorbic acid given to a yellow carnation on lifespan. Forty yellow carnations were split into four groups of ten and each group was given a concentration of ascorbic acid. Zero mg/ml was the control group and 1 mg/ml, 2 mg/ml, and 4 mg/ml were the experimental groups. Each was tested for the amount of time it took for the flower's sepal to turn brown. The results indicated that the carnations given no ascorbic acid with a mean of 23.3 days lived longer than the carnations given 4 mg/ml of ascorbic acid with a mean of 5.30 days. The carnations given 1 mg/ml of ascorbic acid had a mean of 21.3 days and the carnations given 2 mg/ml had a mean of 12.0 days. The data supported the hypothesis that if the different groups of carnations were given 0 mg/ml, 1 mg/ml, 2 mg/ml, and 4 mg/ml of ascorbic acid, then the group of yellow carnations given 0 mg/ml of ascorbic acid will spend the longest time before the sepal turned brown. Based on the results it appears that the more antioxidants given to the yellow carnation, the shorter its lifespan was. Improvements that could be made to this experiment that could produce more accurate results would be to increase the size of the cups in which the flowers were put in so they could have space to bloom, changing the water of the cups every day instead of every three days, and doing more repeated trials.

The Effect of Nitrogen Fixing Bacteria on the Biomass of a Clover

Pragati Kapila, George H. Moody Middle School

Legumes create nitrogen on their own with their own natural process. Rhizobium is the nitrogen fixing bacteria which is found in clovers and other legumes used to create nitrogen into the atmosphere. However, if more Rhizobium was added manually, it is said that even more nitrogen is created. The increase of Rhizobium in a plant makes the plants greener and healthier, which would boost the biomass of it compared to a regular legume with no Rhizobium added. The purpose of this experiment was to figure out was if the plants with Rhizobium added would create a healthier biomass than a regular clover without Rhizobium. The hypothesis for this investigation was if more Rhizobium was added and grew, its

biomass would be greater than the regular clover without Rhizobium. Throughout the procedure, there was data written with the biomass at the end of each week. Also, the amount of nitrogen was taken at the end and compared to each other where the ones with Rhizobium have more nitrogen than the others. Once the investigation was finished, the results showed that the hypothesis was supported from the data. In conclusion, this experimentation gave a great understanding if the natural process of nitrogen fixation was better than manually adding more. In the end, the group of trials with Rhizobium added was better than the ones without it.

The Effect of Acid Pre-treatment on CO₂ Production in Yeast

Taranjit Kaur, Williamsburg Middle School

This project studied the effect of acid pre-treatment on carbon dioxide production in yeast. The purpose of this experiment was to see whether acid pre-treatment affects the amount of carbon dioxide yeast produces. The results showed that pre-treatment of the yeast with vinegar decreased the amount of carbon dioxide that yeast produces. Three 0.3 gram samples of yeast were treated with full strength, half strength, and one-tenth strength vinegar. The control samples had no acid pre-treatment. For each sample, 5 milliliters of the yeast culture was combined with 5 milliliters of 18% sugar solution and 5 milliliters of water in a small test tube. A larger test tube was placed over the small test tube and the pair was inverted to produce an air-free environment. The mixture was incubated overnight at 37 degrees Celsius and the size of the carbon dioxide bubble produced was measured using a ruler. The results showed that the full strength vinegar added to yeast produced the least amount of carbon dioxide and the 10% vinegar produced the most amount of carbon dioxide.

The Effect of Decreasing Salinity Levels on Growth of Algae

Amy Kohan, Gunston Middle School

The purpose of this experiment was to find out if lowering the salinity level would kill salt water algae. The independent variable was the diluted amount of salt and water mixture in the fish bowls. The dependent variable was characteristics of the algae and water. The hypothesis was that if the salinity level decreases then the algae will slowly die. The procedure included making a fresh water solution by adding 3500 ml of tap water and 1/10 prime, which was used to remove chlorine. The second solution was prepared by adding 125 ml of sea salt mixed with the fresh water mixture. The salt and water mixture was measured using a hydrometer. The optimal level for the beginning of the experiment was a level 32 g. Once the 32 g salinity level was attained by adding salt or fresh water depending on if the level was too high or low, the water was divided into two 1890 ml fish bowls. Then equal amounts of algae were added into each bowl. One bowl was marked control and the salinity level was maintained at 32 g while the other was used as the experimental bowl where the salinity level would decline over the course of the experiment. Observations were made about the characteristics of algae and water every three days for three weeks. After observations were made then 60 ml of water was extracted from the experimental bowl and 60 ml of salt water was added to the experimental bowl. After three weeks the salinity level was measured in the bowl which had fresh water added to it. After the experiment, it was found that the data did not support the hypothesis. By the end of the three week experiment, the algae adapted to the changing salinity levels. This experiment was important because it can help gain an understanding of the impacts of the melting of the polar ice caps which is releasing fresh water into our salt water oceans. Given the information obtained from the experiment, lowering salinity levels does not kill saltwater algae and therefore may not impact other saltwater plants.

The Effect of Color on the Growth of Chives

Benjamin Kratzer, Tuckahoe Middle School

In the project, plants were tested to see which color tent makes chives grow the fastest. The independent variable was the colored plastic tent being used. The dependent variable was how high the chives grew. The project showed that the color blue tent had the highest growth rate with an average of 10 centimeters, while green had the next highest growth rate with an average of 8.1 centimeters. The color red group had the least amount of growth out of the three colored filters with an average of 7.4 centimeters. The experiment lasted 14 days after seed germination.

The Effect of pH on the Percentage of Mung Beans Sprouting

Shivani Kundalia, George H. Moody Middle School

Mung beans are one of the world's widely spread and oldest cultivated crops. They originated in Asia, and were used as food as well as healing or cure for injuries. Throughout the world mung beans are used for food and they are eaten as fresh sprouts or dry beans. On the other hand, pH is the acidity or alkalinity of a solution. Overall, major changes in pH from acidic and alkaline can drastically change the development of plants by stunting their growth or even causing death. The purpose of this experiment was to determine the effect of different pHs of solutions, on the growth of the percentage of mung beans sprouting. Forty mung beans were collected and 10, as a control, were placed in water with a pH of 7. Ten were placed in a solution with a pH of 9, 10 were placed in a pH of 3, and 10 were placed in a pH of 4 for one day. After one day the water was drained from each cup and the cups were placed in their original positions for an additional two days. After a total of three days, the percentage of beans which had sprouted was calculated. The results coincided with the hypothesis that if a pH of 7, pH of 9, pH of 3, and pH of 4 were used, then the group receiving the solution with a pH of 7 would display the greatest percentage of mung beans sprouting. The mean of the percentage of mung beans that had sprouted for the group with a pH of 7, or neutral was 91%, whereas the group with a pH of 9 had an average percentage of 0% of beans sprouting. The results showed that unusual pHs that were out of the range of 6.2-7.2 caused dramatic changes in the growth of mung beans. Although, the results would have been more accurate if a wider range of pHs were used.

Plant Sciences and Microbiology B

First Place

The Effects of Different Types of Tea on Protecting Prostate Cells from DNA Damage

Jerry Zhang, George H. Moody Middle School

In the year 2001, a study led by Dr. Karbonik showed that the antioxidant melatonin (N1-acetyl-N2-formyl-5-methoxykynuramine) could protect DNA from oxidative damage. Oxidative DNA damage is caused by oxidation reaction. Free radicals can start chain reaction. Once the chain reaction takes places in a cell, it can cause DNA damage or cell death. An antioxidant is a molecule that inhibits the oxidation reactions by removing free radical intermediates and thereby stops DNA damage. Since tea is rich in antioxidants, the purpose of the study conducted was to find which type of tea could protect prostate cells the best. We hypothesized that if hydrogen peroxidase was used to induce oxidative DNA damage, the group treated the white tea extract would receive the better protection and more cells will survive. Four types of tea were included: green, white, oolong, and black tea. Each of them was used to treat prostate cells in ten trials. After the treatment, the cells were exposed to oxidative assault from hydrogen peroxide for two days. The surviving cells were measured by MTS assay. The results showed that white tea had the best survival rate with 225.6% cells, relative to control group. The tea with the lowest survival rate was oolong tea with 157.9%. The results supported the hypothesis that white tea would provide the highest protection against the hydrogen peroxide-induced oxidative stress. It appeared that the higher concentration of the catechins, a type of polyphenol antioxidant, in the white tea played a major role in this process. However, additional research will be needed to confirm the role of catechins in this protective event.

Second Place

The Effect of Water Salinity on the Growth of *Euglena acus* Algae

Joseph Mistretta, George H. Moody Middle School

Algae are single-celled protozoa organisms that live in aquatic environments. These organisms are autotrophs which undergo photosynthesis and therefore serve as producers for many aquatic food chains. Algae have an ability to double their biomass within 24 hours and have been found by researchers to be potential suppliers of cost-effective biofuel. *Euglena acus* is a species of algae that can grow in fresh and brackish water, as well as salt water. The purpose of this experiment was to test the effect of different water salinity levels on the growth of *Euglena acus* algae. *Euglena acus* cultures were grown in glass containers of water with salinities of 0 ppt, 10 ppt, 20 ppt, and 30 ppt to correspond with types of water of various salinities in which *Euglena acus* can grow. Samples from each container were taken after 25 days of growing time and were measured in a spectrophotometer. The absorbance rate of the sample reflected how much algae had grown for each group. The results indicated that the least algae grew in the water with a salinity of 0 ppt with a measured absorbance of 0.0355, and that the most algae grew in the water with a salinity of 20 ppt with an absorbance of 0.0565. These results supported the hypothesis that the most algae would grow in the water with 20 ppt salinity. Based on the results of the algal growth and its relation to water salinity, *Euglena acus* appears to best grow in areas of brackish water, a point between fresh water and salt water.

Third Place

The Effect of Different Types of Liquids on the Germination of Mung Beans

Selik Morishetty, George H. Moody Middle School

The purpose of this experiment was to determine the effect of different types of liquids on mung bean germination. The hypothesis for this experiment was if different variety of liquids like tap water, strawberry flavored Gatorade, white distilled vinegar, and salty water, are added to the mung bean, then water would help the bean to sprout the best with the longest length. Mung beans (*Vigna radiata*) are protein rich food with excellent source of dietary fiber, calcium, magnesium, phosphorous, potassium, iron, several vitamins along with low sodium and saturated fat content. In the recent times there has been an increase awareness of the health benefits of sprouts and are considered to be a living food. There is a tremendous increase in the nutrients, phytochemicals and antioxidant activity in sprouts compared to the dried beans. In this experiment four groups of equal amounts of mung beans were soaked with four different types of liquids which include tap water, strawberry flavored Gatorade, white distilled vinegar and salty water for 12 hours. Then, the beans were sealed in a cotton cloth and 24 hours later they were unsealed. Observations of germination were made and the sprout length was recorded. It was shown that the mung beans soaked in water had the highest sprout length at 24 hours of germination compared to the other liquids. Statistical tests were performed on the recordings of the sprout lengths for each of these groups. The test results indicated that tap water was the best liquid for germinating mung beans. Since the hypothesis was supported by the data and statistical tests, it could be concluded that mung bean germination was best with tap water compared to other types of liquids.

Honorable Mention

The Effect of Temperature on the Amount of Carbon Dioxide Produced by *Saccharomyces cerevisiae*

Melina Seng, Williamsburg Middle School

The purpose of this experiment was to find the effect of temperature on the amount of carbon dioxide produced by *Saccharomyces cerevisiae* (yeast). Yeast enables scientists to make significant discoveries about curing cancer. Thus, it would be useful to find the best temperature to grow yeast, as determined by greater amounts of carbon dioxide (CO₂) produced. The hypothesis was if the temperature is increased, then the amount of carbon dioxide will increase. The procedure was to use a heating pad to heat a flask with the yeast, sugar, and water and monitor the temperature with a thermocouple. When the yeast would produce CO₂, the gas would go through a tube and push olive oil. The displacement of the oil was measured. The data showed that yeast is most active at an optimum temperature range of 42-47° C. The hypothesis was proven partly false, because CO₂ production only increases at some higher temperatures, but past a certain temperature, it is too hot for the yeast to grow and the CO₂ production falls off. The range of the data was consistent but at higher temperatures the range increased. The experiment could be improved by having a better temperature control and thus more consistent CO₂ production by the yeast. To expand on these results, the experiment could be changed to test different amounts of yeast and sugar or test different heat sources like a convection oven or microwave oven.

Honorable Mention

The Effect of Soil Type on Bean Plant Height

Reilly Towns, Tuckahoe Middle School

Gardening is beneficial for many reasons, both mental and physical. Caring for a garden is great exercise, and being outdoors improves the mood. Some people also grow their own vegetables to avoid pesticides or over-spending. However, plants have specific needs that must be met in order for them to be able to grow. One of the most important needs of the plant is healthy soil, as plants get nearly everything they need from soil. The purpose of this experiment was to test the effect of different soils on the height of bean plants. The independent variable was the soil type. The dependent variable was the height of the beans plants. Four different types of soil were tested. They were clay, sand soil, potting soil, and backyard soil. The experimenter's hypothesis stated that if bean plants were grown in different soils, then the plants grown in potting soil would grow the tallest. There were three trials for each soil type. The experiment was conducted inside the laundry room of the experimenter's residence for 16 days. All trials

were grown in small plastic containers under a grow light. The plants were watered daily. At the end of the experiment, potting soil was found to have an average height of 4.11 centimeters, the highest average height. This supported the experimenter's hypothesis.

Honorable Mention

Effect of Exposure to UV-A Rays on Plant Growth

Jonathan Yu, Tuckahoe Middle School

The experiment was conducted in order to answer the question does ultraviolet affect the growth of *Vigna radiata* more commonly known as the mung bean? The experiment was conducted using a black light (UV-A light) and a grow lamp. The materials needed for this project were a black light, two boxes, a grow lamp, mung beans, tap water, cups, dropper, and a ruler. The results of this experiment showed that mung beans (*V. radiata*) have longer roots under the black light while, the plants under the grow lamp has darker and larger leaves. The experimenter concluded that mung beans could grow very quickly and very tall without any effort. The mung beans germinated in less than a day and grew to almost as long as 20 centimeters. These results show that mung beans are more prone to growing longer in length under black light conditions, but grow shorter and healthier under grow lamps.

The Effect of Type of Hamburgers on Bacterial Growth

Henry Lear, Tuckahoe Middle School

The hypothesis of the experiment was "If the types of hamburgers with the highest organic content and least amount of preservatives are examined, they will contain more bacterial colonies visible to the human eye." The independent variable was the type of burgers that would be tested. The results of the cultured samples seemed to have no correlation with sodium content, beef or vegetarian, or organic or non-organic burgers. No direct connections between bacteria and preservatives (sodium content) could be inferred. All of the burgers showed widely varying amounts of bacterial colonies, with the non-organic beef (41 mg/sodium) having only slightly more colonies in total than the McDonald's (125 mg/sodium) samples.

The Effect of Water Type on Tomato Plant Growth

Vidyaprajna Mastriyana, Tuckahoe Middle School

Agribusiness industries and small businesses marketing tomatoes are thriving worldwide, and Americans plant tomatoes more than any other plant in their home gardens, with varying results. The hypothesis for this experiment was if rainwater is used, the height of the plant will grow taller than plants grown with spring or tap water. This experiment tests which type of water would make the tomato plant grow taller and healthier looking. Results showed that rainwater outperformed tap water and spring water in height as well as leaf growth. By the end of the experiment, the tomato plants watered with rainwater measured 6.88 cm in height (average) 6.78 cm for tap water, and 6.64 cm for spring water; the hypothesis was supported.

The Effect of Microwave Radiation on the Germination of Red Kidney Beans

Kelsey O'Brien, George H. Moody Middle School

Red kidney beans are vitally nutritious legumes that germinate and grow. Many scientists have taken note of the fact that microwave radiation has negative effects on germination in seeds or beans such as red kidney beans. The purpose of the project was to determine the effect of microwave radiation on the germination on red kidney beans. Based on the experiments that stated when a plant is exposed to radiation, important components that are vital for plant survival could be damaged in the process; it is believed that if the amount of microwave radiation were increased, then the germination rate will decrease. Four groups of 25 red kidney beans were microwaved at 0 seconds (control), 5 seconds

(Group B), 10 seconds (Group C), and 30 seconds (Group D). Once microwaved, the beans were placed in moist paper towels in sealed Ziploc plastic bags and were taped to a sunny window. After being in the bags for a total of seven days, the beans were removed and counted. The outcome of Group A was (control) 21 total beans germinated. Group B had 19 beans germinated out of all 25 trials. Group C had 15 beans germinated throughout all 25 trials. Group D had 0 beans germinated throughout all of the 25 trials. Based on the results, the experimenter's hypothesis was supported. In conclusion, microwave radiation does in fact have some negative effects on germination, but only to a certain extent.

The Effect of Different Fertilizers on Tall Fescue Growth

Adam Pleasants, Tuckahoe Middle School

Gardeners frequently purchase fertilizer to help grass grow. Many of these gardeners buy the fertilizers that claim to be best. The purpose of this experiment is to test the various products to see which one grows best. Twelve trays were set up, seeded, and fertilized with different fertilizers. The height of the grass was recorded daily. The fertilizers were categorized as root growth (with high nitrogen and potassium), balanced (a balance of nitrogen, phosphorous, and potassium), and a homemade formula made with common household products. The findings were mixed, with each trial resulting in a different leading fertilizer.

The Effect of Surface Treatment on Carbon Fiber Reinforced Polyether Ether Ketone (PEEK) on the Contact Angle of a Water Droplet

Miguel Rao, George H. Moody Middle School

The purpose of this study was to determine whether CFR PEEK could bind more effectively to human jawbone when treated in three different ways. These included plasma treated, NH_4OH (ammonium hydroxide), and H_2O_2 (hydrogen peroxide). The hypothesis was if CFR PEEK is treated in any way, it will be more wettable (refers to how hydrophilic PEEK is), and therefore more bondable to human bone. The hypothesis was partially supported because two of the three treatments did actually make the CFR PEEK more wettable. Plasma treated and H_2O_2 were more wettable because the plasma and peroxide probably increased the surface energy of the CFR PEEK. The NH_4OH is a base which makes it less wettable, so it likely did not increase the surface energy. PEEK is an organic polymer used in a wide range of engineering related applications including the repair and restoration of solid (bone) aspects of the human body. Despite all of the advances in using PEEK to replace missing teeth, the bondability of PEEK to jaw bone is yet to be perfected. One issue is improving the integration between materials used for tooth restoration and the natural bone matter itself. First, four 2.5 cm² FDA approved CFR PEEK specimens were prepared for control and treatment measurements. A 2nd CFR PEEK square was plasma treated by rotating at 300 RPM under a plasma plume 3 mm in diameter positioned 8mm above the surface for a total treatment time of two seconds per mm squared. Third, CFR PEEK square was ammonium hydroxide treated for three weeks was shaken at 100 RPM at 37 degrees in 25 ml of a 28% solution of ammonium hydroxide. A 4th square was treated in a solution of 3% hydrogen peroxide at 37 °C and shaken at 100 RPM for a week. Ten contact angle measurements were made after placing a drop of deionized water from a micro syringe in different places on the CFR PEEK specimens. A Ramé-Hart digital contact angle goniometer using pictures to capture the contact angles was used.

The Effect of Flour Type on the Growth of a Sourdough Starter

Lilac Rudolph, Sabot at Stony Point

The purpose of this study was to identify how different types of flours affect the growth of a sourdough starter. A sourdough starter is made from wild yeast which is captured from the air rather than made with packaged yeast. When flour is mixed with water, starches become available for the wild yeast in the air and in the flour to feed on. The yeast then multiplies and eventually is strong enough to raise the dough, which can then be used to make bread. After the yeast becomes active, a portion of the starter is combined with fresh flour and water, and made into bread. Sourdough starter is a more natural way of raising bread as compared to using commercially made yeast. It also has a big effect on the flavor of the bread made from it. This study measured the growth rate of sourdough starters made with three types of flour – plain white, plain whole wheat, and a combination of both white and whole wheat. The hypothesis was that the starter made with a combination of both white and wheat flour would rise more and faster

than the other two because whole wheat flour has more nutrients than plain white flour, but too many nutrients can cause a starter to spoil. Therefore, a combination of the two types of flour should produce the best starter.

The Effect of Different Colors of Fall Leaves on How Well the Pigments Separate

Nandita Sangwan, George H. Moody Middle School

Chromatography is traditional method used to separate compounds in multiple different fields of science. This experiment uses paper chromatography. One example of compounds that chromatography is used to separate are the different pigments found in leaves. A pigment is a molecule that absorbs and reflects light. In autumn, leaves begin to change colors due to a pigment called chlorophyll. During autumn when the chlorophyll begins to decrease is when pigments such as carotenoids and flavonoids start to appear. The purpose of this experiment is to find out which color leaf separates the pigments in the leaf the best. The different colors of leaves, or the independent variable, that is used for this experiment is green, yellow, orange, and red. The dependent variable of this experiment was the retention ratio or the Rf value. The hypothesis for this experiment was that, if a yellow leaf is used then its pigments will separate the best. This hypothesis was supported by the data collected. The Rf values for the red leaf pigments were the lowest out of all the leaf pigments. The average Rf value for the yellow leaf pigments was significantly higher than the others. The findings in this experiment agree with paper chromatography theory. Due to the lack of speed that the pigments traveled up the paper, they were not able to separate as well. The speed that yellow leaf pigments were able to move along the paper resulted in the pigments being able to separate better.

The Effect of the Rainbow Colors on Plant Leaf Use

Livana Sarker, George H. Moody Middle School

The light is taken in by the plants, but which colors of the arc are used during photosynthesis? The light that is captured by the plant is changed during this experiment since the light that is being taken in is just one color. That one color affects how the plant grows, changing its process of photosynthesis. Why do an experiment on photosynthesis and how it uses color? It's to find out if all colors from visible light are used during photosynthesis. From the four colors and the clear film that was used, one color was predicted to have the greatest growth difference, which was the blue film. The experiment was done by covering up 10 ivy plants; two plants covered with each color film. The clear film was colored with red, green, yellow, and blue permanent markers, then cut in half and taped shut to the sides of the cup. A hole was cut in the top so that the plant could be watered 8 ml every day. This experiment lasted for one week. When the film was taken off, the results were that the control group had the greatest height difference, and that the blue group came in third. This is different than the hypothesis since the outcomes were that the control group had the greatest difference instead of the blue film. How this might have happened was because the blue group got only blue light, when both red and blue light are needed to make the chlorophyll look green. The control got both colors.

The Effect of Different Types of Electromagnetic Radiation on the Time It Takes for the Growth of *E. coli* Bacteria to Begin

Apurv Shah, George H. Moody Middle School

Radiation is one of the main forms of energy, it can be found everywhere and it is essential for life on Earth. Radiation has many risks and there have also been many discoveries involving such. There are 3 main types of radiation – electromagnetic, cosmic, and nuclear. The bodies of water and the air above it are filled with tiny one-celled organisms called bacteria; scientists conclude that they are the most numerous living things on our planet. *Escherichia coli*, commonly referred to as *E. coli*, are a large a diverse group of bacteria, although most strains of this bacteria are harmless, some can cause severe illness. The purpose of this experiment was to determine if different types of electromagnetic radiation affects the time that *E. coli* bacteria begins to grow. When exposed to radiation, bacteria's growth is suppressed and altered, so testing the time difference between ultraviolet and infrared radiation is important. When exposed to infrared radiation, the growth of the *E. coli* took longer to grow when exposed to ultraviolet radiation. The experiment was conducted in a VCU lab. Both levels of IV were

experimented in a Petri dish with agar disinfected by scalpel. An experiment suggested that the means of the 2 levels of IV and the control to have a significant difference. Since the group of *E. coli* bacterium receiving the ultraviolet light radiation began its growth first (2.1 hours), the hypothesis in this experiment was supported. Infrared radiation took the longest time to grow (6.3 hours) and the control, visible light radiation, started second with an average of about 4.2 hours to begin its growth.

The Effect of Different Water Types on Algae Growth

Brandon Smith, Tuckahoe Middle School

Could life exist on Mars in a nearly anaerobic system? The experimenter was wondering if algae can grow on Mars, so he set up an experiment to test his question. The experimenter also realized that this could also prove how life began to form on Earth 4 million years ago. The objective of the experiment was to determine which type of water, after being boiled for 5 minutes, would grow algae the fastest. The experimenter's approach was to take 800 milliliters of the different water types (ocean, river, pond, and tap (STD)) and boil them individually to kill all bacteria and life in the water samples. Then disperse 250 milliliters of each water sample into three different clear plastic containers; quickly seal the containers with a lid to simulate a nearly anaerobic environment. Samples were stored in a warm sunlit place and visually checked every 10 days until the experiment finished on day 40. What was learned from the experiment: of all of the water samples, the pond water showed the greatest change from nearly clear to a murky light green. The greater rate of change was believed to be from the higher amount of solids, both plant and mineral, in the pond samples (micro-nutrients). One of the pond samples had grown a clear, light red, fuzzy mass about the diameter of a dime at test day 30. Although at test day 40, the red fuzzy masses had dissipated and had been replaced by light green solids. The pond samples had visible algae in the bottom of all samples.

The Effect of Fruit on Time to Grow Mold

Joseph Strait, Tuckahoe Middle School

This experiment determined which fruit grew mold the fastest. The three fruits were apples (*Malus domestica*), pears (*Pyrus communis*), and apricots (*Prunus armeniaca*). The purpose of this experiment was to discover the fruit that grew mold the quickest. The experiment was conducted for ten days. After the experiment was conducted, the results showed that the pear grew mold the fastest in two out of the three trials. In the third trial, however, an apricot grew mold the fastest. These results surprised the experimenter because of the pear's relationship with the apple. This experiment's results were unexpected and will help to inform consumers and stores which fruit grew mold.

The Effect of Different Types of Florae on Change in Height During Simulated Acid Rainfall

Ananya Suram, George H. Moody Middle School

Acid rain is precipitation which contains relatively high concentrations of acidic chemicals that have been released into the atmosphere and combined with water vapor; it is mainly a mixture of sulfuric and nitric acids. The purpose of this experiment was to determine the effect of different types of florae on the change in height during simulated acid rainfall. Based on the experiments that stated sensitive plants to pollutants can present changes in their morphology, it is believed that if *Nemesia karasbergensis*, *Nemesia violiflora*, *Calibrachoa parviflora*, and *Calibrachoa humilis* are used, then the *Calibrachoa humilis* will have the most average height (in centimeters) at the end of simulated acid rainfall showers. The florae were aligned in a grid pattern in which plants of the same trial were placed within the same row horizontally and plants of the same species were placed within the same column vertically. The simulated acid rain mixture was given to each plant in the *Nemesia violiflora* group at exactly 5:00 PM, and the height of each sample was recorded in centimeters at precisely 10:00 PM on the same day. The previous steps were repeated over a period of seven days for each group of plants. The plants with the genus *Calibrachoa* exhibited a greater mean height (14.7 centimeters) than plants with the genus *Nemesia* (12.4 centimeters) throughout experimentation; the mean difference was 2.3 centimeters, though generally, the *Calibrachoa* plants were 1.5 centimeters taller than the *Nemesia* plants. At the end of experimentation, the plants (from tallest to shortest) were *Calibrachoa humilis*, *Calibrachoa parviflora*, *Nemesia violiflora*, and *Nemesia karasbergensis*. Since the mean height of the *Calibrachoa humilis* flowers (14.6

centimeters) was significantly more than the other flowers exposed to simulated acid rain at the end of testing, the hypothesis was supported.

Physical Science A

First Place

The Effect of the Inner Grid Shape and Size on Plasma Concentration

Liam David, Swanson Middle School

Nuclear fusion is the process of combining atoms to form heavier elements and release energy. Every star in the universe is a giant nuclear fusion reactor, fusing hydrogen into helium and heavier elements such as iron. One way to achieve fusion is to use inertial electrostatic confinement (IEC). IEC reactors use high voltages and a central accelerating geodesic grid to create plasma and collide hydrogen nuclei. This method of fusion is extremely inefficient, partially because of the central accelerating grid. This grid blocks a fraction of the nuclei accelerating towards the center of the grid, making it impossible or nearly impossible to reach breakeven or net energy gain from fusion. This experiment evaluated which grid shape and size produced the most concentrated plasma. It was hypothesized that the small spring grid would allow the nuclei to accelerate for a greater amount of time before reaching the grid, therefore producing the most concentrated plasma. The results were supported by the hypothesis. The small spring produced the most concentrated plasma in the center of the spring, with little plasma on the outside of the grid wires. Larger grids produced a less concentrated plasma. These results can be used to determine the best grid size and shape to use when working with an IEC nuclear fusion reactor to produce a concentrated plasma.

Second Place

Identifying Chemical Contaminants through the Use of a Spectrophotometer

Bryce Edwards, Gildersleeve Middle School

The purpose of this experiment was to build a homemade spectrophotometer that could detect the transmittances of common household chemicals in water. A database was built from these transmittances and used to identify contaminants in samples from three natural water sources. The transmittances of the contaminated water samples from Smith's Creek in Shenandoah Valley, the Deep Creek Watershed in Newport News, and gutter water from a residential street in Newport News were compared to the database to identify possible contaminants. The spectrophotometer consisted of a single light source shining through a liquid sample and into diffraction grating. This spectrophotometer was calibrated through the comparison of its values to the known spectrums of red and blue food dyes. The spectrums of Osmocote, Spectracide, Bayer Pest Killer, Malathion, Roundup glyphosate, ammonia, gasoline, and mineral spirits were used to form a database. Chemical contaminants in the three contaminated water samples were identified through the use of the wavelengths of maximum and minimum transmittances of the samples in the database. None of the contaminated water samples appeared to contain the contaminants Spectracide or Osmocote. Smith's Creek appeared to contain bleach. The Deep Creek Watershed sample appeared to contain insecticides and pesticides, while gutter water did not appear to contain any tested chemical contaminants. It was concluded that by using a database built from the transmittances of these chemical samples, it was possible to identify chemical contaminants in water. Each of the contaminated water samples came from the Chesapeake Bay watershed, so this method would allow low-cost monitoring of water quality by average citizens.

Third Place

The Effect of Temperature on the Tensile Strength and Electrical Resistance of a Metal Conductor

Alexander Daglish, Sabot at Stony Point

Power lines all over the United States lose a lot of electrical energy due to electrical resistance. Electrical resistance occurs when free electrons (electrons not orbiting their nuclei), which carry electricity, collide with electrons orbiting their nuclei. This creates friction between the two electrons, thereby producing heat from the electrical energy, and losing some of the electrical energy stored in the electrons. As matter heats up, its atoms vibrate more, and the orbiting electrons collide with the free electrons more often. Therefore it was predicted that as the temperature increases, the electrical resistance would increase as well. Since atoms vibrate more as the temperature increases, the electric bonds weaken, making it easier for the atoms to be pulled apart. It was predicted that as the temperature increases, the tensile strength of the conductor would decrease. An ideal conductor for power lines would have a low electrical resistance so less energy would be wasted. However, it has to be strong enough that it doesn't stretch or break. This experiment was designed to find the most efficient type of conductor for power lines. Four different conductors were tested for their electrical resistance and tensile strength. The tests were performed at different temperatures because power lines are used throughout the whole year, and have to work well in all temperatures. The electrical resistance data collected suggested that as the temperature increased, the electrical resistance in all four conductors increased, supporting the hypothesis. The tensile strength data collected for each type of conductor generally suggested that as the temperature increases, the tensile strength of the conductor decreases. However, the variability of the tensile strength testing results suggests that if more data were collected, the conclusion might not hold.

Honorable Mention

The Effect of Different Brands of Moisture Wicking Fabric on the Amount of Water Wicked

Lauren Bruns, George H. Moody Middle School

Invented in 1929 by Wallace Carothers, polyester retains as little as 0.4% of moisture. Moisture management is the controlled movement of water vapor or liquid perspiration from the skin or surface of the fabric into the atmosphere. Containing polyethylene terephthalate, polyester is able to resist the movement of moisture into the textile. When combined with materials such as cotton, water absorption is limited due to the chemical bonding of the materials. The purpose for this experiment was to determine whether or not different brands of moisture wicking fabric effected the amount of water wicked from the material. Fifteen 20x5 centimeter strips of Sphere Dry material (Nike), fifteen 20x5 centimeter strips of 100% polyester (Adidas climalite), fifteen 20x5 centimeter strips of Heat Gear material (Under Armour), and fifteen 20x5 centimeter strips of 100% cotton were left to soak in water for three hours. After three hours had passed, the fabric strips were removed from the water and the remaining amount (milliliters) was subtracted from the starting amount. The results corresponded with the hypothesis that if Nike Sphere Dry material, 100% polyester (Adidas climalite), Heat Gear material (Under Armour), and 100% cotton were left to soak in water for three hours, then Nike Sphere Dry would wick the most water from the container. Wicking an average of 12.80 ml, Nike was most successful, while Under Armour was the least, wicking only 7.140 ml. Compared to the other brands, Nike contained the least amount of polyester but the highest amount of another fabric, representing that it was necessary to have another material other than polyester. This data would be more accurate if a machine was used to calculate the volume of water vapor in the air.

Honorable Mention

The Effect of Different Chlorine Levels on Swim Times

Christopher Dalla Valle, George H. Moody Middle School

One-hundredth of a second; in the blink of an eye, history can be made. In 2008 Michael Phelps won the men's 100 meter butterfly by one-hundredth of a second. If he had lost, he wouldn't have broken Mark Spitz's record of seven gold medals in one Olympics. Since 1896, the first year swimming was an Olympic event, swimmers have continually developed ways to increase speed. Chlorine has been used to clean pools, but varying the amount used can potentially impact a swimmer's finish time. The purpose of this experiment was to see if chlorine levels impact a swimmer's speed. Previous research shows that

saltwater was faster to swim in than chlorinated water because salt water has a greater density. The researcher hypothesized that if more chlorine is added to the water, then athletes can go faster through the water. This is supported by the fact that chlorine is denser than water. If chlorine is added, water becomes denser, and consequently, easier to swim through. In order to test the hypothesis, a trough was constructed and filled with tap water to a depth of 18 centimeters. The first level of the independent variable was tap water, with no added chlorine. The subject was timed swimming down the trough. This was repeated for the rest of the levels of the independent variable (1 ppm, 3 ppm, and 5 ppm). Overall, higher chlorine levels led to faster times. The fastest two chlorine levels were 3 ppm and 5 ppm with average times of 35.01 and 35.03 seconds, respectively. The tap water containing no chlorine had the slowest average, at 36.06 seconds. While the results are promising, small sample sizes and standard deviations indicate that further study is necessary.

Which Thermocouple Causes the Greatest Change in Voltage?

Iram Amir, Orchard House School

This experiment researched which thermocouple produced the greatest change in voltage under different temperatures. It was hypothesized that the copper-aluminum (Group A) thermocouple would produce the highest change in voltage across the temperature ranges. This is because copper and aluminum are used the most in electrical wiring. This experiment tested the six thermocouples, Group A, B, C, D, E, and F at six different temperatures (0 °C, 23 °C, 100 °C, 150 °C, 175 °C, and 200 °C). This included setting up three different baths (oil, isopropyl alcohol with ice, and water alone) to measure the voltage change under the circumstances. It was observed that Group F at 200 °C produced the highest voltage; whereas, Group A at 23 °C produced the least voltage. Even though copper-aluminum may be good conductors, they are not good thermocouples when paired together.

The Effect of Fuel on Rocket Performance

Michael Anderson, Gunston Middle School

The purpose of this experiment was to find out which propellant would propel a 1-liter rocket further. The five levels of the independent variables were vinegar, water, Alka-Seltzer, baking soda, and air. The dependent variables were the rate, time, and speed of the rocket. The experimental procedure included different materials and tools to measure the height, speed, and pressure of the rocket. After the experiment it was found that the data didn't support the hypothesis because the baking soda and vinegar rocket achieved the best flight performance out of all of the propellants. This project was helpful because data from this project could be cited in other projects if they were similar. The project could be improved by upgrading the launchpad system so no water leaks occurred therefore preventing results from changing.

The Effect of Wing Shape on Aerodynamics

Tamara Ayers, Kenmore Middle School

The topic of the project was airplanes and airfoils. Airfoils are aerodynamically engineered surfaces such as propellers and airplane wings. It was exploring aerodynamics. The purpose of the experiment was to discover the effect of wing shape on the distance a plane flies. The hypothesis was that the plane with rectangular wings would fly the farthest. There were five different wing shapes, which were each flown four times indoors and outdoors. The distance which the planes flew was recorded on a chart. The triangular winged plane had the highest average flight distance indoors. The rectangular winged plane had the highest average flight distance outdoors. The hypothesis was both accepted and rejected.

The Effect of Liquid on Retention of Temperature

Shane Bishop, Tuckahoe Middle School

Have you ever wondered why some drinks stay cold longer than others? This experiment answered this question. The purpose of this experiment was to determine which liquid retained the coolest temperature over the course of 30 minutes. The real world value of this experiment was both in thermodynamics as

well as in household use. With regard to thermodynamics, the experiment showed Newton's Law of cooling & heating, thermal conductivity, and the Soret effect all in action at once. Also, for common household use, it could help somebody decide which drink to choose if they want a cold drink. The independent variable was the liquid used and its levels included Coke, Tropicana 100% orange juice, water, and whole milk. The rate at which the temperature of the liquids rose was the dependent variable. The hypothesis of this experiment was that if the liquid water was used, then the rate at which its temperature rose over time would be less in comparison to the other levels. To complete this experiment, the experimenter cooled each test item down to 3.3 degrees Celsius, placed a thermometer in each, and put them all in the same environment. This environment had an ambient temperature of 22.2 degrees Celsius. The experimenter then recorded the temperature of each test item every five minutes, for 30 minutes. There was one initial trial conducted followed by four repeated trials. The results of this experiment demonstrated that milk retained a cool temperature the longest followed by water, orange juice, and lastly Coke.

The Effect of Air Resistance on the Motion of Objects

Thomas Blue, Sabot at Stony Point

Millions of people use cars every day to get from place to place. When a car has a poor aerodynamic design, it means that it has to use more fuel to move itself around. The force resisting it is aerodynamic drag and various other forces such as skin friction. Aerodynamic drag is caused by the air particles becoming much more compressed when they come in contact with the object. The faster an object moves through the air the more particles build up. Therefore, the faster an object moves through the air the more air resistance that object will encounter. The purpose of this investigation was to see whether a shape with sharp edges would go further than a shape that had curved edges when flung through the air with a consistent force. The hypothesis was that the sphere would fly further than the cube, because the air particles would be able to move around the curved edges more easily than the straight edges. For the experiment a 110 gram sphere and a 110 gram cube were constructed out of modeling clay. The cube and sphere were launched by a spring-powered machine for consistency. The results were not as expected. The cube traveled 754.4 centimeters whereas the sphere traveled 676 centimeters. This was most likely do to the fact that that the cubes edges were still rounded despite many attempts to make them sharp, and the cube spun itself around in mid-air.

The Effect of Lunchbox Material on Keeping Ice Frozen

Carter Bristow, Tuckahoe Middle School

The problem question attempted to answer was, "Which lunchbox material will keep ice from melting for a period of five hours?" To complete this experiment, five ice cubes, each made of 100 ml of water were frozen for eight and a half hours. After the eight and a half hours, each ice cube was placed inside a cup in each of the lunchboxes used for five hours. The independent variable was the type of lunchbox, and the levels were an L.L. Bean lunchbox, a Vera Bradley lunchbox, a stainless steel lunchbox, a paper bag, and no lunchbox (control). After the five hours, the remaining ice was taken out of the cups, and the water that had melted off the ice cubes was measured in a graduated cylinder in milliliters. After that, the amount of water that had melted off the ice cubes was subtracted from 100 to find the amount of water that stayed frozen. This process was repeated three times for a total of four trials. After all the trials were completed, the averages of the measurements were calculated. The average amount of water that stayed frozen in the L.L. Bean lunchbox was 23.9 ml. The average amount of water that stayed frozen in the Vera Bradley lunchbox was 24.1 ml. The average amount of water that stayed frozen in the stainless steel lunchbox was 16.9 ml. The average amount of water that stayed frozen in the paper bag was 26.5 ml. The average amount of water that stayed frozen in the control was 12.3 ml. Based on this data, the paper bag worked the best.

Fancy Flying

Jessica Byers, Thomas Jefferson Middle School

The purpose of this experiment was to find the effect of different wing shapes on how far an airplane flies. The four different wing shapes that were tested were the straight wing, the delta wing, the swept-forward

wing, and the swept-back wing. The wings were tested on small wooden planes constructed from balsa wood. Four different wings were attached to four separate planes that were flown off a launching pad. The distance flown was recorded in centimeters. The hypothesis was: if wing shapes were changed, then the swept-back wing would fly the farthest. The results of the experiment were the swept-forward wing flew the farthest at a mean distance of 373.6 cm while the other planes flew distances of 272 cm, 266.9 cm, and 185.2 cm. The experiment contributed to the area of physics by finding a wing shape that could fly farther.

The Effect of Liquids on Expansion of Gummy Bears

Sarah Cloud, Tuckahoe Middle School

Have you ever eaten a gummy bear and thought that it was too dense and too small? Is it because gummy bears get too dehydrated in its packaging? Without being able to change the packaging, this experiment solved that problem by having the gummy bears absorb liquids, making the gummy bear larger and less condensed. The purpose of this experiment was to see which liquid out of water, milk, and Coca-Cola would lead to the gummy bear absorbing the most of the liquid and expand the most. The hypothesis written by the experimenter said that if a gummy bear were put into three different liquids, such as water, milk, and Coca-Cola, then the gummy bear put into the water would expand the most. The experiment took place in the experimenter's house that had minimal noise and was room temperature. The experimenter first took out the supplies including plastic containers, milk, water, Coca-Cola, and red gummy bears. The timer was started as the gummy bears were put into the liquids. The three trials were run simultaneously. The experimenter's hypothesis that stated that the gummy bear put into the water would expand the most was not supported. The liquid that made the gummy bear expand the least was the milk, and the liquid that made the gummy bear expand the most was the Coca-Cola.

Effect of Cup Material on Alexander Graham Bell's String Telephone

Isaac David, Gunston Middle School

This experiment attempted to recreate Alexander Graham Bell's experience of learning how sound can be conveyed across various mediums. The goal of this cup and string experiment was to determine the optimum material (i.e. plastic, tin, or Styrofoam) for transmitting sound. The hypothesis was that a plastic cup was the optimal material for transference of sound through a string. The experiment was conducted in the basement of a house at midnight to mitigate background noise. Two iPhones were used to broadcast and receive a designated sound over a 4.5 meter string. The independent variables were the different material cups. The result showed that plastic was the most successful in transferring 82.9 decibels (dB) through the string. The Styrofoam transferred 79.4 dB while the tin transferred only 46.2 dB. The results supported the hypothesis as plastic did perform the best. This experiment is pertinent to the field of acoustical engineering and possibly musicians.

The Effect of Different Insulators on Sound Absorption

Riddhima Deshpande, George H. Moody Middle School

When a human hears a sound that is too loud, their instinctive reaction is to cover up their ears with their hands. This acts as a form of sound insulation, which blocks sound and effectively quiets it in such cases. Architectural structures such as houses and buildings usually use a form of sound insulation in objects such as doors and walls so that sound within the building will not be heard outside of the building. The purpose of this experiment was to find out how well different types of insulators would absorb sound. The insulators used in this experiment were synthetic rubber, Styrofoam, cardboard, and cotton. These insulators were chosen because they were the most readily available. Each insulator was cut to be same height and length of the others to ensure the most accurate data. This sound absorption was measured by recording the decibel levels of the sound waves after the sound waves had passed through each insulator and subtracting those decibel levels from the decibel level of the sound waves without any insulators (90.87 dB). The hypothesis of this experiment was that the synthetic rubber would absorb the most sound. This hypothesis was proven correct, as the synthetic rubber had an average dB loss of 15.17 dB, which was the highest average dB loss between all of the insulators. Styrofoam had an average dB loss of 11.99 dB, cardboard had an average dB loss of 10.87 dB, and cotton had an average dB loss of

5.75 dB. These results conclude that the insulators that had more porosity and elasticity (rubber being the best example) seem to absorb more sound than the other insulators. Rubber absorbed the most sound because the structure and material of the rubber itself seem to be created in such a way that more sound waves seemed to be “trapped” within the material.

The Effect of Cellphone Recovery Techniques on the Amount of Water Lost

Malcolm Douglass, Thomas Jefferson Middle School

Water destroys cell phones. There are many ways to recover a wet cellphone. This experiment was conducted to find the best method. The experimenter tested silica gel, rice, open air, and a closed container as the control. It was hypothesized that the rice would absorb the most water, due to its natural hygroscopic properties, thus lowering the mass of the cellphone the most. The phones gained nearly identical amounts of water by having the water forcefully shaken in. The trials were conducted by placing the phones in plastic containers with the various conditions for 18 hours. The mass of the phones was measured every hour for 4 hours, and then left overnight for 10 hours. The phones were then measured hourly for another 4 hours. The water loss was calculated (the containers were the same throughout the trials). It was found that silica gel absorbed the most water. However, the rice initially absorbed water faster, and was very close to the silica gel in terms of total water absorbed. Since time is of the essence when trying to save a phone, and since silica gel is not as accessible as rice, rice would probably be the best choice for an average consumer.

The Effect of Umbrella Brand on How Long it Takes for Water to Soak Through

Quincy Dowling, Thomas Jefferson Middle School

Getting soaked in the rain can really be a “downpour” to any person. The purpose of this project was to find the effect of umbrella brand on how long it took for water to soak through. This experiment tested the umbrella brands in two ways. In Experiment A, the umbrellas were placed upside down in a hot tub, and then were timed to see how long it took for water to soak through. In Experiment B, a cup of water and a paper towel were placed on either side of the umbrella. When it was flipped over, the amount of water that soaked through was rated on a scale of 0-5, 0 being no water and 5 being all the water had soaked through. The “Raines by Totes” brand had an average of 101 seconds in Experiment A and 0.3 out of 5 in Experiment B. The “Blunt” brand had an average of 15.5 seconds (A) and 0 out of 5 (B). The “CVS” brand had an average of 20 seconds (A) and 2.16 out of 5 (B). The “London Fog” brand had an average of 600 seconds (A) and 0 out of 5 (B). The hypothesis was that if the “Blunt” umbrella was used, then the amount of time it took for water to soak through would be shortest. Based on these results, it was concluded that the “London Fog” umbrella was best throughout both experiments. This experiment opened up a whole new branch of questions as to why some brands failed, and what lies beneath the fabric, besides the person!

Pitch Perfect: Optimum Pitch for Maximum Thrust

Cory Dudka, Thomas Jefferson Middle School

This experiment explored the effect of propeller pitch on the thrust propellers generate. What was the best pitch? Would optimizing the pitch enhance performance and efficiency, allowing planes to fly higher and longer? The goal of this experiment was to find the pitch that generated the most thrust. The hypothesis was that if the pitch of a propeller were changed, then the thrust would vary with an optimum pitch for maximum thrust. Different pitches of propellers were tested using a wind tunnel and a variable pitch propeller. The propeller was mounted on a sled that moved forward by the thrust it generated, and was linked to a digital scale to measure thrust. Different wind speeds were tested, but the available fan proved insufficient for significant results. The experiment results showed that 0° of pitch generated 0 kg of thrust; 5° of pitch generated 0.12 kg of thrust; 10° of pitch generated 0.30 kg of thrust; 15° of pitch generated 0.43 kg of thrust; 20° of pitch generated 0.31 kg of thrust; 25° of pitch generated 0.22 kg of thrust; 30° of pitch generated 0.18 kg of thrust and 35° of pitch generated 0.13 kg of thrust (mean figures). The experiment showed a quick rise in the thrust from 0 kg at 0° of pitch, to a peak thrust at 15°, and a slower decline in the thrust to the limit of the propeller’s adjustability, indicating that there was an optimum propeller pitch for maximum of thrust generated. In the jet age, propellers are not as important, but this research was still important for recreational and remote control model planes.

Testing Fabric Durability

Devin Esleck, George H. Moody Middle School

There are two main types of fabrics, natural fabrics and synthetic fabrics. When these fabrics are put into tests of durability, they each take different times to break. The four fabrics tested in this experiment were chino, cotton, denim, and nylon. Denim, which acts like a sponge, is made of 100% cotton. Cotton follows mostly the same principles, and has enough strength to be used daily. Chino is weaved with twill, which means it has threads weaved diagonally into it. Nylon, the only synthetic fabric of the four, is made out of a variety of different fabrics. The purpose of this experiment was to find the most (or least) durable fabric. In the experiment, first, the front grill was removed on a fan, and the fan was placed on a crate. Buckets were set up to hold up a piece of wood (which would later support the fabric.) The samples of fabric were cut to the desired dimensions and were then clamped onto the fan and the piece of wood. The fan was turned on and the time was measured until the fabric broke. This process was repeated twelve times. The fabric dimensions, the number of repeated trials, the fan used, the stopwatch used, the location, and conditions were all constants in this experiment. The hypothesis in the experiment was: if chino fabric, cotton fabric, denim fabric, and nylon fabric are hit by fan blades, then nylon fabric will take the longest to break. To measure the hypothesis, the dependent variable was the time taken for the fabric to break. The results showed that chino fabric took the longest average time to break. Nylon, cotton and denim's results, which took the second, third, and fourth longest, respectively, can be explained by the threading parallel to the edge of the fabric. The reason chino took the longest was because of twill threading, (which means the fibers are weaved diagonally through the fabric,) and the fan blades hit the fibers at more of an "X" shape than a cross, unlike the other fabrics. Chino is also reinforced with the fibers that run parallel to the sides (WEFT and WOOF threads) which caused it to take longer to break.

The Effect of Salt on the Cooling of Ice Water

Nicholas Ferrell, G. W. Carver Middle School

The effect of salt on ice water when cooling soda was tested, to see the equilibrium-breaking effect salt has on ice water. When ice gets put into water the ice melts, and at the same time the water freezes. These processes though, happen on molecular levels. These processes are used in chemical engineering. Theoretically, if more salt is put into the water, the rate of change is faster and the temperature would have to go down in order for the water to freeze as fast as the ice melts again using it's stored energy or chemical potential. In this experiment, the hypothesis was: The more salt that is put into the ice water means the more the soda cools. A picnic cooler filled with approximately 1 liter of water was used in each trial. The temperature was recorded; a Coke Zero® was opened and temperature of the Coke® measured as well; ice was placed into the water. The soda was placed into the water and temperature recorded in 3 minute intervals for a total of 9 minutes. This was repeated for the control (no salt), 15 grams, 30 grams and 45 grams of pickling salt for a total 10 trials. In all trials, the initial temperature of the water and Coke® decreased rapidly. This initial decline was followed in all by a relatively flat temperature trend with time, although as the amount of salt increased ultimate decreased. It was also noted that the temperature for the 45 grams group, the lowest temperature was not as low as 30 grams group, and there was a slight increase in average water and Coke® temperature after an initial decrease. The data derived did not support the hypothesis 100%. There was a minimum and maximum amount of salt that should be put in to cool the soda.

The Effect of Color on Energy Absorption

Bella Finkel, Gildersleeve Middle School

The purpose of this experiment was to explore the effect of sunlight on the temperatures of different colors of construction paper. The correlation between color and temperature is experienced all the time, but it may not be understood why some things heat differently than others. The student first gathered and prepared the materials, then set each color of construction paper out in the sunlight for 15 minutes, measuring the temperature until it stabilized. The results were then recorded and the temperatures converted into watts using the Stefan-Boltzmann equation, $P = \sigma AT^4$. Although the student had originally predicted that red would absorb the least energy, the student's hypothesis was disproved when she found

that orange, yellow, green, blue, and white construction paper all had temperatures of less than 293 degrees Kelvin, and fewer than 1.77 watts of power, the average energy outputs for red. Black produced the most energy, with an average temperature of 300 degrees Kelvin and 1.95 watts, followed by violet, (295 degrees and 1.82 watts) and red. The reason for this was probably because black absorbs the wavelengths associated with all colors, and would therefore reemit the most energy in turn. Red has the longest wavelength (that therefore contained the least energy), and because the wavelength that produces red is the only one that is reflected (why red is the color we see), red construction paper had a higher amount of energy. The student concluded that, based on the measurements of the independent variables in this experiment, the longer a color's wavelength, the more energy that color absorbs.

Physical Science B

First Place

The Effect of Different Greenhouse Roofing Materials on the Inside Air Temperature of Different Boxes

Hunter McGuire, Sabot at Stony Point

Most plants grow in specific climates and temperatures. Therefore, plants that grow in the summer are affected when the temperature drops in the winter and they will not continue to grow. To fix that, greenhouses are used all around the world to grow plants "out of season". Our school has a community garden, and the purpose of this study was to determine which translucent or transparent lid would work best to insulate a greenhouse. Four 61 cm wide, 61 cm long, and 30 cm tall boxes were made, and submerged 23 cm into the ground. The lids used were different thicknesses of Plexiglas and polyethylene. The hypothesis was that two layers of Plexiglas would keep more heat trapped inside during the night. The data showed that on a warm day, one layer of Plexiglas and one layer of polyethylene were both warmer than two layers of Plexiglas and two layers of polyethylene. The data on cold days (which are the most important) showed that two layers of Plexiglas had the best insulative value, with one layer of Plexiglas and two layers of polyethylene having almost the same results for second best insulative value. One layer of polyethylene proved to have the smallest differences between the outside and inside air temperature. Plexiglas appeared to be the best insulator, with two layers of Plexiglas being 0.1 degrees Celsius warmer than one layer of Plexiglas. Two layers of Plexiglas were 0.5 degrees Celsius warmer than a double layer of polyethylene, and 0.8 degrees Celsius warmer than one layer of polyethylene. This is most likely because polyethylene does not let as much light through, especially with two layers.

Second Place

The Effect of Different Voltages on the Viscosity on an Electrorheological Fluid

Max Judish and Justin Lasker, Williamsburg Middle School

The purpose of this experiment was to test the effect of applied voltage on the viscosity of an electrorheological fluid (ERF). The viscosity of ERFs increases when an electrical field is applied. ERFs have the potential to be used for practical purposes. ERF based knee replacements are already on the market, and ERF based physical "surge protectors" could save electric machines from damage. Additionally, ERF based bullet proof vests could be in use in the near future. Previous studies show that the viscosity of ERFs increases when around 5000 volts are applied. In this study, ERFs were tested at a maximum of 90 volts. The team's hypothesis was that if the amount of voltage applied on an electrorheological fluid increased, the viscosity of the fluid will increase proportionately. The team used a mixture of cornstarch and silicone oil to act as an ERF. The viscosity of the fluid was tested in three different circumstances in which no volts, 54 volts, and 90 volts were applied. When no volts were applied, the fluid's viscosity was 18.46 Pascal seconds (Pa-s), with 54 volts, 45.18 Pa-s, and with 90 volts, 79.19 Pa-s. Our results supported our hypothesis, and the viscosity of the fluid in each circumstance was nearly directly proportionate to the amount of applied voltage. This study was a proof of concept study. We demonstrated that ERFs react to low voltages. However, further research is necessary to better determine the exact viscosity of ERFs when exposed to different voltages.

Third Place

The Effect of Relative Humidity Change on a Guitar's Ability to Stay in Tune

Michael Moran, George H. Moody Middle School

String musicians often notice that environmental factors can cause the frequency of their instrument's strings to change, or become "out of tune." While changes in relative humidity (RH) do not directly affect the instrument's metal strings, these changes can cause the wooden body to shrink or swell. This affects the tuning of the metal strings and can cause permanent damage to the instrument. The purpose of this experiment was to test the effect of RH change on a guitar's ability to stay in tune. The following results were expected: an increase in RH would cause the wood to expand, making the strings sound sharp, while a decrease in RH would cause the wood to contract, making the strings sound flat. A properly tuned guitar was placed in a RH-controlled test environment for two hours, with groups having (1) no change in RH (control); (2) extreme increase in RH; (3) extreme decrease in RH. By comparing the control data with data for RH increase and RH decrease, it was possible to determine to what extent RH changes affected tuning. The experiment data supported the hypothesis, because RH changes caused the guitar to go out of tune. Specifically, exposure to increased RH caused the guitar's strings to vibrate at a mean 1.95 Hz higher frequency, and exposure to decreased RH caused the guitar's strings to vibrate at a mean 0.67 Hz lower frequency. Based on the frequency changes measured in this research, there appears to be a direct correlation between RH change and a guitar's ability to stay in tune.

Honorable Mention

The Effect of Different Amounts and Placements of Weight on the Length of the Flight of a Paper Airplane

Maura Graff, George H. Moody Middle School

The four forces of flight that aerodynamics is based upon are interconnected. If the weight of an aircraft was increased, making the wings larger on an aircraft would produce more lift, but would also increase the amount of drag, which would increase the amount of thrust needed to overcome the drag. Since the flight of an airplane depends on the force of lift against drag, and thrust against weight, adding weight in different places on the plane affects how it will fly. Therefore, where the weight and the amount of weight, or the Popsicle sticks, is placed on a paper airplane affects and determines how far the plane flies compared to each different variation of weight placement. The hypothesis stated that if different amounts and different placements of weight were used, then the group receiving no weight will fly the farthest on average. The purpose of this experiment was to determine the effect of different amounts and placements of weight on the length of the flight of a plane. Nine identical paper airplanes were made, each with different amounts and placements of the weight, Popsicle sticks. They were each thrown 20 times, and the flight distance was recorded for each trial. The paper airplanes receiving heavy weight placed in the middle flew the farthest distance on average. A major finding was that the planes with the weight placed on the upper half of the plane or near the front, such as light and heavy weight in the front and the middle, had higher average flight distances. Also, no weight had a high average flight distance. The groups with weight placed on the wings and on the tail did not have as high averages. It was concluded that the groups with the weight more near the center, or no weight, did not unbalance the plane but increased speed and stability.

Honorable Mention

The Effect of Varying Tension of Tennis Strings on the Deflection Distance of a Tennis Ball

Lee Martin, Sabot at Stony Point

Since so many people play tennis with different racquet string tension levels, this experiment was designed to test the deflection distance of a tennis ball with varying string tension. With an understanding of string tension levels in tennis, one can understand how tension works in sports arena floors, baseball bats and basketball backboards. The question asked in this experiment is, does higher string tension on a tennis racquet cause the tennis ball to have a higher deflection distance (distance tennis ball travels to the first bounce), or does it cause the tennis ball to have a lower deflection distance? The hypothesis was that the more tightly the strings are strung, the further the ball will be deflected to its first bounce. In the

experiment there were three sets of data collected. Three tennis racquets were strung at different tension levels (178 Newtons, 222 Newtons and 267 Newtons). At the lower string tension levels, the deflection distance decreased as the racquet gained greater string tension. However, the deflection distance at the greatest string tension level had the highest distance to the first bounce.

Honorable Mention

The Effect of Spin on a Rocket's Maximum Speed

Andrew Mottley, Tuckahoe Middle School

The objective of the experiment was to study the effect of rocket spin on maximum rocket speed. To perform this study, the experimenter designed an experiment using four different rockets with different angled fins. Angling the fins causes spin. The experimenter used a digital altimeter in the rocket to measure maximum speed. The hypothesis was that a spinning rocket will not travel with as high of a speed as a non-spinning rocket. The results of the experiment showed that the non-spinning rocket had a mean maximum speed of 344.399616 kilometers per hour (km/h) and the spinning rockets had a mean maximum speed of 636.584963 km/h, for a difference of about 292 km/h. Based on the large difference in the results, the experimenter believes that the altimeter may not have properly read maximum speeds in two of the spinning rockets (the ones with the 4 degree and 6 degree angled fins). If the results from those two rockets are discarded, the results still show that a spinning rocket reaches a higher speed than a non-spinning rocket, but the difference is only 53 km/h. The conclusion is that a spinning rocket will travel at a higher maximum speed when launched, but it is not certain how much faster it will travel.

The Attraction Reaction

Lauren Ford, Mary Ellen Henderson Middle School

Every magnet has a field of attraction. When a magnetic object is within that field it is drawn toward the magnet, increasing speed until they collide. The energy in the object is transferred to the magnet and then released through sounds and vibrations, but it is possible to utilize the energy to launch an object. The goal was to increase the range of a Gauss (magnet) rifle without using any external equipment. The distance was increased between each magnet stage and was measured in centimeters. It was found that the farther apart each magnet stage is, the shorter distance the launched ball travels, as well as lower velocity. This is most likely because of the increased friction and subsequent loss of speed between every magnet when the ball is momentarily outside of the field of attraction. The general conclusion from the data is that the longer the Gauss rifle is, the shorter the distance traveled by the launched ball.

The Effect of a Solution's Sodium Chloride Concentration on Transit Time through a Magnetic Field

Catherine Green, George H. Moody Middle School

One type of magnetism is diamagnetism. Diamagnetic materials are repelled from an externally applied magnetic field, and create their own magnetic field to oppose that field. Water is diamagnetic, so as it flows through a magnetic field the magnetic force slows it down. Simultaneously the water exerts a counterforce that weakens the force against it. A sodium chloride solution has weaker diamagnetic properties than pure water, because some volume is taken up by sodium and chloride leaving fewer water molecules present. This experiment was done to determine the effect of sodium chloride concentration on the time required for a solution to flow through a magnetic field. The times it took for varying concentrations of sodium chloride solutions and distilled water to flow through a magnetic field were recorded. Results indicated that the time was longest for the highest concentration with a mean time of 42.0 seconds, and time was shortest for the lowest concentration with a mean time of 40.48 seconds. The data supported the research hypothesis that if the concentration of a sodium chloride

solution flowing through a magnetic field is greater, then the time it takes for the solution to flow through that field will be longer. Based on these findings, there is an effect of sodium chloride concentration of a solution on the time it takes for the solution to flow through a magnetic field. The data indicate that the greater the concentration of the sodium chloride, the longer it takes to flow through a magnetic field.

The Effect of the Angle of Incidence of Light on the Power Output of a Photovoltaic Cell

Thomas Green, George H. Moody Middle School

Photovoltaic cells convert light energy directly into electricity. The angle at which light strikes the photovoltaic cell influences the amount of energy absorbed. Angle of incidence is the angle a ray of light makes hitting the surface of the cell compared to a line perpendicular to the surface. Light directly over a photovoltaic cell has an angle of incidence of 0 degrees; one parallel to the cell has an angle of incidence of 90 degrees. The purpose of this experiment was to examine the effect of the angle of incidence upon the power output of a photovoltaic cell. The angle of incidence of a light above a photovoltaic cell was varied from 0 to 90 degrees at 15 degree intervals and voltage and amp output was measured. The power output was greatest when the angle of incidence was 0 degrees with a mean output of 0.0135 W and smallest when the angle of incidence was 90 degrees with a mean output of 0.0008 W. Results supported the research hypothesis that if the angle of incidence of light shining on a photovoltaic cell is smaller, the power output of the photovoltaic cell will be greater. Based on the power output determined in this research, there is a direct correlation between the angle of incidence of light shining on a photovoltaic cell and the power output of the cell. The data indicate that the angle of incidence influences the power output. The lower the angle of incidence, the higher the power output of the cell.

The Mpemba Effect

Abhijun Gupta, George H. Moody Middle School

A Tanzanian student put boiling milk into the freezer to reserve the freezer to make ice cream before other kids who waited for milk to get colder. To his surprise his ice cream froze faster than all other kid's ice cream. He later researched into this topic and found that hot water can freeze faster than cold water. His findings were later called the Mpemba Effect after his name. The purpose of this project was to see how hot water can freeze faster than cold water. The hypothesis that was stated said if the water is hot then it can freeze faster than colder water. In the experiment three identical glasses were filled with identical amount of water at different temperatures, 343.15 Kelvins (70 °C), 294.15 Kelvins (21 °C), and at 283.15 Kelvins (10 °C). All three glasses were placed in a freezer and first observation was made after two hour and subsequent observation were made every half an hour. The results proved that the glass with the warmest temperature froze first with an average time of 4 hours and 30 minutes. The data supported the hypothesis; if the water is hot then it can freeze faster than colder water. Based on the results it will be smarter to use hot milk for freezing ice cream instead of waiting for it to cool down. Lots of ice cream companies actually use the Mpemba Effect to save money on energy and time.

Influence of Wind Resistance on Speed

Lorien Hinsz, Mary Ellen Henderson Middle School

This experiment tested how changes in surface area and angle of a piece of cardboard on the front of a bike would affect the time it takes to accelerate down a hill. A frame was planned and made to support cardboard on the front of a bike. The angle of the cardboard was adjusted between angles of 90°, 45°, and 15° for each of three cut cardboard sizes, 180 cm², 145 cm², and a 100 cm². Then the bicycle coasted 90 meters down a hill for three trials per size and angle and the time was recorded. Three hypotheses were tested. If the angle of the cardboard on the bike is closer to 90°, cardboard area is greater, or if 17 kg of weight is carried on the bike then it will take longer to go 90 meters. The results showed when the cardboard was at the 90° angle and the 180 cm by 180 cm size, the bike took 37.1 seconds to go 90 meters while the 100 cm by 100 cm size took 25.7 seconds. The 45° and 15° angles showed similar, but smaller differences. When the cardboard size was 180 cm by 180 cm and the angle was 90° the bike took 37.1 seconds, while it only took 25.5 seconds for the cardboard at 15°. The 145 cm square and the 100 cm square showed similar, but smaller differences. Without a frame or cardboard the bike took about a second longer when 17 kg was carried than without weight. All three hypotheses were supported.

The Effect of the Width of a Tire on a Bicycle with Equal Tire Drop on the Speed of the Bicycle

Jackson Jeffrey, George H. Moody Middle School

As global warming becomes a prominent issue around the world, finding environmentally friendly alternative forms of transportation are important. The purpose of this experiment was to find a way to maximize the efficiency and viability of the bicycle as a form of transportation. One of easiest and least expensive variables to change on a bicycle is the width of the tire. It is hypothesized that if three different tire widths are tested to see which travels at the highest rate of speed then the 21 C (narrowest) will go the fastest. In order to determine the fastest tire width a circuit was created to test the 21 C, 23 C, and 25 C tires. Ten trials were carried out on each tire width at a constant power output with the time recorded for each test. The 21 C had the greatest speed followed by the 23 C, and finally the 25 C tire. These findings are important because they were gathered in real-world conditions as opposed to previous tests completed in a lab.

The Effect of the Length of the Effort Arm on the Amount of Effort It Takes to Lift an Object

Dylan Kalten, Thomas Jefferson Middle School

The purpose of the experiment was to make lifting an object require less effort. To some people, it had been backbreaking work to lift an object up. Sometimes they just did not have the force required. That was why simple machines were made; to make life easier. This experiment was focused on a simple machine, the lever. This explains how a heavy object on one side could be lifted with just someone's hand. The goal of this experiment was to find the effect of the length of the effort arm on the amount of force it took to lift an object. The procedure of this experiment was simple and brief. First, the different lengths of the effort arm were adjusted. Then, the two sides were equaled out. After that the effort arm was adjusted to the new length and then the last part of the previous step was repeated. Then the previous step was repeated. Then all of those steps were repeated twice, but a different amount of weights were used for the load arm. The hypothesis was, "If weights were put on the load arm of a seesaw and there were different lengths for the effort arm then when the effort arm is longer it will take least amount of effort". The experimental results supported the hypothesis by showing that the second level of the independent variable was 20 times more efficient than the control group. It also showed that by making the effort arm shorter it actually took a person more energy than when both sides were already equal.

The Effect of Negative Electrode Foil Type on the Thrust of an Asymmetric Capacitor

Jaya Kambhampaty, Williamsburg Middle School

This project explores and tests which of four metals best increases thrust at an asymmetric capacitor's negative electrode. It was hypothesized that using aluminum as the negative electrode would result in the greatest thrust. To test this, four capacitors were constructed with their four negative electrodes being constructed of different metals, and the ability of the capacitors to levitate was tested. The four metals were aluminum, brass, copper, and stainless steel. Due to the fact that the capacitors were unable to levitate, it was not possible to make conclusions based in direct measurements. However, upon an analysis of the metals used in other lifters, aluminum foil was used the most, leading to a conclusion that it has favorable properties for its use in the capacitor. Further study with direct measurement will allow deduction of what these properties are and if aluminum is, in fact, the metal which produces the most thrust.

The Effect of Angles on Speed of Water Flow

Caleb Long, George H. Moody Middle School

There is a need to create a very efficient, eco-friendly power source with the dwindling supply of natural resources and the effects of pollution on climate change. With an efficient hydraulic power source, countries wouldn't have to exploit their rivers and would have more power to go around. The main focus or purpose of the experiment was to test the influence of kinetic energy on speed of water flow. A pipe

was set up at different angles so the flow of water landed on a water wheel that was connected to a weight on a string. The amount of time it took for the weight to be lifted by the water was used to determine the energy the water flow created. This process was repeated ten times for all levels of the independent variable. The angle of the pipe was adjusted at 15° intervals using a protractor. A test was done at 0°, 15°, 30°, 45°, 60°, 75°, and 90°. Rather than testing power output, the speed of the water was tested; the faster the weight was lifted resulted in high energy output. The tested angles resulted in 45° angle lifting the weight in 5.687 seconds, while the 15° angle lifted the weight in 4.703 seconds with a difference of only 0.984 seconds. The experiment had insignificant differences between the data results. The hypothesis, that if the angle from which the water would come was 45° the water wheel would spin the fastest and would take the least amount of time needed to lift the weight, was not supported. Since the water flow started at different heights with different potential energy, the water's kinetic energy aided by the gravitational pull was not utilized. In future experiments, improving the positioning of the pipe to simulate a constant height and adding a nozzle to concentrate the water would be considered. Efficient water power remains an important area to investigate in order to best use this natural source to help power the world.

Surface Area Ratio that Best Enhances Solar Energy using Simple Mirrors

Lewis McAllister, Gildersleeve Middle School

The purpose of this project was to see when solar panels (large and small) had the least amount of efficiency by measuring the speed of a direct current fan. The problem in the project was what does the time of day have on the speed the fan can go run on solar panels. A large and small solar panel was attached to different 5 watt fans. At half hour increments on 4 separate days, the fans RPM was measured and recorded. While using the LSP, peak RPMs occurred between 12:00 and 12:30 and the lowest RPMs occurred prior to 10:00 and after 2:30. While using the SSP, peak RPMs occurred between 12:00 and 12:30 and the lowest RPMs occurred prior to 10:00 and after 2:30. The averages of the largest panel were 9:30 (13,000 RPM), 10:00 (16,000 RPM), 10:30 (18,761 RPM), 11:00 (18,822 RPM), 11:30 (19,192 RPM), 12:00 (19,247 RPM), 12:30 (19,514 RPM), 1:00 (18,952 RPM), 1:30 (18,910 RPM), 2:00 (18,907 RPM), 2:30 (18,184 RPM), 3:00 (5,707 RPM.) The averages of the smaller fan was 9:30 (369 RPM), 10:00 (2,937 RPM), 10:30 (3,049 RPM), 11:00 (3,512 RPM), 11:30 (3,547 RPM), 12:00 (3,637 RPM), 12:30 (3,791 RPM), 1:00 (3,498 RPM), 1:30 (3,531 RPM), 2:00 (3,515 RPM), 2:30 (3,157 RPM), 3:00 (1,237 RPM.) The scientist results conclude that at 12:30 is the peak solar production time because it had the highest average speed. This experiment could be used by people thinking about using solar energy for their homes. If people want to use solar energy they will have to have a battery for in the energy use in mornings and afternoons.

The Effect of Wood Type on the Amount of Thermal Energy Transferred when Burned

Colette McCord-Snook, Swanson Middle School

The purpose of this experiment was to identify what type of wood created the largest temperature change and transferred the most energy. It was hypothesized that oak would have the largest effect on temperature change because of its high density and BTU rating. To test this hypothesis, small fires were created and used to heat a beaker of water with them. The water's final and initial temperatures were recorded to find the effect of the fire and figure out how much energy it gave off. In the end, it turned out that the hypothesis was correct when stating that oak would create the greatest temperature change, as the oak on average created a change 1.58 degrees more than pine and 1.93 degrees more than poplar. The results are in support of the hypothesis.

The Effect of Lens Color on How Well Eyes are Protected from Ultraviolet Rays

Libby McFadden, George H. Moody Middle School

The purpose of the experiment was to see which lens color will protect the human eye the best. The experimenter's hypothesis was if grey, black, brown, and no lens colors are tested, then the brown glasses will protect eyes from UVR the best. The different lens colors were to be placed on the sun sensitive paper and rinsed with cool water afterwards. First the paper and the lens colors were left outside for 5 minutes 30 seconds. Glass was placed under and on top of the lens color and paper so that no wind or moisture changed the results of the experiment. Once brought inside, the paper was rinsed in water

for 2 minutes. After completely dried, the observations took place. The darker blue the shape, the more the UV light got through the lens color. The whiter the shape, less UV got through the lens color. This procedure was repeated 10 times for each colored lens color. Once this was finished, the sheets were copied in grey scale. This way, the colors could be compared with a value grey scale labeled 1-100 in protection. In the experiment, 3 sets of lens colors were used plus one control (no lens color). The lens colors included brown, black, and grey. The whiter the shape of the imprint left on the sun paper, the less transmission of light got through the lens color and the better the lens color protects the human eye. It was found that "no lens color" provided no amount of protection from the sun. The black lens color provided the most protection from the sun. The brown lens color provided less than 50 on the grey scale. The grey lens color provided almost minimal sunlight protection (over 70 on grey scale). In conclusion, the black proved to be the lens color that blocked the most light. This was because the black scored the lowest on the grey scale. The hypothesis was proven wrong.

The Effect of Battery Brand on Flashlight Duration

Christian Mize, Tuckahoe Middle School

The hypothesis for this experiment was if 4 batteries are tested, then Duracell will make the flashlight run longer than the other batteries. Hurricanes, earthquakes, tornadoes, and many other natural disasters strike on a daily basis. These disasters can cause numerous power outages, houses to fall apart, or even death. People who face these things should have the longest running flashlights, but how will they be able to know which is the best? The experiment tests which level of the independent variable would make the flashlight run for the longest period of time. There were 3 trials run, and 4 batteries were tested in each trial. In each trial, there was a flashlight with Duracell batteries, Energizer batteries, Ace batteries, and Rayovac batteries (control). The Rayovac batteries were the control because they were the batteries that came with the flashlights. During the experiment, the measurements were calculated and recorded. After averaging all of the flashlight lengths, the hypothesis was not supported. The flashlight with Ace batteries lasted an average length of 26.1 hours. The flashlight with Energizer batteries lasted an average length of 18.17 hours. The flashlight with Rayovac batteries lasted an average length of 12.4 hours. The flashlight with Duracell batteries lasted an average length of 19.19 hours. Overall, the flashlight with Ace batteries outlasted the flashlights with the other batteries.

Catapults

Lydia Morse, Kenmore Middle School

This experiment was about the effects of different amounts of force, different fulcrums, and different weighing loads on the distance flown by a load launched from a catapult. The purpose was to find out how far different combinations of a load, force, and fulcrum would fly. It was hypothesized that the load that weighed the least, launched using the force that weighed the most, on the higher fulcrum would fly the greatest distance. To test this, a catapult was launched using each combination of three different loads, two different forces, and two different fulcrums. The hypothesis was partially rejected. The load that weighed the least, launched with the force that weighed the most, on the lower fulcrum flew the farthest.

The Effect of Water on Height of Ball Bounce

Emily Mortimer, Tuckahoe Middle School

This experiment tested how high a tennis ball bounced after being exposed to different amounts of water. The experiment was very successful. The results supported what was said in the hypothesis: if tennis balls are rolled in amounts of water (0 ml, 2.5 ml, 5 ml, and 7.5 ml), then the ball with no water on it will bounce the highest. The average height of the bounce of tennis balls with no water was the highest in 3/5 trials. The heights of the bounces of the control balls and the balls with 2.5 ml of water on them were very similar. The height of the balls with 7.5 ml of water made the most difference, as they had the most water added. Most of the balls that had 2.5 ml or less of water seemed playable. Balls that have been exposed to a small amount of water are probably still playable.

Physical Science C

First Place

The Effect of Commonly-occurring Sounds on the Human Cochlear Cilia

Radu Teodorescu, Williamsburg Middle School

The goal of this project was to assess whether the human cochlear cilia could be affected by common daily-occurring sounds and noises. Research showed that the human ear's threshold for noise is 85 decibels that can be heard for maximum of eight hours, which is the "safe time" one can be exposed to that particular sound intensity without the cilia being damaged. The project has not taken into account the effect of the sound frequency on the safety threshold. This study involved measurements of sound intensities taken at repeated moments in time as well as measurements of sound intensities taken at different distances from the same source. The following sources have been investigated: home phone, loud person, metro car, building generator, cement truck, construction site, school bus, and a middle school cafeteria. The results showed a maximum intensity level of less than 85 decibels, with the highest values belonging to sound sources that usually emit for time periods of much less than eight hours. Thus, it could be concluded that human cochlear cilia would not be damaged by the sounds emitted by the sources considered in this project.

Second Place

The Effect of Surrounding Medium of a Fluid on its Rate of Heat Loss

Jacob Yirga, George H. Moody Middle School

The effect of the surrounding medium of a fluid on its rate of heat loss was conducted by the experimenter. The sciences behind the investigation include the five primary methods of heat loss and the characteristics of the fluid encompassing mediums, such as being good conductors of thermal energy and having low emissivity. The purpose of the experiment was to establish the best medium for sustaining the temperature of a fluid. The experimenter hypothesized that if a liquefied substance is placed in Styrofoam, metal, glass, and thermoflask medium, then the substance's rate of heat loss will be slowest in the thermoflask medium. To conduct the experiment, the investigator poured 90 degrees Celsius water into the four mediums; Styrofoam, metal, glass, and thermoflask, then recorded the temperatures after 30 minutes. The result temperatures were divided by 30 to calculate the degrees Celsius lost per minute. The hypothesis turned out to be correct with thermoflask losing heat the slowest at a rate of 1.01 degrees Celsius lost per minute. The glass medium had the fastest rate of heat loss at a rate of 1.26 degrees Celsius lost per minute. There was an explanation behind why the results came out the way they did. According to the Stefan-Boltzmann law, materials with low emissivity lose radiated heat slowly. Thermoflasks have a low emissivity which gives reason to why the thermoflask was more efficient at sustaining a temperature of a fluid. The glass' speedy rate of heat loss was partially because of the wide opening of the glass which increased evaporation, the most effective method of heat loss. The varied surface areas in contact with the air slight skewed the data. The experiment was intended to help identify mediums efficient at maintaining the temperature of fluids to solve issues as common as coffee cooling down too fast.

Third Place

The Effect of Soccer Ball Bladder on Distance Traveled

John Vithoulkas, Tuckahoe Middle School

How far a soccer ball is kicked is very important, especially with high competitiveness in the soccer world. Balls of different construction materials, specifically bladders, were tested to see if they would travel different distances when impacted with the same force. To test the hypothesis, if the ball with the latex bladder is kicked, then it will go the same distance as the ball with the butyl bladder; a kicking machine was made out of a four pound hammer, wood, and a steel rod. To collect data, the hammer was raised to a consistent level and was dropped, striking the ball. A measuring tape was used to measure the distance the ball traveled. The latex and butyl balls traded places after each was kicked. It was discovered that both balls traveled the same distance due to Newton's second law. The key results of the experiment showed that both balls traveled the same distance. Additionally, latex balls show smaller standard deviation, proving them to be more repeatable and consistent than a ball with a butyl bladder. This matches the published manufacturer's information which states that latex balls are more precise and reliable than their butyl bladder counterparts.

Honorable Mention

The Effect of Angle and Lens Type on Light Refracted in Lux

Catherine Qian, George H. Moody Middle School

Lenses are often used in optics (the study of light) to study various things such as refraction and magnification. Since lenses have been developed, the study of them has allowed them to be used for common items such as cameras and glasses. In this experiment, the effect of angle and lens type on light refracted in lux was tested. Lux is the System International unit of measurement for luminous intensity. There were two independent variables in this experiment, with three levels of each, making a total of nine different levels of the independent variables. The three different angles were 0°, 30°, and 60° and the different lenses were biconcave, biconvex, and no lens. Research indicated that biconcave lenses disperse light, which would decrease the luminous intensity, while biconvex lenses concentrate light. Also, based on Snell's law, the angle of refraction would cause the light to hit farther away from the lux meter. From this research, a hypothesis was formed that if a light was shone in the dark through different lenses at different angles, then the measurement of the total light refracted in lux would be the least for the light that was tested at a 60° angle through a biconcave lens. The experiment was conducted at room temperature inside a cardboard box. A hole was cut into the side of the box and the flashlight was placed inside. The sensor of the lux meter was taped to the opposite side and the box was closed. After conducting 10 trials of each level of IV, the results were recorded. As the angle increased, the lux decreased. The 0° biconvex lens had the greatest lux measurement with a mean of 1302.6. Second was no lens and the least was with a biconcave lens. However, this changes with 30° and 60° for various reasons that were discussed and supported with further research. In conclusion, the angle and type of lens has a direct effect on the luminous intensity of light.

Honorable Mention

The Effect of Acid Rain on the Corrosion Rate of Common Building Materials

Ethan Schlusell, George H. Moody Middle School

Corrosion is the reaction between the environment and a material. This reaction is becoming a common problem with the dropping pH levels of rain due to air pollution. The purpose of this experiment was to determine how common building materials react to acid rain. The hypothesis was if building materials were placed in an acidic solution, then the wood would corrode the most. For the experiment, 10 samples each of steel, copper, concrete, and wood were placed in cups to simulate acid rain. The acid rain was simulated by a combining water, vinegar, and ammonia to create a solution with a pH of about 4.0, the average pH of acid rain. Each sample was measured in grams and placed in the acid rain cups for five days. After five days, the samples were removed from the solution, measured and placed in the cups to dry and oxidize. After oxidizing, the mass of the samples was recorded again and placed back in the solution; this cycle repeated to represent a rain cycle. After 40 days, on average, the steel lost 8.33% of its mass, the concrete lost 2.20% of its mass, copper lost 5.79% of its mass, and wood lost 2.86% of its

mass. The hypothesis was not proven correct in the experiment because both the steel and copper lost more mass and showed more change than the wood. The steel lost more mass than the other materials because it is mostly iron, which oxidizes quickly with moisture, especially when the moisture is acidic. The concrete grew efflorescence, which is caused when salts evaporate and could lead to a weakened concrete state over the long-term. The copper turned blue/green and created a copper sulfide; the corrosion would eventually cause water leaks. The wood showed little effects to the acid rain solution but it absorbed the solution and doubled the mass after being in the solution. This wet-dry cycle with acid could eventually cause structural loss in the wood and cause the wood to break.

Honorable Mention

Achieving Flight: Quantum Levitation

Kelton Williams, Thomas Jefferson Middle School

The purpose of this experiment was to study the effects of mass (in grams) on the maximum height of a floating superconductor while it was under the influence of Quantum Levitation. The hypothesis was if mass was placed on the superconductor then it would decrease and hold its position. The superconductor was cooled to 77 Kelvin, or -196.15 Celsius. The superconductor was placed on a neodymium magnet, where it was locked in space. The mass ranging from 0-25 grams was placed on the superconductor and the maximum height of the superconductor was measured. As hypothesized, the superconductor decreased when mass was placed on it, but under some amounts of mass it would stay the same. As predicted, the superconductor with no mass on it had a maximum height of 17.712 millimeters. For 2 grams of mass it had a maximum height of 16.404 millimeters. The superconductor with 20 grams had a maximum height of 12.7 millimeters. In conclusion, this research was critical because it involves possibilities for the future of transportation.

The Effect of Type of Sunscreen on How Much UV Light Reaches an Object

Laine Mumford, George H. Moody Middle School

The purpose of this experiment was to determine the effect of type of sunscreen on the amount of UV light that reaches an object in milliwatts per square centimeter. The hypothesis was that if Coppertone sunscreen was used then less UV light would reach the UV light color changing bead. Three different types of sunscreen were gathered; Coppertone, Neutrogena, and Target Up and Up. For each of these brands, 10 bags were filled with 10 UV beads, and covered evenly with 3 tablespoons of sunscreen. There was also a control group which had no sunscreen applied on top. The bags were laid out in the sun for one minute each, and then measured for UV light in milliwatts per square centimeter using a UV light meter. The results did not support the hypothesis. The average UV in milliwatts per square centimeter of the Coppertone beads was 0.01, while the average UV of the beads in the Neutrogena and Target bags was 0. The measurement for the control was 2 milliwatts per square centimeter. It can be concluded that all three sunscreen brands provide efficient protection against UV light. However, Coppertone is slightly less efficient. The results would be more accurate if the experiment was done in the summer, when more UV light reaches North America. Also, the results would be more accurate if spray sunscreen was used, to spread the sunscreen more evenly on the bag.

The Effective of Diameter of Coiled Wire on Electromagnetic Strength

Megha Nair, George H. Moody Middle School

The purpose of the experiment was to find the effect of the thickness, or the diameter, of wire in a coil wound around a metal piece on the amount of iron filings that an electromagnet can attract. The hypothesis of the experiment was that if the diameter of wire in a coil wound around a metal piece is increased, then more iron filings will be attracted to the electromagnet. The experiment was conducted using copper wires of four different diameters (18 G, 20 G, 22 G and 24 G) that were wound around a 5

inch long iron nail for a total of 30 times. The free ends of the wire were connected to a D cell battery (1.5 V) to create an electromagnet. The magnetized iron nail was allowed to attract as much iron filings as possible, that was measured in grams. The result of the experiment was that the mean mass of iron filings attracted by the electromagnet was highest when an 18 G copper wire was wound around it. The mean mass of iron filings attracted by the electromagnet decreased with decreasing thickness of the conducting wire, with the 24 G wire wound nail attracting the least amount of iron filings. The conclusion of the experiment was that as the diameter of the conducting wire increased, the amount of current flowing through the wire increased. The higher the current flow, the stronger the magnetic field strength was, as measured by the mass of iron filings attracted by the electromagnet.

The Effect of Different Airplane Wing Shapes on How High Airplane Wings Will Fly

Kevin Nguyen, George H. Moody Middle School

Planes are a very important part of today's travel. They are used to go almost everywhere around the world. Airplane wings are one of the parts of the airplane that help it fly and steer to get to locations needed in a very short time. The wings help the plane fly higher into the atmosphere as well. The higher that the plane flies, the faster it will go because there is less air pressure in the air pushing it down. It will also fly higher if the wing is thicker because it takes up more space in the layer of the atmosphere. The purpose of this project was to determine which airplane wing shape would fly the highest. The plain shaped airplane wing (control), zap shaped, fowler shaped, or double slotted shaped wing. The hypothesis was that the zap shaped wing would fly the highest because there is more space between the wing and flaps connected to the wings. The wings were placed one by one while the fan was turned on until the wing was about to drop. Each was tested to see which wing would fly the highest. The results indicated that the fowler shaped wing flew the highest when the fan was turned on in front of it. This wing flew for a mean of 52.6 centimeters. The data collected did not support the research hypothesis, that if there is more surface area between the airplane wing and the flaps then it would fly the highest. Based on the airplane wing principles and laws, there is a direct correlation between the airplane wings and how they flew the highest into the air. Newton's third law of motion states the tilt of motion in the airplane wing lets it fly higher, because of the air pushing the wing up. That also led to Bernoulli's principle. That meant that the less air pressure on the top of the wing carried the wing up because there was more air pressure under the wing. Before the fowler wing can be concluded as the highest flying wing, there will need to be more experiments to test it.

The Effect of Air Pressure on Soccer Ball Bounce

Mayu Ovando, Gunston Middle School

The purpose of the investigation was to tell whether the air pressure of a soccer ball makes a noticeable difference on the bounce height. The researcher's question was how the pressure in kPa (Kilopascals) of a soccer ball affect its bounce height. The hypothesis stated by the researcher was the higher the kPa, the higher the bounce and the lower the kPa, the lower the bounce. The procedure involved making a giant ruler then videotaping the bounces from 2 meters of the soccer ball at pressures of 70 kPa, 140 kPa, 210 kPa, 280 kPa, and 350 kPa. Next all of the videos were viewed and the heights of the peak of each bounce were recorded. The manipulated variable was the air pressure in pounds per square inch, while the responding variable was the bounce height in centimeters. The findings were while the soccer ball with 70 kPa averaged a bounce height of 111.8 cm, the soccer ball with 140 kPa averaged a bounce height of 136.8 cm. With increasing pressure, the change in kPa did not make as much of a difference. With 210 kPa, the ball averaged a bounce height of 141.8, with 280: 148.6, and with 350: 152.2. The data supported the hypothesis. Although the higher kPa values produced proportionally less change, the lower kPa changes were the ones that had dramatic increases in height. These pressures were the only ones really applicable to the regulation pressure for a soccer ball which is between 60 and 110 kPa.

The Effect of Different SPF's on Sunscreen on the Ultraviolet Irradiance

Grace Powers, George H. Moody Middle School

Sunscreen is a product used to prevent skin damage from the harmful UV-A and UV-B rays. This product reflects and absorbs UV rays to protect the skin. The SPF of sunscreen determines how long one can be in the sun and still be protected. The higher the SPF of the sunscreen, the lower the UV irradiance is. UV

irradiance is a measure of the instant movement of radiant energy from all areas per square unit. The purpose of this experiment is to determine which of the lowest SPF's sold in stores will prevent the best against UV rays. The different SPF's used in experimentation were SPF 4, SPF 8, and SPF 10. If the UV irradiance of the SPF 10 is taken, then it will be the lowest of the three SPF's. To determine this, the sunscreen was put on pieces of plastic wrap (5 cm x 5 cm) and left to dry (10 minutes). The UV irradiance was found for each of the ten trials of each level using a UV monitor (The Educator). The average was found for each level and compared to the reading of a blank piece of plastic wrap to determine which SPF blocked out the most rays. The mean for each of the trials was as follows: Blank piece- 72.8 mW/m², SPF 4- 32.4 mW/m², SPF 8- 35.1 mW/m², and SPF 10- 0 mW/m². It was concluded that SPF 10 was the best at blocking out the UV rays. A major finding of this experiment was that the SPF 4 sunscreen blocked out more UV rays than the SPF 8 sunscreen. Improvements to this experiment included better measuring equipment to improve the constants and using spray on sunscreen instead of sunscreen lotion.

The Effect of Different Kinds of Fabric on Insulation

Ariela Press, Tuckahoe Middle School

Clothing manufacturers that specialize in warmer garments must be sure to optimize insulation in their clothing in order to keep customers warm. The purpose of this experiment was to test multiple different kinds of fabric and determine which fabric would provide the best insulation. In this experiment, eight yogurt containers were filled with 147.87 ml of water and placed into the freezer for 6.5 hours. After the water was frozen, each yogurt container was encased in one of the following fabrics: cotton, polyester, leather, faux leather, wool, fleece, or nylon, and one container was left with no fabric at all (control). The containers were left out at room temperature for one hour and then the containers were unwrapped and the volume of water present in each container was measured. After three trials, it was found that the leather fabric provided the highest degree of insulation with an average of only 23.3 ml of water present after sitting out for one hour in room temperature. This is in contrast with the container wrapped in no fabric (control), which contained an average of 89.3 ml of water after the same hour. Overall, the data did not support the hypothesis that the fleece material would provide the highest degree of insulation, for the container encased in fleece contained an average of 44.0 ml of water after an hour at room temperature, 20.7 ml more than the leather which had 23.3 ml of water.

The Effect of Different Temperatures on Magnetism

Kaustav Rajesh, George H. Moody Middle School

Magnetism has been around for thousands of years. Today, magnets are used in many household and industrial applications. Magnetic levitation trains are no longer science fiction but are in use in countries such as Germany, UK and Japan. The quest is now towards more effective use of magnets. This experiment was conducted to see if temperature did affect the strength of a magnet to make them more effective. The research hypothesis stated that if the temperature of the magnet was decreased, then the strength of the magnet would increase. The way this experiment was conducted was by using the three temperatures; hot (100 degrees Celsius), cold (0 degrees Celsius), and room temperature (22 degrees Celsius). The magnet was used to pick up paperclips at room temperature, and then later put in the freezer for cold temperature, and boiled for hot temperature while counting the paper clips picked at the same time. Then, the data on paperclips picked were recorded by maximum, minimum, variance, and other measurements. The result stated that cold temperature affected the most on the strength of a magnet (mean of 14.9) and hot the least (mean of 11.1) which makes the research hypothesis true. These results were compared to research conducted by other scientists' findings which were similar in nature. The principle that supports the hypothesis that magnets are affected by temperature is called Curie's Law. This conclusion could be grounded further by additional research using alternative mediums to vary the temperature of the magnet.

The Effect of Angle of Approach on the Curve of a Soccer Ball

Pulkit Rampa, George H. Moody Middle School

The purpose of this experiment was to use science to examine a topic which I am actually passionate about. When I was conducting research on the topic I also learned about what actually happened to the

ball in the air and I got a basic understanding of scientific principles that I hadn't learned about before. My hypothesis was that the sharper your approach to the ball, the more curve that would be generated, because the sharper the angle you enter the more you have to swing your body. Next, I had to set up the experiment. When setting up the experiment, I knew because there would be a lot of variation in the results that I would have to conduct several trials. This of course is because no two kicks are ever the exact same and I would have to find an average. I conducted the experiment and after 260 trials I went home to analyze the results. The results supported my hypothesis showing little to no spin when the ball was approached at 90 degrees and gradually increasing after that. This proves that more spin and Magnus force pushing in the same direction, the more curve the ball will have.

The Effect of Angle of Photovoltaic Cell on the Amount of Energy Produced

Pranaav Rao, George H. Moody Middle School

Solar energy, which refers to any form of energy radiated from the sun, is the result of thermonuclear fusions from within the sun. The energy in fossil fuels and other natural resources are all derived from energy of the sun. Difficulties with these energy reserves led to the innovation of devices that directly convert solar energy into electricity. Photovoltaic cells are one of those many innovations and they get their name because they convert light, or photons, into electricity, or volts, also called the PV effect. Since the time of their invention, they have been increasing efficiency by 20% per year and are becoming more popular. The purpose of this experiment was to determine how the angle of a photovoltaic cell would affect the amount of energy generation of that cell when the angles were set at 0°, 45°, 90°, and 135°. Four solar cells were placed in front of a light source, preferably the sun, and were tested with a multimeter to see the amount of electricity being generated, which was done ten times. The results indicated that the solar cell at the angle of 45° had the highest electricity generation with a mean of 2.084 DCV and the solar cell at the angle of 135° had the lowest electricity generation with a mean of 0.984 DCV. The data supported the research hypothesis that if a photovoltaic cell is set at an angle of 0, 45, 90, and 135 degrees, then the photovoltaic cell at 45 degrees will generate the most electricity. Based on the DCV values of this experiment, angle and electricity generation of a photovoltaic cell are both connected. Before it is certain that this inference is correct, another test may be necessary for correct results after further research on weather and photons. More variables could also preferably be adopted for more accurate results.

The Effect of Notes on the Distance Salt Travels

Eleanor Reavey-Gilbert, Orchard House School

The object of this experiment was to find out if higher notes have more of an effect on salt than lower notes, or vice versa. The experiment was based on Chladni's experiment and design. Chladni placed sand on a metal plate to measure the vibration. This experiment used salt, but like Chladni, measured the vibrations and movement of it. The study of Cymatics, or visible sound and vibrations, is the basis of both this experiment and Chladni's. It was hypothesized that the higher notes would have more of an effect than the lower notes. This was believed because although lower notes have fewer sound waves than higher notes, the waves are thicker and therefore cause stronger vibrations. The notes D, E, and B were tested. The setup was able to measure the distance salt traveled when exposed to those notes. The results were then collected and analyzed. The data showed a significant drop in distance as the higher notes were played. The lowest note E had the most effect, while B, the highest note, had the least effect on the salt. As the notes were played the salt would vibrate and quiver on the latex sheet, making its way out of the center. The hypothesis was proven to be correct. The experiment demonstrated the strength of different sound waves and their effect on salt. The lower notes had a bigger effect on the salt, whereas the higher notes barely affected the salt at all.

The Great Candle Experiment

Dean Schiller, Hines Middle School

A partial vacuum is created when a jar is placed over a lit candle in water. When the candle goes out, the water rises. This project was to see if the starting temperature of water could change the speed at which the water rises. The hypothesis for this experiment was that the water would rise the most quickly with hot water instead of room temperature or cold water. Three sets of trials were conducted – one with hot

water, one with cold water, and one with room temperature water. Food coloring was added to the water, the water was poured into a wide shallow bowl, and then the temperature was taken. A tea light was placed into the center of the bowl, lit, and then covered with a glass jar. The number of seconds the candle burned before going out was measured. The time it took for the water to rise was also measured. The candle extinguished the fastest with hot water. It stayed lit the longest with cold water. The water rose the fastest with hot water. The water rose relatively slowly with cold water. The data collected in this project supports the hypothesis. The water did rise the quickest with hot water. In a closed environment hot air has more pressure than cold air, but when the candle went out both the temperature and the pressure fell quickly. This occurs because hot air changes temperature more rapidly than cooler air when the candle goes out.

The Effect of Temperature on Magnet Strength

Ryan Smith, George H. Moody Middle School

Magnets are frequently used in daily life. Even the Earth itself is a magnet. A magnet is any object that produces a magnetic field. Magnetism is created by the alignment of small domains within a specific set of metal. Some magnets, referred to as permanent magnets, hold their magnetism without an external electric current. The purpose of this experiment was to determine how temperature affects the strength of a magnet. A magnet was heated or cooled to three different temperatures (100 degrees Celsius, 20 degrees Celsius, and -60 degrees Celsius). The results suggested that the colder the magnet gets the more strength it loses, which did not agree with the experimenter's hypothesis that if a magnet is cooled down then it will gain magnetic strength. Based on the repeated trials there is a correlation between temperature and magnet strength. Before this can be confirmed the tests have to be done on many different types of magnets in a real world setting.

The Effect of Friction on How Far a Balloon Car Travels

Tanner Smuthkochorn, Kenmore Middle School

The project focused on the problem stated: which surface provides the least amount of friction for the balloon car to travel on? It was hypothesized that if the surface was wood floor, then the friction of the surface would be less. I built my own balloon car, pumped six times in a balloon using a pump, let it go on each surface, and measured the distance it traveled in centimeters. The hypothesis was accepted. Out of the surfaces wooden floor, carpet, asphalt, concrete, and grass, wooden floor provided the least amount of friction. Three trials were completed on each of the surfaces. The averages of the three trials were used in the final results. Wooden floor had an average distance of 306.41 cm. Concrete had an average distance of 167.47 cm. Carpet had an average distance of 117.01 cm. Asphalt had an average distance of 99.99 cm. Finally, grass had an average distance of 17.19 cm. In conclusion, I believe that all of this information could be useful to engineers, architects, or even if anyone wanted to know the friction of the surface they stepped on. This science project may be useful to engineers or architects who need to know the friction of the surfaces used in order for the build to function; one example could be building a racetrack. Knowing the friction of the different materials can help in finding what material to use.

Extinguishing Fire with Sound Waves

Eliza Spencer, Gildersleeve Middle School

The purpose of this experiment is to find out how many Hertz is most effective at extinguishing a small flame. To do this, I first set a candle 5 cm away from a subwoofer. Next, I went onto YouTube and found a video of 10-100 Hz being played in 10 Hz intervals. Then, I played the video and watched the flame. Finally, I paused the in between Hz changes and recorded how much the flame was effected on a 0-10 scale (0 being not effected and 10 being blown out.) I repeated these steps two more times for three trials. The results of my testing were that 20-60 Hz extinguished the flame, and 100 Hz performed worst with an average score of 0.667. In the end, I concluded that fire can be extinguished with a certain amount of Hertz. Therefore, my experiment was a success. I made a few errors while performing my experiment. While setting up the candle for my last trial of 70 Hz and my first trial of 100 Hz, I believe that I may have bumped it away from the speaker a tiny bit, causing the results to be a number less on the 1-10 scale then the other two trials. When I do this project in the future, I will mark a line where the edge of the candle should be. This project can be used to help in real-life situations. If a fire starts in a spacecraft,

where there is no gravity, a regular extinguisher or a fire blanket would not work. Since sound waves do not require gravity to extinguish fire, then they can be used in this situation.

What Is the Effect of House Structure on How Long the Structure Can Go Undisturbed in Extreme Weather?

Gabrielle Spranger, Thomas Jefferson Middle School

Houses come in all different shapes and sizes, but which houses are the sturdiest? The purpose of the project was to find the effect of different house structures on how long the house could stand undisturbed in extreme weather. The hypothesis was that if three different house structures were exposed to three different extreme weather conditions, then the control house would stay undisturbed for the longest amount of time. After the houses were built using Popsicle sticks, they were exposed to 15 minutes of cold, rain, and wind each for the same amount of time. As soon as the house started to show damage, the timer was stopped and the time, in minutes, was recorded. The averages were then calculated for each of the houses using all data points. The results showed that the average time that the cube structure remained undisturbed was 7 out of 15 minutes. The average time that the control house (a cube with a pitched roof) remained undisturbed was 8.5 out of 15 minutes. The average time that the pyramid remained undisturbed was 8 out of 15 minutes. The results supported the hypothesis because the control house remained undisturbed for the longest amount of time. During the project, one error that occurred was that the temperature of the water in the rain was not held constant. Since the water was turned on and off between each rain trial, the results could have been affected to a slight degree. Overall, the results for this experiment were intently valid because sources of error were controlled. However, the results from this experiment may not be as externally valid for a real house because of the differences in scale.

The Effect of PSI on Distance of Football Throw

Samuel Williams, Tuckahoe Middle School

Football is one of the most popular sports in America, with the NFL and NCAA. Quarterbacks are always training, and working to improve the distance and accuracy of their throws. The experimenter asked the question: what if the psi of the ball could affect the distance of the throw? The experimenter inflated the same ball to 1 psi, 5 psi, 9 psi, 13 psi, and 17 psi. The experimenter had each psi thrown 10 times, and then took the average of the 10 throws. The control group (13 psi) was thrown the furthest, with an average throw of 47.5 feet. Key results in the experiment were that the hypothesis was supported. The experimenter hypothesized that the 13 psi would be thrown the farthest. This experiment answers the problem question: can psi affect the distance a football can be thrown?

The Tape Tester

Hanna Xu, Swanson Middle School

The purpose of this experiment was to study the effect of the temperature on the amount of quarters tape can support. The hypothesis was that if the temperature was freezing, cold, cool, and room temperature when tested, then when the temperature is at room temperature, the tape will support the most amount of quarters. Using a metric ruler, 13 centimeters of tape was measured and kept in a certain temperature of freezing, cold, cool, and room temperature. Once the tape reached the temperature, 0.5 centimeters of the tape was pressed onto a piece of wood. The end 5 centimeters was wrapped around the handles of a plastic bag. One quarter was placed every second into the bag at the same height. The amount of quarters, not including the quarter that caused the bag to drop, in the bag was counted. Six trials were done for each independent variable level. Tape at the freezing, cold, cool, and room temperature supported an average of 106, 110, 109, and 125 quarters respectively. These results show that tape at room temperature supported the most amount of quarters with an average of 125 quarters. Also, tape at a freezing temperature supported the least amount of quarters with an average of 106 quarters. Furthermore, room temperature had an abnormally large range of 82 quarters. This was probably caused by experimental error. The results are believed to be caused by the materials of which the tape is made. In low temperature, the material can become brittle, thus affecting the efficiency of the tape.

Psychology

First Place

The Effect of the Tempo of a Mozart Song on a Student's Academic Success

Abigail England, Washington-Lee High School

The objective of this experiment was to determine the effect of the tempo of classical Mozart on a high school student's academic abilities on an Algebra I SOL. Measurements used to interpret the students' achievements were the number of problems (out of 12 per survey,) that were attempted, and the percentage of questions from each assessment answered correctly. It was hypothesized that a faster tempo would increase student's scores both quantitatively and qualitatively. This was predicted because past studies have shown that listening to music, specifically at a faster tempo, increases adrenaline to the brain, in turn increasing ability on intellectual assignments and causing one to answer at a faster pace. Thirty high school students completed four surveys, each three minutes long, with problems taken in a random order from the 2010 Algebra I SOL. An ANOVA test was run for both dependent variables to analyze the data. While the data showed an increase in percentage of correct problems and number of questions attempted as the tempo was increased, the ANOVA test results showed there was not a significant difference in the data for both of the dependent variables. Therefore, the null hypothesis was not rejected and the data was not significant. The hypothesis was not supported because of the lack of significant data and the results from the statistical test.

Second Place

Utilization of Gender Stereotypes in Children's Television Advertising

Zoe Pettler, Mountain Vista Governor's School

There has been extensive research of the differences in portrayal of the sexes on television; however, there has been minimal research of the extent to which gender stereotypes are used in children's television advertising. To explore this, a content analysis was used to identify stereotypes in 168 television advertisements. The six stereotypes used were taken from previous research. They were: 1) females use body products more than males, 2) females are more dependent than males, 3) females stay at home more than males, 4) males have greater authority than females, 5) females work better in groups than males, and 6) males are more competitive than females. Each stereotype was identified by analysis of the interactions in each advertisement, and the results were verified by unaffiliated assistants. This analysis revealed that four of the six stereotypes were present in the sample a significant number of times. The stereotypes were 1) females use body products more than males, 2) females stay at home more than males, 3) males have greater authority than females, and 4) males are more competitive than females. The presence of these stereotypes indicates that it is highly probable that children's television advertising incorporates common gender stereotypes by utilizing them in the promotion of products.

Third Place

Cloudy with a Chance of Murder: The Effects of Monthly Seasonal Trends and Significant Weather Patterns on Criminal Behavior

Emily Brown, Chesapeake Bay Governor's School for Marine & Environmental Science

In a world of crime, criminal behavior based on psychology as affected by weather has been frequently questioned. Western societies have long hypothesized that environmental factors, such as monthly trends of seasons, heat waves, storms, and lunar cycles have influence on the frequency of criminal acts. Using police and weather data from cities along the east coast of the United States, this study examined these

relationships. Statistically, this study showed a link between crime and monthly trends, but no link between crime and heat waves, crime and major storms, and crime and strong lunar phases. If this study were to re-examine those relationships yielding no statistical significance, there would need to be a larger dataset gathered to increase the statistical power of the numerical values being analyzed. Yet based on the results of this research, municipal police departments can still take all these trends into account when making decisions as to how to allocate manpower, when to cut back on staffing for officer leave and when to be particularly vigilant for spikes in criminal activity related to the environment.

Honorable Mention

The Effect of Melodic Phrases on Recall of Words

Samuel Havron, Mountain Vista Governor's School

The primary objective in the study was to find what amount of musical phrases within a melody facilitates better recall for associated words; the secondary objective was to find support for melody as an effective aid to memory for words. Participants (n = 19) listened to 11 different words associated with either one melodic phrase, two melodic phrases, three melodic phrases, a flat pitch control condition, or a random pitch condition. Each condition was repeated, and after each condition was presented, participants recalled as many words as possible by typing a response. The number of new words introduced by the participant in recall was also recorded. The null hypothesis in the study was that there was no difference in performance between recall for words accompanied by different numbers of musical phrases. The alternative hypothesis was that performance on recall of words accompanied by one musical phrase would be higher than that of words accompanied by more than one musical phrase, or zero musical phrases. The results failed to reject the null hypothesis or accept the alternative hypothesis, confirmed by ANOVA tests. Further investigation of the effect of melodic phrases on recall of words under different design methods may yield results more comparable to theories found in literature.

Honorable Mention

Get in Touch: Kinesthetic Learning and Student Interest

Virginia Jarvis, Chesapeake Bay Governor's School for Marine & Environmental Science

Students need interaction in the classroom in order to maintain interest, because students who are interested in the material that they are learning are more likely to retain the knowledge. Kinesthetic methods of teaching utilize the knowledge we have of brain function and help students remember the concepts they are taught in class. Kinesthetic learning is any type of learning that involves hands-on activities or physically engaging classroom exercises. This study seeks to determine the effectiveness of kinesthetic learning from the student's perspective. Advanced high school students were given a survey that measured their interest in learning correlated with the style of teaching that is typically used in the classroom. Also, in a fourth-grade classroom that uses hands-on activities (kinesthetic learning), students' attitudes were observed and test scores were compared to classrooms that use standard classroom learning. In the observed classrooms, students were more excited about learning when they were allowed to use hands-on, kinesthetic activities and there was a higher level of class participation than there was with standard classroom learning. The results of the survey taken by Governor's School students showed that a great majority of the students prefer kinesthetic learning over traditional classroom learning, such as with the use of lectures, textbooks, or worksheets. The statistics found in this study allow the null hypothesis to be rejected. Kinesthetic learning appears to motivate students more than traditional classroom learning techniques, such as taking notes and completing worksheets.

Honorable Mention

Memory of Dancers: Iconic, Echoic, or Haptic

Claire Veasey, Southwest Virginia Governor's School

Memory is a very important part of any dance career, whether it's professional or just for fun. In order to succeed as a dancer, memorization needs to be done quickly and efficiently. There are different modes of memorization that can be utilized by the mind. Sensory memory is the shortest term memory, and is split up into three parts: iconic, echoic, and haptic. Iconic memory is visual memory, echoic is auditory memory, and haptic is kinesthetic memory, or memory by touch. Dancers are said to have different cues to remember choreography or movements, and these different cues apply to the three different branches of sensory memory. What if one cue works better than the others? In order to test whether dancers are more receptive to a certain type of memory, three tests were given to 34 female dancers, ages 12-18, from various dance studios. Three short memory tests were given, each pertaining to a different type of memory. After each test the dancers were asked to recall as many words or objects as they could and write them down. After the tests were given and the data were collected the results were analyzed using an ANOVA test. The ANOVA test analyzed the deviations that were found by averaging each dancer's three scores and then subtracting the mean score from each individual score. Then the mean of all of the test subjects' deviations was found. The results were found to be statistically significant. Dancers were found to be most receptive to the haptic memory test. The results of this research suggest that dancers may have a common characteristic when it comes to learning and memorization, or maybe even normal life events.

Brain Power: Perception versus Reality

Ann-Marie Coleman, Southwest Virginia Governor's School

The Rubber Hand Illusion is an experiment that involves making a person believe they have ownership of a rubber hand versus their real hand. If one watches a rubber hand being stroked while one's own hand is also being stroked, one will feel a sense of ownership over the rubber hand as if it is one's own. This study aimed to answer the question: Will a subject respond the same way as one responds in the Rubber Hand Illusion if a foot is tested instead of a hand? This study was conducted by testing 30 human (*Homo sapiens*) test subjects. Each participant sat in a chair with his or her right leg behind a partition. A false leg was placed between the partition and the subject's left leg in the line of sight of the subject. The participant's natural right foot and the false right foot were brushed across simultaneously with two small paintbrushes for four minutes. Out of the 30 people who were tested in this experiment, 26 felt the sensation in the rubber foot. A proportion test was conducted utilizing the fact that up to 85% of amputee victims experience phantom limb pain and resulted in a p-value of 0.7982. The findings of this study correlate with phantom limb pain data. This study showed that people will respond the same way to the Rubber Hand Illusion if a foot is used instead of a hand. This experiment could be applied to amputee victims to help relieve phantom limb pain.

Does Grocery Store Branding Affect the Frequency of Reusable Bag Use?

McKinley Dyer, H-B Woodlawn Secondary Program

The experiment was designed to test whether grocery store branding directly affects customers' use of reusable grocery bags. The hypothesis states that Whole Foods' customers will use reusable bags at a higher rate compared to customers at Harris Teeter, Safeway, and Trader Joes. The experiment was conducted by going to each selected grocery store and recording how many customers out of a total of 50 left with reusable or non-reusable grocery bags. Customers that didn't use bags at all were not counted. Whole Foods had the highest percentage of customers that used reusable bags with 40%, then Trader Joes with 20%, followed by Safeway with 18%, and Harris Teeter with 16%. A chi-square was used to determine if the differences between the frequency distributions of customers that use reusable grocery bags versus non-reusable grocery bags were statistically significant. The research hypothesis was supported.

The Effects of a Beverage's Color on Flavor Interpretation

Mary Hawkins, Shenandoah Valley Governor's School

The effects of a beverage's color on children's flavor interpretation were studied to see if the color of a beverage would influence a child's flavor perception. Subjects were 50 children who were among each of the combinations of age (7-9 years of age, 11-13 years of age, and 16-18 years of age) and sex (male and female). Two types of soda (Sprite and Sprite Zero) were dyed two colors each (red and orange) were the testing substances; subjects tasted each of the four cups and dictated. The results were analyzed using t-tests that gave a significant test result showing that children chose red beverages more than orange beverages. The null hypothesis was rejected. These conclusions were altered by age, but not by sex or beverage type.

The Effect of Time on Human (Location) Memory Jullianne Meany, H-B Woodlawn Secondary Program

The purpose of the experiment was to test the extent of a human's ability to remember the location of an object and whether location memory is stronger than a human's ability to remember information. This was tested by asking a group of test subjects to place a paperclip in a drawer of their choice out of a set of 24 drawers. The subjects were tested the day they placed the paperclip in the drawer, one day later, one week later, 18 days later and one month after the initial test day. On each test day, they were asked to retrieve the paperclip from the drawer they initially placed it in. It was found that 100% of the test subjects were able to remember the location of their paperclip on the first attempt. This proves that a human's ability to remember the location of an object is stronger than the ability to remember information.

The Effect of Confidence from Sports Drinks on Performance Hallie Miller, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effect of confidence from a sports drink on performance. Many factors affect an athlete's performance including confidence. Confidence can be derived from many aspects of a game including pre-game rituals and home field advantage. If athletes' perceptions of competition factors affect confidence, and confidence affects performance, then maybe an athlete's perception of sports drinks can affect swimming performance. Fifty swimmers swam the 100 freestyle twice, and the second time they consumed a sports drink prior to the race. Twenty-five of them were told that the drink would help them swim faster. The control was the 25 who were not told anything. It was hypothesized that swimmers would swim faster if they were told the sports drink would help them swim faster. The results revealed that on average, the swimmers who were not told that the sports drink would help them swim faster improved by 0.20 seconds, while the swimmers who were told the drink would help them swim faster gained 0.56 seconds. A t-test was done on the data, and it revealed that the data was not significant. The results did not support the research hypothesis. The results may have been caused by people's perceptions of the sports drink prior to participation. This would have affected their confidence levels, and thus their performance. Further studies could investigate the effects of a figure such as a coach on confidence levels.

The Effect of Incentives on the Ability to Memorize Words Amith Prakash, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effects of incentives on short term memory in middle and high school students. Incentives have been used by parents and teachers to manage their misbehaving kids, since incentives have been successful in training domestic animals such as cats and dogs. Middle and high school students were either told about the incentive or not told anything and were then given two minutes to memorize 10 five-letter words. Then, students were given two more minutes to write down the words that they could remember. The control that was used in the experiment was not being told about the incentive. It was hypothesized that a positive incentive will lead to students being able to memorize more words. The results revealed that giving a positive incentive, on average, did not have any difference in the number of words a student can memorize. A t-test was done on the data and it revealed that the data was not significant (0.000). This shows that the data was most likely due to chance. The results did not support the research hypothesis. It is believed that the results are due to the anchoring effect, or people thinking that the incentive was insufficient. People may also have done the bare minimum just to get the incentive. Working memory capacity, or the limit to what somebody can

memorize, may have also played a part in the results of the experiment. This research could lead to further studies that investigate the ideal incentive to use.

The Effect of Exercise on Memory of High School Student

Vamsiraman Raman, Mills E. Godwin Specialty Center for Science, Math & Technology

For many years, people have debated whether or not exercise improves memory in students. This topic has dominated many discussions in the science community, and many researchers have been studying the above relationship to see if it will help with improving students' scores on standardized tests. The objective of this experiment was to find out the effects of exercise on memory of high school students. This research topic looked appealing as it involved studying the benefits of exercise as being more than an activity keeping one fit, and would also help encourage teachers to allow their students to exercise more. In the experiment, 25 students studied 30 objects prior to taking a memory test. After five minutes, they were asked to write down all the objects they could remember. The next day, the same students were asked to remember a different set of 30 objects and this time they jogged for five minutes, and then wrote down as many objects as they could remember. The control used in this experiment was the test before exercise. It was hypothesized that students would perform better on a memory test after exercise than before. The results revealed that average student's score on the test did not improve after exercise; in fact the average decreased by two points. The reason for this might be that the students' t-test was done on the data and it revealed that the data was not significant for students' score before and after exercise. These results did not support the research hypothesis. These results, fortuitously, could lead to further research about the impact of exercise on a different cognitive function and observe the effects. On the other hand, these results could also lead to studies involving other activities' influence on memory.

The Stereotypical Perceptions of Visible Piercings and Employment

Megan Ray, Appomattox County High School

Today, visible piercings have become a common topic in American society. This led the researcher to question if visible piercings have an effect on employment. The experiment took place at a convenience store and high school. Fifty random adult participants completed a survey while viewing a picture of a female without piercings, and 50 other adult participants completed a survey while viewing a picture of the same female with piercings. The survey included questions regarding the perceived character and willingness to hire her based on the picture, along with personal demographic information about the participant. Based on the two-way analysis of variance (ANOVA) of the data, the participants that were 44 years old and younger were more likely to hire an employee with visible piercings, rather than those that were 45 years and older. The education level of the participant was also a factor when considering whether to hire an employee with visible piercings. Participants that had some high school education or less were more likely to hire a person with visible piercings than the participants with education beyond high school. An extension of this research would determine if the stereotypical perceptions change as individuals become older or acquire more education.

The Effect of Font Emphasis on Passage Comprehension

Dylan Schuler, Washington-Lee High School

The objective of this study was to determine which font emphasis was most conducive to passage comprehension. It was hypothesized that italicized font would lead to the highest comprehension scores because disfluent, or harder to read fonts, use more mental focus than fluent (easy to read) fonts, and when the brain is more involved in obtaining information, that information is more easily retained. Four passages and four 12 question surveys, each relating to a passage, were given to 25 (will update when complete) participants. Participants were given a timed period to complete a passage and a questionnaire. This was repeated for all 4 passage-survey sets. For statistical analysis, an ANOVA test was performed on the data. The ANOVA test that was run showed that there was not a statistically significant difference between the lack of emphasis, bold, italics, and underline, the four emphases used in this study. Because no significant difference was exhibited in the data, the hypothesis cannot be supported. Improvements that could be made to the experiment include a larger and randomly selected sample, a removal of the time limit, and creation of original texts that would not be influenced by prior

knowledge. Further studies might include surveys testing metacognition (perceived performance/self-evaluation of the mind's performance).

Zoology

First Place

The Effect of Varying Types of Fruit on the Attracting and Trapping of Fruit Flies

Emma Mayes, Mathematics & Science High School at Clover Hill

Fruit flies seem to be found swarming across a wide variety of produce, but is there a certain fruit that attracts them the most? This project looked at the effect of different varieties of fruit on the attracting and trapping of fruit flies. Fifty fruit flies (*D. melanogaster*) were released into a fish tank to choose which fruit they preferred. Same-sized pieces of banana, apple, grape, orange, and strawberry (levels of IV), were placed into canning jars with paper funnels to trap the flies that were attracted to the fruit inside, and one jar with a taped funnel was left empty to represent the control. The flies were counted at 24-hour intervals (dependent variable), and 30 trials of the experiment were conducted. The temperature and lighting of the environment was constant, and the number of flies, the size of the fruit, and the ripeness of the fruit were also kept constant throughout the experiment. The experiment was conducted to target the most attractive fruit to the fruit flies to determine which fruit farmers need to focus on when conducting fruit fly control. The hypothesis was that the orange would attract and trap the most fruit flies. The experimental results supported the hypothesis with the orange on average attracting and trapping the most fruit flies, with the banana almost attracting and trapping the same amount of flies.

Second Place

Effects of an Underwater Treadmill on Canine Rehabilitation

Kendra Hale, Southwest Virginia Governor's School

A canine rehabilitation underwater treadmill can cost tens of thousands of dollars. The exact benefits of an underwater treadmill are unknown. Canine rehabilitation is a new field that has only been around for a short time. Information regarding specialized equipment has not been studied. This work provides the field of veterinarian medicine the research and knowledge about the effects of an underwater treadmill. Canine rehabilitation practitioners will learn about the effects before they make a large investment. This study investigated potential benefits with underwater treadmill usage. Ten dogs underwent a canine rehabilitation plan under the supervision of a certified practitioner. They received multiple sessions on the treadmill. Thigh measurements from a spring loaded tape measure were taken before and after the use of the underwater treadmill for three sessions. Both the left and right rear legs of the dogs showed a significant gain in thigh muscle mass. The p-value of the rear left leg was 0.0031 and the p-value of the rear right leg was 0.0043. These are significant at the comparative significance level of 0.05. The average gain for the left rear leg was 1.55 centimeters and the average gain for the right rear leg was 1.3 centimeters. The findings show that underwater treadmills provide gains for dogs participating in rehabilitation. The findings will give confidence to practitioners about the use of their equipment. The work supports other work surrounding different animals, like horses. The results are general to all dogs and help to understand the effects of the underwater treadmill and information that practitioners need to know.

Third Place

The Effect of Nano Silver on Aquatic Ecosystems

Peter Huson, Washington-Lee High School

Nano silver is a common ingredient in many commercial products currently on the market; mainly because of the antibacterial and antifungal properties it exhibits. Some consumer products include

dietary supplements, eating utensils, washing machines and socks. During and after use however, these commercial products release large quantities of Nano silver into wastewater and aquatic ecosystems in the local area. Microscopic silver particles harm aquatic ecosystems by damaging the delicate food webs of the aquatic ecosystem and by inhibiting reproductive abilities of organisms. Due to Nano silver's inhibitive effects on microorganisms, a hypothesis was drafted that the more Nano silver in an aquatic ecosystem, the more toxic an aquatic ecosystem will become to natural organisms. The purpose of this experiment was to measure the effects of Nano Silver on aquatic environments. Different concentrations of Nano silver were tested with *Daphnia magna* over a 4-day testing period. The most *Daphnia* died in the environment with 3 mg/L, the highest concentration of Nano silver. Stepping down the concentration to 0.5 mg/L, 0.2 mg/L and 0.1mg/L less *Daphnia* died. For each of the 5 concentration groups, there were 7 individual trials. As the experiment progressed the death rates of *Daphnia* tapered off. The control group however, died 5 times as slowly as the environments with Nano silver. Overall, any *Daphnia* that had been exposed to Nano silver died eventually. Therefore, this experiment demonstrated that Nano silver raises the toxicity of an aquatic ecosystem even in very low concentrations.

Honorable Mention

The Effect of Concentrations of Lavender Oil on Equine Heart Rate Spike

Grace Grossen, Chesapeake Bay Governor's School for Marine & Environmental Science

This study aimed to determine the effect of different concentrations of lavender on the equine spike in heart rate in order to explore using lavender as an aid to equine weight loss problems due to stress. Three different concentrations of lavender essential oil were each applied before a stressor to 13 different horses. The results and additional observations indicated that using lavender before a stressor (loud noise) would decrease the horse's heart rate spike by 10.5 bpm compared to the control, but would not necessarily affect the larger spooked behaviors, such as tensing, head tossing, jumping to the side, or turning about to face the noise. The linear regression test on the heart rate spike data yielded a p-value of 0.0253, so the null hypothesis that there would be no difference in heart rate change based on different concentrations of lavender was rejected. Observations of equine behavior led to the conclusion that lavender would serve the purpose of an addition to a weight gain plan for a stressed horse better than as a safety precaution for a skittish horse, especially because the lavender treatment had the largest effect on specific breeds such as thoroughbreds that are both the most susceptible to the weight loss and stress issues and most known for skittish or jumpy behavior as a result.

Honorable Mention

Eco-friendly versus Standard Laundry Detergent Effects on *Daphnia magna*

Andrew Miller, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effects of different types of laundry detergent, environmentally friendly and standard, on *Daphnia magna*. Many new laundry detergent brands state that their detergent causes less harm to the environment than their competitors. The *D. magna* were exposed to either no detergent, Tide, Tide free, Seventh Generation, or Seventh Generation free. All levels of the independent variable had 2×10^{-5} ml of detergent added to the Petri dish. The control in this experiment was the group that received no detergent. The experiment was conducted for 6 hours, counting every hour the number of deceased *D. magna*. A research hypothesis was formulated that if the *D. magna* were exposed to the different types of detergent, then the fewest would die in the Seventh Generation than any of the others. The results showed that Seventh Generation and Seventh Generation free are more detrimental to the *D. magna* than the Tide and Tide free. All detergents were more detrimental than the control. A t-test was conducted on the data and it showed that the results were all significant with the exception of Tide versus Tide free and Seventh Generation versus Seventh Generation free. The results did not support the research hypothesis. It is believed that the results are caused by the Seventh Generation's naturally derived chemicals and the modifications that may be done

to them. The research could lead to further research to isolate the harmful chemicals present in Seventh Generation and not in the Tide.

Honorable Mention

The Effect of Day Rhythm on *Daphnia magna* Heart Rate

Kaya Peterson, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to find the optimum day rhythm for reducing *Daphnia magna* heart rate. This was studied as a lowered heart rate in *Daphnia* was analyzed as a lower amount of stress on the organism's body. Parallels can be drawn in the basic bodily reactions between *Daphnia* and humans making data applicable to humans. It was hypothesized that if *Daphnia* were exposed to a 12 hour light-12 hour dark day rhythm, their heart rate would be reduced. In this experiment, 25 *Daphnia magna* were placed in each of four units in a light resistant containment structure. In each unit was placed a light, there was one for continuous light, continuous dark, 12 hours of light - 12 hours of dark, and 16 hours of light - 8 hours of dark. There was no control as there was no rhythm that was known to be *Daphnia*'s natural rhythm. *Daphnia* were exposed to these conditions for one week then heart rate was tested. When data was collected, the 16 hours light - 8 hours dark day had the lowest heart rate and the 24 hour dark day had the highest heart rate. However, the difference in heart rate was only significant between 24 hour dark and the 16/8 day and the hypothesis was disproven. It was concluded that insignificant stress was induced as the *Daphnia* adjusted to the new rhythms. The receptor protein on cells probably altered transcription protein production which attached to the regulatory modules in the DNA and changed gene expression to the new rhythm.

The Effect of Pyrethrin on the Survival of *Daphnia pulex*

Suraj Bala, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to find the effect of various concentrations of pyrethrin on the survival of *Daphnia pulex*. Pyrethrin has been used in the farming industry to increase the yield of crops by reducing harmful insects. Through runoff, pyrethrin can enter aquatic ecosystems. In this experiment, *Daphnia pulex* were exposed to different concentrations of pyrethrin for 24 hours and their survival was measured. The control that was used in the experiment was no insecticide. It was hypothesized that if higher concentrations of pyrethrins are used, then it will result in a lower survival of *Daphnia pulex*. A chi-square test was done on the data and it revealed that the data was significant for 0%, 0.2%, and 0.3% concentration of pyrethrin, but not significant for 0.1% concentration of pyrethrin. The modes for 0.1%, 0.2% and 0.3% solutions showed that the majority of *Daphnia* perished, supporting the hypothesis. It is believed that the results are due to the fact that pyrethrin paralyzed the *Daphnia* and reduced their survival. This research could lead to further studies that investigate the minimum lethal amount of pyrethrin for *Daphnia pulex* and how it may affect other organisms in the lake or run off water ecosystem.

The Effect of Moonlight on the Catch Rate of the American Eel

James Ficklin, Chesapeake Bay Governor's School for Marine & Environmental Science

The North American eel (*Anguilla rostrata*), spends most of its life in the Chesapeake Bay and its tributaries, migrating to the Sargasso Sea to mate and spawn. It is a valuable resource for local fisherman to harvest, but the market is often limited. Most buyers will only buy certain times of the month, or a certain number of times per month. So it would be valuable information for watermen to know when it would be most profitable to harvest eels. The rumor among them is that the best time to set eel pots is when the moon is at its darkest, or during a dark night. This study attempted to determine if eel harvests vary over several complete lunar cycles. This was done by setting multiple eel pots out in multiple locations for two months, checking them every day and recording the amount of eels inside. Then data was received from NOAA that provided information about the cloud coverage for those days, and that data was then multiplied by the percent the moon was visible, to give an accurate amount of light for

those nights. This data was then graphed with the amount of eels and tested with a linear regression. The tests came back as insignificant, but the graphs tended to indicate that this was because of a lack of data, and that had more data been collected, the results would likely have been different. However, graphically it was shown that moon phase is not as related as overall moon light that hits the water. Thus, one important conclusion that can be made from this study is that the catch rate of eels is influenced by several factors, not just moon phase.

The Effects of Different Concentrations of Caffeine on *Daphnia magna* Over Time

Judy Ho, Chesapeake Bay Governor's School for Marine & Environmental Science

Caffeine was used to determine the variation in the heart rate of *Daphnia magna*. Five stock solutions were used: 0 M, 0.1 M, 1 M, 10 M, and 100 M. This logarithmic scale was used to cover a large amount of the different levels of caffeine. Twenty *D. magna* were experimented within each level of caffeine and the heart rates were recorded at 0 minutes, 10 minutes, 35 minutes, and 50 minutes. In the control group, the heart rate decreased by 20 bpm from 10 minutes to 35 minutes. The heart rate rose back up by 10 bpm at 50 minutes. The irregular pattern of decreasing to increasing is the same for 10 M. In 0.1 M, the heart rate decreased from 198.7 bpm taken at 0 minutes to 160.9 bpm at 10 minutes. At 35 minutes, it increased by 8 bpm and continued to increase. This pattern is similar to the 1 M and 100 M. However, the effect of the different caffeine levels was not significant to individual *D. magna*. Multiple linear regressions resulted in a significant effect of caffeine over time on the heart rate of *Daphnia magna*. These results show that the amount of caffeine intake matters to the beats per minute on the heart, but not specifically different between the test subject of *D. magna*. The increase concentration of caffeine affects the heart rate. As *D. magna* can be compared to humans, this continuation of increase in caffeine may lead to damage to the body and possibly death.

The Effect of Sound Tempos on the Rate of Occurrence of Aggressive Actions in *Betta splendens*

Elena Hurtado, Mountain Vista Governor's School

The experiment investigated the effect of sound tempo on the frequency of aggressive actions displayed by a *Betta splendens*. The experiment consisted of five fish (*Betta splendens*) being shown a "stimulus" fish (to induce aggressive actions) for 15 minutes while 1 of 5 tempos were played in the background. Each fish was tested 3 times per tempo while the tempo ranged from 60 beats per minute to 140 beats per minute. Aggressive actions were defined as fin hares, attempted bites, and tail flips. An ANOVA test was used to calculate the results and the p-values were all under 0.05, indicating statistically significant results. The experiment supported the hypothesis that there was a correlation between increased sound tempos and the frequency of aggressive actions. By finding a correlation between the two, it could be an indicator that sound therapy could be used to control actions of fish. Being able to alter a fish's actions can help with stabilizing the fish to an ecosystem and reducing domesticated fish deaths.

The Effect of Various Polystyrene on *Blaptica dubia*'s Consumption

Suyeon Kim, Mills E. Godwin Specialty Center for Science, Math & Technology

The purpose of this experiment was to determine the effects of various types of polystyrene on *Blaptica dubia*'s consumption. Over the past few decades, polystyrene has been quickly piling up in landfills. The plastic is difficult to recycle because it will not break down and it cannot be burned due to its toxicity; thus, the voluminous plastic continues to pollute the earth. *Blaptica dubia* cockroaches were exposed to Expanded Polystyrene (EPS), Extruded Polystyrene (XPS), or Polyisocyanurate Polystyrene (ISO) and after 24 hours, the mass of the remaining polystyrene was measured. There was no control for this experiment because there was no standard or typical group of polystyrene. It was hypothesized that if expanded polystyrene (EPS) was given to the roaches, then the most polystyrene would be consumed. The results revealed that the XPS polystyrene impacted the consumption amount the least, and the EPS and ISO polystyrenes impacted the amount consumed equally with the same mean of 0.02 grams. The t-test done on the data revealed that the data was not statistically significant, with the exception of the XPS polystyrene versus ISO polystyrene. The results partially supported the research hypothesis because the hypothesized group, EPS polystyrene, and ISO polystyrene resulted in the same average. It is believed

that the results were due to the fact that EPS polystyrene is less rigid than XPS polystyrene which makes EPS polystyrene easier to consume by cockroaches. ISO polystyrene's originally high R-value was affected by the removal of the foil-facing, which may have affected the results to favor ISO polystyrene for this experiment.

The Effect of Frequency on the Rate of Continuous Chirping

Dylan Melton and Rebecca Rieling, Chesapeake Bay Governor's School for Marine & Environmental Science

Crickets are important to the ecosystem in large areas all over the world, but are easily affected by noise pollution. An experiment was conducted to find out if changing the frequency of a sound would change the rate at which the *Acheta domestica* chirped, and thus interrupt their mating practices. Using several groups of crickets, frequencies were played aloud and the new chirping rates were taken. The chirping rates were taken by measuring pauses in the chirping. The frequencies were 0, 10,495, 4,500, 7,500, and 25,000 Hertz. The averages were 11.99, 18.01, 8.44, 4.66, 2.92, and 33.01 seconds respectively. The averages indicated that there was a correlation between the frequency and chirping rate. A linear regression was done to determine to see if there was an impact of frequency changes on the chirping rate of house crickets, and yielded a p-value of 1.89×10^{-9} . The result of this study was that there was an impact of frequency on the rate at which crickets chirp. It can be said that certain frequencies affect crickets' chirping rate more than others, though it is unclear as to which decrease or increase chirping rates.

The Effects of Varying Tempos of Music on the Movement of Goldfish

Emily Milham, Shenandoah Valley Governor's School

Fish use sound to orient themselves underwater, which if able to plan and understand the patterns between the sounds and movements of fish, species of aquatic life could be protected by manmade sounds in large bodies of water. To carry out this experiment, a varied version of the shoaling method was used just as a way to divide sections of a fish tank in order to tally how many times a fish swam in a certain direction. This method was used with three different goldfish in three testable variables; fast, medium, and slow. A control of no sound was used as well. Once the data was collected in the X, Y, and Z direction for each fish, ANOVA tests were used to test the significant differences in the speeds for each variable. There were some significant differences that were consistent for each variable, but between each speed there was not always a significant difference. However, there was a visible pattern along with patterns from the ANOVA charts that showed that there was a significant difference between the slow and fast tempos. The hypothesis was supported but does not have concrete results.

The Effects of Tides on Green Sea Turtles (*Chelonia mydas*) Abundance in Kahaluu Beach Park

Paul Smith, Chesapeake Bay Governor's School for Marine & Environmental Science

The green sea turtle (*Chelonia mydas*) can grow to be about four to five feet in diameter, and to weigh up to 400 pounds. The turtles occupy a couple of different habitats, convergence zones in the pelagic habitat, and benthic feeding grounds in relatively shallow waters. This study examines the potential correlation between tides and the sightings of green sea turtles in Hawaii. Turtle appearances at Kahaluu Bay have been almost entirely unpredictable. By determining patterns of turtle appearance, turtles can be better protected from harmful interactions with humans, and humans may better be able to observe the turtles with a more predictable frequency. It is possible that green sea turtles may appear in Kahaluu Bay in relation to tidal fluctuations that influence foraging behavior. By monitoring turtle abundance during different portions of the tidal cycle, correlations may be determined. During the research period it seems as though the appearance of turtles has been directly correlated to the phase of the tide. During periods of low tides locations received little to no turtle appearance, then during periods of increased tide activity turtle appearance increased. The experiment produced a p-value of 0.0032 for turtle abundances.

The Effect of Magnets on the Movement of *Gromphadorhina portentosa*

Grace Tolbert, Mathematics & Science High School at Clover Hill

The purpose of this project was to discover if magnets affected the movements of the Madagascar Hissing cockroach. Magnets were used to see if the cockroaches would be attracted to them or repelled. Cockroach legs were dipped in paint, and then the cockroaches were placed in the center of a four-quadrant testing paper. During the 30 trials of the control testing, none of the quadrants had magnets placed beneath them. For the experimental testing, quadrant one had magnets placed beneath it, first with weak magnets for 30 trials, then with strong magnets for 30 trials. The quadrant location for each cockroach was recorded, every 10 seconds for one minute. The results for all 90 trials were all very close. The magnets did not seem to have an effect on the hissing cockroaches' movement. The cockroaches still went to quadrant one (one with the magnets in it) even in the trials without the magnets.

The Effect of Food on the Learning Process of Goldfish

Caroline Twigg, Mountain Vista Governor's School

This experiment tested the effects of different types of food on the learning process of goldfish using a maze. The null hypothesis was that there would be no difference between the average losses of time of the groups of goldfish and their different types of food, while the alternative hypothesis stated that there would be a greater average loss of time for the banana, broccoli, and romaine lettuce groups compared to the control group. To test the hypothesis, each goldfish from the four groups (i.e., banana, broccoli, romaine lettuce, and fish flakes) completed the maze every day for a week. The average time loss for each group was calculated at the end of the week. The null hypothesis failed to be rejected, and the results of this experiment did not support the alternative hypothesis. Numerically, the banana group had the greatest average time loss, but it was shown to be statistically insignificant. The different types of food did not affect the learning process of goldfish. After a two sample t-test comparing each experimental group to the control, all p-values were greater than 0.05, thus failing to reject the null hypothesis.