2026 NORTHERN VIRGINIA SCIENCE AND ENGINEERING FAIR

February 28, 2026

TABLE OF CONTENTS

7 BE 200

Asfaw, Ethan

Gunston Middle School

Are AI Large Language Models Dependent on Race-linked Cues in Resumes?

Artificial intelligence (A.I.) large language models (LLMs) are increasingly used to evaluate résumés, raising concerns about potential bias. This study investigated whether LLM résumé evaluations depend on race-associated cues. Five résumés with identical qualifications, experience, and formatting (but differing in race-linked cues) were evaluated by ChatGPT, Grok A.I., and Claude. Outcomes were analyzed using chi-square tests of independence, with Cramér's V used to assess effect size. Results showed that only Grok A.I.'s evaluations were significantly associated with race-linked cues (p = 0.02), while no statistically significant association was observed for ChatGPT or Claude. These findings suggest that some A.I. systems may exhibit bias under controlled conditions, highlighting the importance of fairness, transparency, and continued evaluation in automated résumé screening tools.

Behavioral and Social Science

8 BE 201

Budde, Ella

Francis C. Hammond Middle School

Human Perception vs Artificial Intelligence

The realism of AI generated images has become so true to life that it makes it difficult for people to distinguish between real photographs and artificial intelligence. This project investigated if people can correctly identify the AI images from real photographs.The hypothesis is that participants would be able to correctly identify the AI generated images better than random guessing. The project used a google form where images were paired (Real Vs AI) and then single images. It collected basic demographic data (age and gender). The google form was distributed via Text, Email, Instagram, and Facebook. A total of 54 people completed the survey. The majority of the people were in the 18-44 age range. For the findings that were gathered it was observed that as age increased, the average number of correct answers decreased. The 18-44 age group averaged nearly 14 correct answers, meanwhile the 65+ group averaged 9 correct answers. Of survey participants, 51.9% were female and 46.3% were male. One elected not to say. Females averaged 13 questions correct, Males averaged 14 questions correct. There is no major statistical difference comparing the rate of correctly identified images between males and females. The hypothesis, being that the human eye correctly identifies artificial intelligence, was proven correct by administering the test.

Behavioral and Social Science

8 BE 202

Carstens, Kaeli

George Washington Middle School

The Catch to a Catchy Tune: The Correlation Between Popular Songs and the "Magic Four Chord Progression" I-V-vi-IV

The purpose of this experiment is to investigate the correlation between I-V-vi-IV, the "magic chord progression," and Billboard's "Year End Hot 100 Singles." This will reveal if the "magic chord progression" helps musicians write a hit song. To conduct this experiment the following procedures were used: First, find the top 10 songs on Billboard's "Year End Hot 100 Singles" every year from 1960 to 2025. Next, using hooktheory.com or a piano/guitar, find each song's chord progression. Determine if that progression is the "magic chord progression," a variation or rotation of the "magic chord progression," or none. Examine how many songs contain the chord progression. Lastly, determine whether there is a correlation between the "magic chord progression" and the songs on Billboard's "Year End Hot 100 Singles." The data does not support the hypothesis because 38 songs, less than half of the 660 songs, contained I-V-vi-IV. However, the data shows that 105 of the songs contained a variation where the chord progression had the same chords in a different order or substituted one note in one of the chords, and 19 songs were a rotation of the progression. For example, Taylor Swift's "Anti-Hero" has the rotation IV-I-V-vi. The chords are in the same sequence, but start with a different chord. All these chord progressions create a pleasant and similar sound to the "magic chord progression." To conclude, the "magic chord progression" acts as a foundation for artists to build off of to create unique and catchy tunes.

Behavioral and Social Science

8 BE 203

Lao, Naomi

Kenmore Middle School

The Effect of Emotional Tone in TV Advertising on Candidate Popularity

In a democracy voters decide who is in power, and by extension, what policies are implemented. The key to ensuring that the best policies are implemented is to ensure that the voters understand what the best policies are. One way of doing this is using the right emotional tone. The effects of political advertising have been debated with much disagreement by social scientists, the press, and politicians alike, in particular the ability of positive versus negative advertising to gain the public's favor. This study seeks to provide some clarity about the influence of negative compared to positive political advertising. It was predicted that no correlation between positivity of advertising and change in candidate popularity would be found. Using a database, the positivity of the ads from various presidential candidates and election years were evaluated on a scale of negative four to four. The popularity of a candidate before the race for office began was taken from the average of polls, and the popularity of the candidate after was taken from their share of the popular vote. The change in popularity and the median positivity score were graphed showing a negative relationship, and a statistically significant relationship was discovered, meaning the hypothesis was not supported, and suggesting that negative advertising is more effective at earning votes than positive advertising.

Behavioral and Social Science

9 BE 204

Kaplan, Yuki

Washington-Liberty High School

The Effect of State Spending for Anti-Tobacco Campaigns on the Percentage of High School Students Vaping

Vaping is especially dangerous for teenagers because nicotine can harm the developing brain, leading to problems with memory, focus, mood, sleep, mental health, and increased risk of addiction and risky behaviors. Many teens underestimate its health risks, such as lung cancer, heart disease, brain damage, and more. This experiment was conducted to determine if state spending for anti-tobacco campaigns had an effect on the percentage of vaping among high school students. The hypothesis was that if state spending for anti-tobacco campaigns was higher, then high school vaping percentages would be lower because anti-tobacco campaigns help people quit tobacco use and increase knowledge of the dangers of tobacco use. A regression analysis was conducted to determine the significance of per capita state spending for anti-tobacco campaigns on the vaping rates of high school students, keeping the state percentage of adults with a bachelor's degree or higher, the state percentage of families below poverty, and state-level tobacco company spending per capita constant. The regression analysis showed that the state spending for anti-tobacco campaigns was not statistically significant, having a p-value of 0.39, and did not correlate with the percentage of high school students vaping. Research shows no state met the CDC's recommended anti-tobacco spending amount, suggesting that current anti-tobacco campaign funding is insufficient to make a difference. Given the health risks and size of the teenage vaping market, this study is relevant in creating policies and making decisions about the usage of government funding for these campaigns.

Behavioral and Social Science

10 BE 205

James, Justine

Alexandria City High School - King Street

AI Image Detection

The purpose of this experiment was to determine in what ways self assessment would present itself with the use of AI generated images. The procedure was to create a survey of 10 AI vs Real images with the first question in the survey should be asking about the age range the participant falls into and the second question should ask about confidence levels. Next obtain and document review and permission from a IRB after completing all ISEF forms then have written approval from the IRB before approaching participants, give survey to 100 people in an age range of 18 to 100 getting an about even range over the time period of a month making sure informed consent is given then calculate the average estimated ability for all age groups then find actual ability for all age groups, graph and calculate percent error. The results of this experiment disproved my hypothesis and all age groups underestimated their skills in determining AI image. In conclusion my hypothesis that the age group 1-25 would overestimate their skills by 20% was incorrect and they along with all other age groups underestimated their skills.

Behavioral and Social Science

10 BE 206

Krustapentus, Claire

Alexandria City High School - Minnie Howard

Method behind the Madness

My project analyzes the relationship between the psychological disorder of a serial killer and their chosen methods of killing. The main objective of my project was to examine if specific mental health disorders were linked to the same chosen technique of murder. To investigate this research question, I researched, collected, and analyzed old serial killer cases and psychiatric reports. I compared the details, methods, and diagnosed disorders. The findings proved surprising; they showed a clear correlation: certain psychological disorders were very frequently associated with patterns of the way serial killers choose to carry out their murders. This could help law enforcement and profilers to spot warning signs and understand how these killers think. My research highlights the importance and impact of mental health when studying and investigating serial killers and their crimes.

Behavioral and Social Science

10 BE 207

WITHDRAWN

10 BE 208

Pines, Molly

Yorktown High School

The Effect of Different Chat Bots on Rate of AI Sycophancy; The Effect of Prompt Strategies on Rate of AI Sycophancy

AI sycophancy is defined as the pattern in which chatbots "single-mindedly pursue human approval", by "tailoring responses to exploit quirks in the human evaluator to look more preferable, rather than by actually improving responses." This happens because AI companies want to create an AI that consumers enjoy, usually by making the chatbot agreeable or flattering to the consumer (Georgetown Law). AI sycophancy can be extremely dangerous when it confirms low evidenced medical beliefs in order to appease the reader, accelerating the spread of misinformation and medical fears. This project tested five different chat bots (Chat GPT, Google Gemini, Deepseek, Pi, Snapchat AI) on rate of AI sycophancy using two different prompts posing as pregnant women seeking advice (MMR Vaccine Prompt, Tylenol Prompt). After finding the two most sycophantic occasions, different consumer focused interventions were given before the previous prompts in an attempt to reduce the rate of AI sycophancy (Don't worry about my feelings, Talk to me like you're my doctor). Results found that interventions had no statistically significant effect on the rate of AI sycophancy (With p values of 1.00 and 0.30 respectively). Additionally, Deepseek turned out to be the least sycophantic chat bot, while Snapchat and Pi exhibited the most sycophancy. There have been numerous studies performed covering the prevalence of AI sycophancy, but none who discuss AI sycophancy specifically regarding low evidenced medical beliefs.

Behavioral and Social Science

12 BE 209

Brodsky, Anna

H-B Woodlawn Secondary Program

Comparative Structural Analysis of Neurological Disorders

Globally, one in three people is affected by a neurological disorder, while only ten percent receive proper diagnosis and treatment. In the United States, these conditions have an economic impact estimated to be over $800 billion, a cost driven by delayed intervention, since reduced levels of treatment can suffice when provided earlier in the course of the disease. This project created a 3D Convolutional Neural Network (CNN) built from structural MRI scans with the ability to predict, simply from brain structure, whether or not patients have these disorders. A model with an accuracy of over 80% was derived from publicly available data sets of 70 patients with and without neurological disorders, but more importantly, this project identified the structures of the brain most likely involved in depression, primarily the brain stem. Other research has similarly found variability in brain stem structure of those suffering from depression. This finding can allow for improvements in targeted treatment strategies, such as deep brain stimulation or other interventions that can be directed to a particular location. This method of identifying potential illness also allows for an impartial diagnostic technique not affected by human bias. Using a CNN model can improve the possibility for early detection of neurological disorders, improving both a patient's prognosis and the effectiveness of early intervention. Improved understanding of structural causes of neurological disorders, as well as deep learning models with the ability to predict diagnoses, are crucial in reducing the economic impact that neurological disorders impose on society.

Behavioral and Social Science

6 BI 300

Nguyen, Abigail

Kenmore Middle School

The Effect of Popular Drinks on Tooth Enamel

Inside and outside of school, kids and teens often drink fun beverages, but they also often don't know the effect it has on their teeth. It is important to know the effect things you drink have on your teeth because if the effects are negative, then you can take measures to help your teeth and be more healthy. The goal of this project is to find the effect of different drinks on eggshells. I am using eggshells to simulate tooth enamel because eggshells and tooth enamel are both made of high-calcium compounds. To do the experiment, I put eggs in mason jars and filled them up with the different drinks. I then left them there for approximately 24 hours, and took a picture of each egg the next day. The eggs were soaked for two more days and every 24 hours I took a picture of the eggs. After three days, each drink did have an effect on the eggshells (Sunny D = 3 units of change, Coca Cola = 2 units of change, Alani Nu = 3 units of change, coffee = 2 units of change). In conclusion, my project shows people that they should not constantly consume drinks like these because of the effect it can eventually have on your tooth enamel, but it is okay to have them every once in a while.

Biochemistry

8 BI 301

Bradley, Emmalene

Kenmore Middle School

The Effect of the Hydrogel Type on the Water Conservation of the Soil and Hydrogel

The purpose of this experiment was to test ways to conserve water in agriculture. Earth's water is limited, so finding ways to conserve it is vital. Hydrogels are a potential method to reduce the water used in agriculture. When in soil, hydrogels absorb irrigation and rain water and distribute it back to plants. However, the ones currently used in farming contain harmful chemicals, so the hydrogels tested in this experiment were environmentally friendly: Agar, derived from red algae; HEC, found in plant cell walls; and a combination of Agar + HEC. The hypothesis was that HEC would perform best, because it acts as a barrier for cell components, and therefore could serve as a barrier to water. The first part of the experiment was putting the hydrogels into containers and weighing them to evaluate the amount of water absorbed. The second part was chopping up hydrogels, mixing them into pots of soil, pouring water in, and measuring their weight daily. As the experiment progressed, the hydrogels lost water as shown by a decrease in weight, and the one that lost the least amount retained the water best. The results showed that Agar lost the least amount of weight/water in the container part of the experiment, and therefore retained water better under those conditions. However, the HEC and Agar + HEC hydrogels tied in losing the least amount of water in soil. In conclusion, HEC or HEC + Agar would be best at helping retain water and decrease the water loss

Biochemistry

8 BI 302

Downs, Sam

Dorothy Hamm Middle School

What is the Effect of the Type of Liquid on the Amount of Tooth Decay?

For my experiment, I studied the effect of different liquids on tooth decay. I used cow teeth because they have a similar structure and composition to human teeth, and the reactions to different liquids may be the same. This experiment could help humans prevent tooth decay over time from drinking unhealthy or harmful liquids. My testable question was, "What is the effect of the type of liquid on the amount of tooth decay?" To test this, I placed a cow tooth (of mass between 6.5 g and 11.3 g) into 100 ml of a liquid. The liquids included carrot juice, lemon juice, spring water, whole milk, Original Coke, and Diet Coke. I weighed each tooth after 1 week in liquid, then after 2 weeks in liquid. I found that lemon juice, the most acidic, caused the teeth to lose an average 15.4% of its starting mass. The teeth in Coke, Diet Coke, and spring water lost less than 1% of the original mass, and the teeth in carrot juice and whole milk gained around 1% of its mass. These findings can help people care for their teeth by limiting the amount of acidic liquids, like lemon juice, they drink.

Biochemistry

8 BI 303

Forster-Jones, Hannah

Dorothy Hamm Middle School

The Effect of Banana Ripeness Levels on Sugar Content

Fruit ripens- the fact is unmistakable. It turns from inedible and unappetizing to delicious over time. My science project was conducted to find if sugar content is changed during the fruit ripening process. More specifically, it examined the effect of ethylene gas and other factors on the sugar concentration of bananas as they ripened. This was done using a ^{o}Brix refractometer, a tool that refracts light to measure the percentage (^{o}Brix) of sugar in any given liquid. Every other day, findings for six sections of bananas were recorded on a document. The color of banana and average ^{o}Brix of each day were also noted. After five days of data recorded, my overall results showed a significant increase in sugar concentration from green bananas to fully ripe ones, with an outlier on the final day. These results confirm that the chemical composition of bananas does change over time, and that sugar is a factor influenced. Additionally, they could help people who have to or would like to minimize sugar consumption now and in the future.

Biochemistry

9 BI 304

Cohn, Zoe

Alexandria City High School - King Street

Feel the Heat: The Effect of Temperature on the Rate of Catalase-Hydrogen Peroxide Reactions

Enzymes are catalysts that facilitate important biological processes in plants and animals, from helping convert light to energy in photosynthesis to aiding digestion. All enzymes have a "Goldilocks zone" optimum temperature where they function most efficiently. This project investigated how temperature affects the efficiency of catalase, an enzyme that breaks down harmful hydrogen peroxide in cells into oxygen and water. I hypothesized that catalase exposed to higher temperatures would work faster because warmer environments have more kinetic energy, resulting in more collisions between molecules. To test this, I extracted catalase by blending potato chunks with distilled water and ice and running the solution through a coffee filter. I submerged 3x3 cm. coffee filter squares in the solution and dropped the squares into seven jars filled with 40 milliliters of hydrogen peroxide at temperatures from 0 to 60 degrees Celsius. I measured the catalase efficiency by timing how fast the squares rose to the surface, propelled by oxygen bubbles as the hydrogen peroxide broke down. I found that the catalase worked faster as the jars grew warmer. The square rose fastest at 40°C, with an average time of 11.56 seconds over five trials, and slowest at 0°, taking 61.08 seconds on average. At 60°C the filter remained at the bottom after two minutes, indicating the enzyme had denatured. This shows enzymes exposed to 40°C are more efficient than those in cooler environments. Learning about the conditions for optimal enzyme activity is important to further the development of life-saving biotechnology.

Biochemistry

10 BI 305

Cahir, Elizabeth

Alexandria City High School - King Street

Plastic vs Algae

The goal of this project was to find the most harmful microplastic type to chlorella vulgaris growth, which is highly compacted with nutrients and is commonly consumed by many life forms. The death and decline of a chlorella vulgaris area woud cause dead zones due to its extreme contributions to oxygen levels in freshwater ecosystems. To test which types of microplastics are most harmful to algae growth, the project starts with five different petri dishes all containing the same amount of water and chlorella vulgaris culture. One petri dish will be grown normally as a control group, with no added plastics. Four different types of microplastics are placed in their own individual dish. The four plastics are polystyrene, polyethylene terephthalate, polyvinyl chloride, and polyester. For five days, the algae was grown normally with nutrients and regular mixing periods but with the addition of the plastics. At 4:25 each day, the dishes were photographed to measure their growth using the green index scale/ arbitrary units. Data collection lasted over a two month period starting in late -mid November moving into late December, Polyvinyl Chloride was found to be the most harmful to algae growth. In the petri dishes, Polyvinyl Chloride had repeatedly absorbed the algae culture and the water in the dish. On average the Polyvinyl Chloride dish had a unit of 63 a.u which documented the least average growth out of all of the cultures. In conclusion, Polyvinyl chloride was the most harmful to chlorella vulgaris cultures.

Biochemistry

10 BI 306

Ghosh, Sophia

Yorktown High School

The Effect of the Amount of Time on Iron Supplement Absorption When Calcium Is Present

Iron deficiency is the most common form of nutritional deficiency in the world, and it is estimated that 14-18% of Americans take an iron supplement. Calcium is an inhibitor of iron absorption, meaning when iron and calcium are absorbed in the body simultaneously, iron absorption is significantly reduced. In this project, a simulation of iron absorption was conducted to examine how time affects the absorption of iron when calcium is present. Hydrochloric acid simulated stomach acid, dialysis tubing represented the small intestinal lining, and distilled water represented the bloodstream. The IV was the amount of time, and the DV was the amount of absorbed iron. The levels of IV were 0 hours, 1 hour, 2 hours, 91 hours, and 99 hours. The hypothesis was that the most iron would be absorbed after 99 hours, because the calcium would have the longest time to pass through the dialysis tubing, so the iron and calcium would not be absorbed simultaneously. Two solutions were mixed, one composed of iron tablets and hydrochloric acid, and another of iron tablets, calcium tablets, and hydrochloric acid. The solutions were piped into 4 dialysis tubes. The dialysis tubes were placed in four separate beakers of distilled water, and a spectrophotometer was used to measure the amount of iron absorbed into the distilled water after each of the IV times had elapsed. The data was not reliable due to an error in the testing method. Further testing would need to be conducted to reach a viable conclusion.

Biochemistry

10 BI 307

Jolly, Avaani

Yorktown High School

 Investigating Hidden Sugars (Glucose and Sucrose) in Food Using Invertase

This study investigated the presence of hidden sugars in everyday foods by measuring glucose levels before and after treatment with the enzyme invertase. The human body breaks down sucrose into glucose, which directly affects blood sugar. Many foods contain hidden sugars, especially sucrose, that are not always obvious from taste alone, which can cause serious health risks like diabetes. Four foods: pure maple syrup, orange juice, strawberry yogurt, and banana, were selected to represent a range of natural and processed sugar sources. Glucose concentrations were measured in each sample both prior to and after the addition of invertase, which breaks sucrose down into glucose. The hypothesis predicted that foods high in sucrose would show a significant increase in glucose following enzyme treatment, while foods already high in glucose would show a smaller change. The results supported this hypothesis: maple syrup exhibited the greatest increase in glucose, while orange juice and yogurt showed smaller changes. These findings demonstrate that many foods contain more hidden sucrose than is apparent from their initial glucose readings, and that enzyme testing can help reveal these hidden sugars. The study underscores the importance of understanding how sugars are processed in the body, particularly for individuals who need to manage their blood sugar levels.

Biochemistry

10 BI 308

Soronzonbold, Orgil

Washington-Liberty High School

Engineering a More Thermostable Hemagglutinin H Measles Protein: A Computational Protein Engineering Approach

The purpose of this project was to determine if a more thermostable Hemagglutinin H protein could be discovered. The research question is: What is the effect of Protein Engineering methods through computation tools on the thermostability of a mutated Hemagglutinin H protein? The independent variable was the residue mutation. The dependent variable was the average ΔΔG score across 10 computational tools. The control in this experiment was the original Hemagglutinin H protein.

A variety of mutations were tested. The hypothesis was: Mutating specific residues of the Hemagglutinin H protein using different protein engineering methods will result in increased thermostability with a more favourable ΔΔG score. The null hypothesis was: Mutating specific residues of the Hemagglutinin H protein will not yield any differences in stability.

After testing all mutations, two key findings were found, including the high consensus rate of the E90L mutation and the possible stability hotspot of residue G157. The E90L mutation reached a consensus rate of 90%, meaning 9/10 tools deemed this mutation stabilizing, with an average ΔΔG score of -0.74 (stabilizing). Also, position G157 was found to be a potential stability hotspot due to multiple mutations at this position being favourable with a consensus rate of 70%. These findings are novel and not found in preexisting literature. The results agree with the Protein Engineering goal of enhancing and modifying properties of proteins

Biochemistry

10 BI 309

Kwakye, Clara; Eyeson, Leslie

Alexandria City High School - Minnie Howard

Blood Pressure in Position

The purpose of this study is to further investigate how different body positions impact blood pressure readings. This is significant to the ever-expanding medical field because understanding what role our body positions contribute to blood pressure readings can prevent misdiagnosis and other inconsistencies. Moreover, this study may benefit individuals who routinely check their blood pressure. If you or someone you know regularly checks blood pressure, it's important for you to understand the various implications.

With that being said, we hypothesized that an individual's blood pressure when recorded is the most accurate when standing in comparison to sitting with legs crossed or lying down. Our procedure involved measuring blood pressure while in various positions. Sitting upright in a chair with proper posture, feet flat, and arms resting and cuff at the level of the heart is considered the standard, accurate blood pressure reading. Our independent variable was the body position, and the dependent variable was the blood pressure reading. Our data showed that standing had a 3-5 systolic difference and a 2-4 diastolic difference. This was the closest to our control. In contrast, sitting with legs crossed had a systolic difference from the control of 4-7, while diastolic was a difference of 4-6. Lastly, lying down had a systolic difference of 8-15, while the diastolic difference was 8-20. Lying down displayed the most contrasting blood pressure reading. In conclusion, our science fair project contributes to cardiovascular research, providing insight into how body position plays a role in blood pressure readings.

Biochemistry

11 BI 310

Goshiye, Nahom

Veritas Collegiate Academy

In Silico Analysis of Peptide-Binding Affinities to Transferrin Receptor 1 (TfR1) for Targeted Blood-Brain Barrier Drug Delivery

The Blood-Brain Barrier (BBB) is an anatomical structure of endothelial cells held by tight junctions that limit paracellular transport, excluding approximately 98% of potential neurotherapeutics. This renders the treatment of pervasive brain diseases such as Alzheimer's and brain cancer challenging. Receptor-Mediated Transcytosis (RMT) is a mechanism that can be utilized to penetrate the BBB by using receptors on the luminal membrane to facilitate drug delivery into the Central Nervous System (CNS). Human transferrin receptor 1 (TfR1) is highly expressed on BBB endothelial cells and facilitates iron transport via the protein transferrin (Tf), making it a target for studies targeting drug delivery to the brain. This study aims to quantify binding affinities via Gibbs Free energy in kcal/mol and provide an analysis of intermolecular hydrogen bonds of various peptide "shuttles" to the apical domain of TfR1 (PDB ID: 1CX8). Targeting the apical domain avoids competitive inhibition with the natural Tf ligand, which would lead to iron deficiency. A comparative analysis will be conducted using four ligands—T7 (HAIYPRH), THR (THRPPMWSPVWP), CRT (CRTIGPSVC), and a scrambled T7 sequence (IPYHRAH)—to evaluate the role of primary structure and sequence specificity in binding. This study utilizes molecular docking via AutoDock Vina, with visualization provided by UCSF ChimeraX, and peptide structures acquired from AlphaFold3. Binding will be simulated at pH 7.4 (bloodstream) and pH 5.5 (endosome) to evaluate release potential. This in silico approach provides a computational roadmap for optimizing BBB drug delivery systems, potentially accelerating treatments for neurological disorders.

Biochemistry

11 BI 311

Fan, Jerry Jiayu; Xue, Lezi

Veritas Collegiate Academy

Enzymatic Engineering with Molecular Dynamics Guidance for the Computational Screening and Mechanistic Analysis of SARS-CoV-2 nsp5 Inhibitors

The SARS-CoV-2 influenza virus Coronavirus replication and transcription are assisted by the catalytic enzyme SARS coronavirus main protease (Mpro, nsp5). Although it is of great significance, about the structural factors that determine its catalytic activity are little-known, and there is no effective functional screening procedure. In this study, I have established a computation-first framework, and analyzed the structural and dynamic modulation mechanisms of the distal mutation control nsp5 function. Using molecular dynamics simulations, I studied the effects of a distant mutation (T21I) on the antiviral inhibitor ensitrelvir interactions, binding pocket stability, and protein flexibility. According to these models, the T21I mutation helps to fix the binding bag and enhance important non-covalent interactions. I isolated and expressed wild-type and mutant nsp5 proteins in E. coli. Then using fluorescence-based kinetic analysis, I quantified their enzyme activity, which provided experimental verification for these predictions. The catalytic efficiency of T21I mutants has been greatly improved. These results show that mutations away from the active site can improve the binding of inhibitors, thus improving the catalytic efficiency. All in all, this study, by creating a calculation framework for the mechanism analysis and prioritization of nsp5 inhibitors and mutations, provides the theoretical foundation for protease engineering and antiviral drug development.

Biochemistry

6 CH 400

Black, Elizabeth

Williamsburg Middle School

The Effect of Bioplastic Composition on Tensile Strength

Bioplastics are a growing alternative to petroleum-based plastics. Bioplastics that use starch are often biodegradable. The experiment explored how the amount of glycerin used in a starch-based bioplastic affects the tensile strength of the material. The experiment tested the hypothesis that if the amount of glycerin in the bioplastic increases, then the tensile strength of the bioplastic will also increase because the material will be more flexible and less brittle. A series of bioplastics were synthesized and then samples were tested to failure using a force meter. Three different compositions of bioplastic with low, medium, and high quantities of glycerin were made. The medium sample group performed the best with a mean maximum force resisted of 75.33N followed by the high samples group (48.16N) and the low sample group (43.61N). The hypothesis was partially supported because comparing the low and medium samples groups showed that higher amounts of glycerin did increase the force needed to break the samples. Comparing the medium and high samples groups showed that too much glycerin reduces the amounts of force needed to break the sample. The results suggested a curve with the optimal amount of glycerin found in the medium sample group made with 10g of glycerin. This resulted in a balance of flexibility and strength.

Chemistry

6 CH 401

Midboe, Michaela

Kenmore Middle School

The Effect of Temperature on the Amount of Voltage and Amperage Produced by a Piezoelectric Crystal When Struck

The purpose of this experiment is to determine the relationship between temperature and the amount of electricity (voltage and amperage) produced by a piezoelectric crystal when struck. The data obtained in this experiment could be used in piezoelectric technology to more precisely control the amount of electricity generated by the device. The procedure consisted of exposing a piezoelectric sensor to four temperatures: -2°F, 61°F, 125°F, and 176°F, about 60°F apart each. To achieve the correct temperature of the sensor, an oven was used, and for the cold temperature, a freezer. The crystal was measured with a multimeter, and a standard weight was applied to the crystal, then the amount of electrical energy produced by the crystal was recorded. The results showed that as the temperature increases, the amount of voltage and amperage produced by a piezoelectric crystal increases. The average amperage increased by almost 3 times every 60°F increase in temperature. Voltage increased slowly, between -2°F and 125°F it increased only by about 0.01 volts, but at 176°F the volts increased by almost 3.5 times. The range of the trials stayed constant, but the standard deviation went up to 0.18 volts at 125°F. This could indicate to researchers that piezoelectric crystals can generate a larger range of electricity as temperature increases. The applications of this experiment could be used to create more precise piezoelectric technology that is affected by weather conditions such as temperature. It could also be used to create inventions, such as a piezoelectric thermometer.

Chemistry

6 CH 402

Walters, Elia; Chauvenet, Sonia

Gunston Middle School

The Effect of Different Produce on Conducting Electricity

In our experiment we were trying to find which food would give off the highest voltage. Out of a lemon, a potato, and an orange the orange had the highest voltage, but when we found the average the lemon won! We tested three of each fruit. The lemon having the highest voltage average matched up with our hypothesis.

Chemistry

7 CH 403

Dominguez, Emilia

Francis C. Hammond Middle School

Towel Troubles: Which Material Dries The Fastest?

Everybody spills water around their house from time to time. Normally people would just use a non-reusable towel to clean it up, but despite its efficiency non-reusable towels are horrible for the environment, creating problems like water pollution, deforestation, and landfill crisis so what if you could have a reusable towel that air dries easily, is efficient, and doesn't affect the environment as much? The purpose of this experiment was to determine the difference in drying times between a variety of towel materials. Non-reusable towels are harmful to the environment, with this data the most efficient reusable hand towels can be identified. If the microfiber towel absorbs water, then it will take the shortest time to air-dry. This data can be found by soaking different materials of hand towels in water for five minutes and timing how long the towels take to dry indoors. The results of this experiment show how the microfiber towel takes the fastest time to air dry with the average of all the trials being 00:53:27. In conclusion, the fastest reusable towel at drying is the microfiber towel.

Chemistry

7 CH 404

Gupta, Leena

George Washington Middle School

Rust Warriors: How Paint Prevents Corrosion

The purpose of this experiment is to investigate what brand of paint protects steel exacto knife blades from corrosion the best. To conduct this experiment the following procedures were used:

  1 Prepare the metal by washing and sanding it.

  2 Paint the metal and place in petri dishes with just enough water to cover the metal. The water has salt in it with a ratio of 2 teaspoons to every 1 cup of water.

  3 Observe and take photographs every other day for 2 weeks.

  4 Place a graph with 0.5 ㎠ and count how many squares have corrosion.

  5 Record the data on a graph.

      The data does not support the hypothesis because the hypothesis was that the Golden paint would protect the metal from rust the best. On the contrary, the Folk Art paint brand protected the metal from corrosion the best. The data shows that the average of all of the folk art trials is less than the averages of the other paint. For example, the average bars on the graph show that the metal with the Folk Art paint has the least amount of corrosion, with an average of 21.4/40. Based on the finding, the Folk Art brand paint had the greatest protection from corrosion. But, it can also be inferred that acrylic paint is not great for protecting metal from corrosion, because all metal showed rusting within the first 2 days.

Chemistry

7 CH 405

Rahmatullah, Husna

Francis C. Hammond Middle School

The Effects of Different Ice Shapes on Their Melting Time

While trying to equalize temperatures, heat moves from warmer to colder areas. This means as ice cools your drinks, its surface absorbs the heat of the liquid. The larger the surface of the ice the faster it will absorb the warmth. However the heat quickly melts the ice cubes leaving dissatisfaction as you force yourself to gulp down the now warm diluted drink. If cubed ice is used in a drink, it will melt faster than if spherical ice is used. To test this, spherical and cubed ice of the same volume are placed out to melt. They are timed and the results are placed into a data table. The results show on average sphere shaped ice melts after 165.75 minutes while cubed ice melts after 159.75 minutes. Spherical ice melts slower than the ice cubes because its surface area is smaller. Having a smaller surface area allows the sphere to absorb the heat at a slower rate therefore slowing down how long it takes to melt.

Chemistry

7 CH 406

Removic, Maya

Patrick Henry K-8 School

Lemon Batteries and LED Lights

Lemon batteries are a example of how people use natural materials to generate electricity to power a small device like a LED, without producing any waste. However, not many individuals stop to think about what factors affect how long that light will stay bright. Commercial batteries don't last very long and use chemicals that harm our planet. It is extremely useful to explore how to use natural resources and improve their performance.

The purpose of my experiment was to determine whether the lemon size affects how long a 2V LED stays lit. My hypothesis was that a lemon battery made with big lemons would keep a 2V LED Light bright longer than the battery made with small lemons.

To test this, I set up 2 three lemon batteries; one using big lemons and one using small lemons. I connected each battery to a 2V LED and then measured the voltage and observed the brightness in the span of 2 hours.

The result showed that the big lemon battery kept it's brightness and voltage longer than the smaller one. After 2 hours, the big lemon battery had 1.3 V while the smaller lemon battery dropped to 1.1 V.

In conclusion, my project contributes to the study of how the amount of electrolytes affects how long the battery lasts. My objectives were met, providing that the results supported my hypothesis.

Chemistry

7 CH 407

Wilhelm, John

Francis C. Hammond Middle School

The Effect of the Water Brand on pH

This experiment investigated the relationship between brands of water and pH. It was hypothesized that if Fiji, Deer Park, Dasani, and Tap water were tested for pH the brand with a pH closest to neutral would be Fiji. Three brands of water and the control of tap water were tested three times for pH with a pH meter. The results showed that the brand of water with a pH closest to neutral was Deer Park with an average pH of 7.13 and the brand with a pH farthest from neutral was Fiji with an average pH of 7.40, the farthest pH from neutral of all water tested was tap with an average pH of 7.46. The hypothesis was not supported by the experiment and the brand of water with a pH closest to neutral is Deer Park.

Chemistry

7 CH 408

Wirtz, Elaine

Patrick Henry K-8 School

Bustin' The Rust

This experiment's goal was to test and identify a good rust remover for iron. This experiment tested 2 commercial products (RustAid Rust Remover, and Naval Jelly Rust Dissolver) including one household remover made of 1 part lemon juice and 2 part baking soda. Each rust remover had a different acid. The Naval Jelly had phosphoric acid that I thought would work better than the hydrochloric acid in RustAid and the citric acid in the lemon juice paste. I started by making the rust by spraying on a homemade solution.Then I applied an even layer of each rust remover to one of the three sections of the metal and started the stopwatch. I applied a remover to a new section at minutes 0, 5, and 10. to see how quick each remover worked. I let them all sit for 5 more minutes then at minute 15 I rinsed them all off except for the metal affected by the lemon juice paste in which it was scrubbed with steel wool. In order to make my results more fair I also used some steel wool to scrub at the control to see if the lemon juice paste did all the work or if steel wool did it by itself. In my opinion the lemon juice paste showed the worst results probably because citric acid isn't as strong, but it is easy to make. The RustAid rust remover ended up removing more rust than Naval Jelly because the hydrochloric acid worked better.

Chemistry

8 CH 409

Epstein, Stella

Dorothy Hamm Middle School

The Effect of Different Temperature Water on Reaction Time of Alka Seltzer Tabs

For my project, I dropped Alka Seltzer Tabs into different temperature waters to see which water temperature made the Alka Setzer tabs dissolve faster. This experiment is important to people all around the world and specifically to the health industry. My experiment is a first step to having a faster treatment to aspirin which can make pain go away quicker more efficiently! My testable question was the effect of water temperature on the reaction time of Alka Seltzer tabs. In my procedure, I poured 250 mL water of different temperatures into various glasses. From there I dropped the alka seltzer tab in and individually tracked the amount of time it took for each tab to fully dissolve. For the hot water which was about 49°C it took about 15.99 seconds to fully dissolve. For the room temperature at 3° C it took about 49.02 seconds to dissolve. Then for the cold water which was about -12° C it took about 173.43 seconds to dissolve. The final conclusion was that the temperature of the water did matter when it comes to the difference in reaction time.

Chemistry

8 CH 410

Fairfield, Sean

Dorothy Hamm Middle School

The Effect of State of Matter on the UV Light Retention of Glow-in-the-dark Materials

Ultraviolet light is fascinating to me- especially the invisible parts of the light spectrum. The things that we don't know and the things that we can't see are what drive us to investigate and experiment. For my experiment, I investigated how glow-in-the-dark materials absorb UV light, which can have a diverse range of impacts.

My hypothesis was as follows: If the state of matter of a glow-in-the-dark substance is a solid, then it will have a greater absorption of UV light, proven in luminescence, because phosphor atoms are tightly packed into a solid, allowing it to waste less energy as heat, which may happen in liquid form. With this, I answered the question: How does the state of matter of different glow-in-the-dark materials affect UV light absorption?

To conduct this experiment, I placed each of the materials I was testing (paint, stickers, and a lighter) under a UV light for approximately five minutes. Next, I moved them to a dark room, where I captured their individual Kelvin measurements every thirty seconds for five minutes. This was repeated three times so the data could be averaged.

For the results, there were a few outliers; however, the data showed, on average, the paint had the highest UV light retention at 5100.333333 K, and the lighter had the least at 4718.333333 K.

Although this experiment may not have a clear societal impact, it can actually help in the development of fertilizers that improve photosynthesis, as well as certain military processes.

Chemistry

8 CH 411

Mcdonald, Emma

Williamsburg Middle School

The Effect of the Household Liquid on the Amount of Electrolytes in That Content

Electrolyte's are in so many drinks around us. Electrolytes are very important for your body but also are very dangerous if you have too many. Electrolytes can help when you are sick and help your body regulate chemical reactions and maintain fluids inside and out made your cells. However if you have too many it could cause things like alkalosis and hypocalcemia. During my project I tested the amount of electrolytes in the drinks milk, filtered water, tap water, coke, orange juice, and blue Gatorade. During my experiment I found out that milk had the most electrolytes and filtered water had the least. This surprised me because I thought that Gatorade would have the least because people always drink it after they workout so they can replenish themselves. The ranges between the variables were low, therefore the experiment was trustworthy. Another reason that my experiment was trustworthy is because I had lots of constants, for example I set out all the liquids until they were room temperature so they would be the same. I measured the electrolytes in Milliequivalent per liter or millimoles per liter. The first thing I did to start my project was set up the electrolyte tester. The way I did this was connect a bunch of wires to a straw and a meter to measure the amount of electrolyte.

Chemistry

8 CH 412

Pines, Oren

Williamsburg Middle School

What Is the Effect of the Type of Citrus Fruit on the Amount of Energy Generated

This project investigated whether the type of citrus fruit affects how much electricity it can generate in a simple "fruit battery." Fruit batteries can be useful for understanding basic energy production during power outages because acids in fruit help enable a chemical reaction between two different metals.

The research question was: Which citrus fruit generates the most electricity? The hypothesis predicted that a lemon would generate the highest voltage because lemons contain a high amount of citric acid, which supports the movement of ions needed to produce electricity.

To test this, the student used the same circuit setup for each fruit: one zinc piece and one copper piece inserted into the fruit the same distance apart, then connected to a voltmeter. The independent variable was the type of fruit (lemon, orange, lime, grapefruit), and a banana was included as a control comparison. Several constants were kept the same, including fruit temperature, countertop temperature, metal size, fruit ripeness, and the instrument used to measure voltage. Five trials were completed for each fruit, and the mean voltage and range were calculated.

The results showed that the lemons produced the highest average voltage (0.9374 V), followed by limes (0.8944 V) and oranges (0.8686 V). Grapefruit produced the lowest average voltage (0.4932 V). The findings supported the hypothesis that lemons generate the most electricity in this setup.

Chemistry

8 CH 413

Rouland, Sophia

Dorothy Hamm Middle School

The Effect of Urbanization on Calcium Concentration in Soil

This project examined how urbanization affects calcium concentrations in soil, measured in pounds of calcium per acre. Calcium is an essential nutrient for plant growth, but excessive amounts can negatively impact soil health by raising pH and interfering with the positive effects of other nutrients. The purpose of this study was to examine differences in soil calcium levels among disturbed and less disturbed locations in Arlington.

My hypothesis was that soil from urban and industrial sites would contain higher calcium levels than soil from parks or schools due to human activities such as construction, concrete use, and lime application. Soil samples were collected from six sites representing different land uses, including a former coal trestle, gas station, park, school, former municipal parking lot, and my front yard. Four samples were taken from each site using clean tools to avoid contamination. All samples were sent to the Virginia Tech Soil Testing Laboratory for analysis.

Results showed that five of the six sites had calcium levels above the recommended healthy range of 721–1,440 lb/A. The former coal trestle, gas station, and residential front yard had especially high calcium levels, while the school site was the only location within the healthy range. These findings generally supported the hypothesis, although the high calcium level in my front yard was unexpected.

Overall, the study suggests that urbanization and past land use can significantly increase soil calcium levels. Understanding these effects is important for managing healthy urban soils and supporting plant growth in cities.

Chemistry

8 CH 414

Saperstein, Laura

Swanson Middle School

The Effect of Polymer Concentration on Hydrogel Viscosity

The purpose of my experiment was to create a method to control the thickness of a drink. The results of my experiment are beneficial to people who experience a medical condition known as dysphasia, which affects 15 million Americans. Dysphasia makes swallowing difficult and dangerous because of the risk of aspiration. One way to manage dysphasia is by adding a drink thickener to liquid liquids, so they flow more smoothly and reduce the risk of choking. My experiment determined how collagen concentration affected the viscosity of water through gelation. My hypothesis was if polymer concentration is increased then hydrogel viscosity will increase as well. Hydrogels were prepared at concentrations of 5%, 6.25%, 7.5%, and 8.75%, with 0% as control. A falling ball viscometer was used to measure the viscosity of a gel by recording the time for a steel ball to fall through two points on a graduated cylinder. Each trial was repeated 10 times to ensure accuracy. My data supported my hypothesis through 7.5% concentration. For tests at 8.75% concentration and higher, the ball drop time was infinite. At a polymer concentration between 7.5% and 8.75%, the gel became too viscous for the ball to drop. Excluding 8.75% concentration, there was a statistically significant, positive relationship between polymer concentration and viscosity. This work provides an approach to control drink thickness for someone with dysphasia. I would recommend 7.5% concentration, as it is more than three times as thick as water.

Chemistry

8 CH 415

Scanlon, Harper

Jefferson-Houston PreK-8 School

Does the Amount of Salt Added to Water Affect How Rapidly It Boils?

In my experiment I tested the known old wives tale: does putting salt and water make it boil faster? Me and my mom love to cook together and every single time we always talk about if adding salt to water is just a norm passed down, or does it really help speed up the boiling process. To run my experiment I tested three different amounts of salt 10 g, 20 g and 30 g. To measure how fast it would boil I would start my stopwatch when I started boiling the water, keep a thermometer in and once the thermometer hit 212°F boiling point, that amount of time would be my data. After running my experiment I found it quite inconclusive. Once I averaged each of my amounts of salt they came out at all different amounts sometimes being more than the last amount and sometimes being higher for no apparent reason. With even the 20 G having an 8 seconds less average than the 30.

Chemistry

8 CH 416

Stanley, Ruby

Kenmore Middle School

The Effect of the Concentration of Hydrogen Peroxide on the Duration and Brightness of Light in the Luminol Reaction

In crime scene investigations forensic scientists use a multitude of different tools and technologies. One of these includes a chemical solution called "Luminol". Luminol is a blood identifier that utilizes chemiluminescence to produce a glowing light. The researcher hypothesized that if the concentration of hydrogen peroxide is increased then the duration of light and brightness of light will decrease. In an at home reaction hydrogen peroxide is combined with a mixture of potassium ferricyanide, sodium hydroxide, and water. The hydrogen peroxide works as an accelerant and activator in the reaction. Adding differing amounts of the hydrogen peroxide the duration and quality of light in the reaction will differ. Without knowing the optimal ratio and concentration risks losing vital evidence, therefore the goal of this scientific investigation is to determine the most favorable concentration of hydrogen peroxide. To prepare this experiment two mixtures were created, mixture A & mixture B. In the control, mixture A contained 100ml water, 0.18g of luminol, and 3ml of sodium hydroxide. In mixture B, 100ml of water was combined with 1ml of hydrogen peroxide and 0.03g of potassium ferricyanide. When combined in equal parts a blue glowing light is produced. Due to the increasing amount of hydrogen peroxide, the light and duration decreases. This happens due to the excessive energy taken by whatever amount of hydrogen peroxide is added. Knowing the most effective concentration of hydrogen peroxide will allow for more accurate and effective tests. Therefore, improving an essential tool in the forensic community.

Chemistry

8 CH 417

Timbo-Jalloh, Aaliyah

Francis C. Hammond Middle School

Crystal Creations

This project tests if the amount of salt in water changes how large salt crystals can grow on a string. For the experiment, different amounts of salt were mixed into cups of hot water, then a string was hung in each cup. Everything else, (the cup, water, string, and room temperature) stayed the same. After one week (7 days), the sizes of the crystals on each string were measured and graphed. This experiment helps show if using more salt will make larger crystals form.

Chemistry

8 CH 418

Tsang, Amalee

Swanson Middle School

The Effect of Sport Drink Brand on Electrical Current

Electrolytes are critical for the body to function, and also conduct electricity when dissolved in water.

This experiment compared electrolyte content in different drinks. A circuit was built with a multimeter to measure current and the liquid to close off the circuit. Then the current was measured determining the conductivity of a drink.

The hypothesis was if the current of each drink was measured, drink B will have the highest current, and therefore, electrolyte content. In this project, the independent variable is sport drink brand, and dependent variable is electrical current. Levels being water (control), drink A, and drink B. Constants in this experiment included using the same amount of liquid, multimeter, dish and circuit.

After conducting the experiment, the data supported the hypothesis. After 10 trials, drink B had an average current of 19.74 milliamperes, followed by drink A with 8.11 milliamperes, and then water with 2.6 milliamperes. The conductivity was calculated using conductivity = current/voltage. The voltage was constantly 9, and therefore a higher current resulted in higher conductivity.

Using this, the conclusion was that drink B has the highest current, and therefore, highest electrolyte content; and it's followed by drink A, then filtered water.

Electrolytes are crucial for the body helping with water balance and much more. However, these electrolytes are lost during exercise through sweating. The data shows drink B will help replenish lost electrolytes the best, and drink A still helps more than water.

Chemistry

8 CH 419

Singh, Ronin; Batsukh, Odjargal; Idris, Yusuf

Thomas Jefferson Middle School

Saltwater Battery

In this experiment, we investigated how Himalayan salt, compared to iodized salt, in water changes the amount of electricity produced from the saltwater. Based on our background research, a hypothesis was formed stating that increasing the salinity of the water would increase the voltage produced. To test this hypothesis, a saltwater battery was constructed using a container of water, measured amounts of salt, and electrodes made from copper and zinc metal. The independent variable was the amount of salt added to the water and the type of salt used, while the dependent variable was the voltage measured with an ammeter. The constants included the type of metal used, the volume of water, and the testing equipment. Multiple trials were conducted for each salt concentration to improve accuracy and reliability. Data was recorded and averaged, then analyzed using charts and graphs to identify trends. The results showed that different salts affect the voltage output. Some salts, like Himalayan salt, increased the voltage output, while other salts, such as iodized salt, decreased the voltage output. Our findings could be influenced due to the fact that iodine is a natural insulator while Himalayan salt contains minerals that are conductors such as potassium, magnesium, calcium, and iron.

Chemistry

9 CH 420

Bagai, Saira

Arlington Tech and Career Center

The Effect of Different Cooking Methods on the Depletion of Vitamin C in Oranges

Due to the importance of vitamin C in the human body and its role in various bodily functions, it is essential to ensure we're getting a sufficient amount to maintain these processes and prevent scurvy. You also want to ensure that you are not consuming too much vitamin C, as your body is unable to absorb excessive amounts, which can lead to diarrhea, nausea, and stomach cramps. My hypothesis stated that if the oranges were boiled for 25 minutes, then the oranges would have the least amount of vitamin C left because boiling involves high levels of heat and water, and the oranges would be exposed to both of these factors for a prolonged period. I conducted my experiment by cooking orange slices using different cooking methods and then determining the amount of vitamin C they retained after cooking with iodine. After determining which cooking method depleted the most vitamin C on average, I then cooked the orange in that method for varying periods of time and tested the remaining amount of vitamin C using iodine. My results showed that, although there was no statistical significance for all the methods, a statistical significance would be observed if two methods were compared directly. On the other hand, there was a statistical significance among the time periods. This shows that although cooking methods can affect vitamin C depletion, the amount of time spent cooking makes the most difference.

Chemistry

9 CH 421

Foerster, Patrick

Arlington Tech and Career Center

The Effect of Common Insulators on Water Temperature

This project investigates how common heat insulators affect water temperature over time. Insulators are objects that slow down the transfer of energy, and in this project the focus is temperature/heat. This project aims to determine which material best minimizes heat loss. 5 standard jelly jars were used to hold the water, and it was either wrapped with nothing (control), bubble wrap, aluminum foil, fiberglass, or styrofoam. A DS18B20 digital temperature sensor was used to record water temperature every five minutes for a total of 60 minutes. Ten trials were conducted for each material. After ten trials, the control had an average end temperature of 46.3°, bubble wrap had an average of 53.3°, aluminum foil had an average of 57.5°, fiberglass had an average of 67.4°, and styrofoam had an average of 62.5°. On average, the trials that had a thermal insulator performed better than the trials without one. Fiberglass on average was the most effective, and bubble wrap was the least other than the control group.

Chemistry

9 CH 422

Luckett, Malia

Washington-Liberty High School

Comparing the Effects of Cleaning Agent Combinations on Tomato Sauce-Stained Fabric

This experiment was conducted to test the effects of different accessible and environmentally safe stain-removing solutions on tomato sauce-stained white cotton fabric. The hypothesis was that Dawn Original Dish Soap, combined with different cleaning agents, would remove the tomato sauce stain with fewer brush strokes because the biodegradable surfactants in this specific dish soap merged with another strong cleaner would break down food cells better.

The experimental groups were dish soap combined with baking soda, hydrogen peroxide, and white vinegar, while the control group used water. Nine trials were conducted on a white cotton shirt for each group, with 7.5 mL of tomato sauce applied and blotted in designated sections. A solution of 2.5 mL of dish soap and 5 mL of each cleaning agent was applied to the stains, which were left for 24 hours to maximize the effectiveness of the biodegradable ingredients. Stain removal was conducted using a clean toothbrush, limited to 950 brush strokes per trial.

Statistical analysis revealed statistically significant differences in stain removal, with a p-value of 0.01760207 from an ANOVA conducted. T-test comparisons between groups indicated that only one of the three t-tests had a statistically significant difference. Hydrogen peroxide was the most effective agent, with a mean of 908.2 brush strokes compared to the control and baking soda with 950 brush strokes, and white vinegar with 935.7 brush strokes.

The experiment is significant in discovering the effectiveness of these different kinds of household cleaning agents in stain removal.

Chemistry

9 CH 423

Roske, Quinn

Washington-Liberty High School

The Effect of Preservatives on Orange Juice pH Over Time

This study examines the effect of preservatives on orange juice pH. This experiment is important in determining the most effective preservative in terms of microbial growth, safety, and pH maintenance.

The hypothesis stated that if sodium benzoate is put into orange juice, then it will have the least impact on pH compared to the control because it inhibits microbial activity. 100g of orange juice was treated with four variables: no preservative (control), sodium benzoate, potassium sorbate, and malic acid. The experiment used four trials per variable to measure the pH of unsealed orange juice over time. Over 192 hours in room temperature, the control ranged from a pH of 3.485 to 4.05. Potassium sorbate increased the orange juice pH the most, followed by sodium benzoate. Malic acid lowered the pH from hours 48 to 144, but increased to reach equilibrium with the control at hour 192. An ANOVA test showed that the data was significant with a p-value of 2.2773×10^{-15}. The T-Test concluded that potassium sorbate resulted in significant change compared to the control. The orange juice treated with potassium sorbate and sodium benzoate darkened in color, demonstrating microbial growth.

 Another experiment was conducted to understand the effects of temperature on the preservatives functionality. The independent variables remained constant, but the variables were stored in 4.44℃. The results showed that refrigeration slows microbial activity. The data did not show a statistically significant difference between the variables, therfore the null hypothesis was accepted.

Chemistry

9 CH 424

Silva, Zavier

Francis C. Hammond Middle School

Erasing Tomato Stains for Good

For my project, I wanted to know how well different stain removers worked. I researched the different cleaning products and found three stain removers that would best suit this project. The three stain removers I selected were Oxi Clean, Spray 'n Wash, and Miss Mouths Stain Treater. I also used a spray bottle of water to be my fourth option.

I was interested in this project because I eat a lot of spaghetti, which seems to always get spilled on my shirt. My mom is able to get the stain out but I wanted to know which of the products works the best. This project also interested me because I like using chemistry in real life and this seemed to be a good way to use it. I predicted that Oxi Clean would do the best because it has surfactants which lower the surface tension of water and allow the cleaner to go deeper in the fabric, and two different types of enzymes, which help to break down the particles of food on fabric.

For this project I chose white shirts to get stained because the stain would show easier. After I finished doing the experiment, I photocopied the shirts in gray scale. Using the grayscale chat, I gave each pixel in a grid a color score. I found the average the color of the stain using a chart and numbers. I found that, unlike I predicted, the spray bottle full of water did better than any of the other stain treatments.

Chemistry

9 CH 425

Silverbrand, Isabella

Washington-Liberty High School

Activated Charcoal's Ability to Filter Water Better than Filters Without Activated Charcoal

The purpose of this experiment was to determine whether filtration devices containing activated charcoal purify contaminated water more effectively over time than filters without activated charcoal. My hypothesis was the filters containing activated charcoal are more efficient at removing impurities than those without activated charcoal. In order to test my hypothesis, I mixed water samples with either vegetable oil or soil and filtered the samples using different filter types, some containing activated charcoal and some without. I measured the turbidity before and after filtration of all samples and the pH of the soil samples. I conducted multiple trials over time to evaluate the effectiveness of the different filters.

The results demonstrated that filters containing activated charcoal mostly produced lower post-filtration turbidity than filters without activated charcoal, especially for the samples contaminated with soil. The ANOVA tests showed statistically significant differences among filter types for both oil and soil turbidity. I conducted t-tests for certain filter pairs which had overlapping error bars which showed no statistically significant differences between those pairs. The pH data showed little change across the different filters, and the ANOVA test for soil PH was not statistically significant.

Overall, my results support my hypothesis that activated charcoal improves filtration by reducing turbidity. As my research and experiment demonstrated, activated charcoal is an excellent and inexpensive water filter that can be used around the world.

Chemistry

9 CH 426

Spahr, William

Arlington Tech and Career Center

The Effect of the Balloon Material on its Resistance to Internal Air Pressure

All materials have a known property called an elastic limit which defines how much it is able to stretch before it breaks. The purpose of this project was to determine how the balloon type affects its ability to withstand internal air pressure. The "best" balloon will have a high elastic limit so it can inflate the most without popping, allowing for consumers to find the most inflatable balloon type for an event of their choice. Three different types of balloons: mylar, latex, and natural rubber, were placed onto an automatic air pump which would increase the internal air pressure until the balloon pops. A stopwatch was used to time how long the balloon would take to pop. Under this experiment, natural rubber balloons were the best-performing, followed up by mylar and latex. Natural rubber had the highest elastic limit, but mylar has a lower elastic limit than latex, meaning that the hypothesis was disproven. This is because mylar is more rigid than latex, thereby making it more resistant to internal air pressure. The experiment shows that elastic limit only suggests a general trend—it does not entirely determine whether a material is more resistant to internal air pressure or not.

Chemistry

9 CH 427

Swift, Charlotte

Yorktown High School

The Effect of Electrolytes on Electrolysis

In my experiment, I added an electrolyte (salt) to a beaker full of water. Two pencils were submerged in the water, and the opposite (dry) end of each pencil was attached to a 9-volt battery.

The purpose of this experiment was to observe electrolysis as it splits compounds in the pencil graphite, causing the tips of the pencils to bubble.

I did this experiment by adding slightly more table salt for each group, observing the changes in reaction times.

In my data, I noticed a few things. Each group, when I added salt, the time it took for the reaction to happen significantly decreased. The more salt I added, the faster the reaction happened. The average reaction time for each group went down every group (or every time I added salt.) Interestingly, the range for each group of data also went down. There were less outliers. The same was true of the group medians, which also significantly lowered with each group.

My hypothesis was that the more electrolytes (salt) were added, the faster the reaction time would be. My statistical tests show that my hypothesis was correct, and that my hypothesis was statistically supported overall, and between almost all groups. Overall, my hypothesis was correct, and the reaction time got shorter based on the amount of salt I added to the reaction.

Chemistry

9 CH 428

Viser, Abigail

Washington-Liberty High School

Type of Beverage and The Effect on Teeth-like Material

This experiment was conducted to test the type of beverage and its effect on teeth-like material. The hypothesis was the more acidic the drink is, the more solids would dissolve from the teeth-like material. This is because the acid will weaken the enamel on the outside of the tooth. Eggshells were soaked in four independent variables: water (control), orange juice, Coca-Cola, and Diet Coke for five trials. After 24 hours, the parts per million (ppm) was measured with a total solids dissolved (TDS) meter. Orange juice was proved to have the most impact on the eggshells.

After an ANOVA test was completed based on the results, it was shown that there was a significant difference in the beverages with a p-value of 1.12×10^{-39}. A T-test also showed a significant difference. Due to this, the null hypothesis was rejected, which stated that if there is a different type of beverage then there will be no difference in how much the tooth enamel has eroded. Observations from the experiment displayed that after being placed in the beverages, the eggshells were brown, stained, and had a bubbly presentation on them. Following the experiment, the mean of total solids dissolved was 376 ppm for water, 3953 ppm for the orange juice, 289 ppm for the Coca-Cola, and 806 ppm for the Diet Coke. The results supported the hypothesis and proved certain beverages have a negative impact on teeth and the tooth's health.

Chemistry

9 CH 429

Wagner, Simon

Arlington Tech and Career Center

How Liquids and Temperature Affect Alka-Seltzer Dissolving

My project talks about how different liquids at different temperatures affect how quickly Alka-Seltzer tablets would dissolve. The purpose of this project is to reinforce my understanding of molecules and chemical reactions. My hypothesis for what the outcome of this experiment would be is that if Alka-Seltzer tablets are dropped in different fluids at various temperatures, then they will dissolve more quickly in warm water and warm apple juice because warmer temperatures mean higher speeds for all molecules, including those of the dissolving fluid. My approach for this experiment was to place four Alka-Seltzer tablets into four glasses each with a different liquid that had varying temperatures, then time the outcome. The results of my experiment were that the warm water dissolved the Alka-Seltzer tablet the quickest with an average time of 43.36 seconds while the oil in each temperature did not dissolve the Alka-Seltzer tablet at all. In conclusion, my hypothesis on the outcome of this experiment was proven. This project contributed to the chemical field by demonstrating how the molecules inside of an Alka-Seltzer tablet react when in contact with different liquids and how the heat of molecules affects how quickly they move around and break down.

Chemistry

9 CH 430

Whelan, Sophie

Alexandria City High School - Minnie Howard

Sweet Solutions: The Effects of Sucrose Concentration on Rate of Hydrolysis

My project tested how sucrose concentration affects the rate of hydrolysis. I changed the amount of sucrose in solutions of water and used the enzyme invertase to catalyze the hydrolysis. I used urinalysis strips to measure the glucose at regular intervals. Then, I calculated the average number of milligrams of glucose created per minute. I hypothesized that as sucrose concentration increased, the rate of hydrolysis would also increase. In reality, the independent variable level with the greatest rate of hydrolysis was the median (4%). The 0% sucrose solution yielded the lowest rate of hydrolysis. The graphs show that as time passed, the amount of glucose in the solution generally increased; showing that the enzyme worked. There were several outliers in the data set; sometimes the glucose concentration measured to be lower than it had been the previous measurement. This was likely due to malfunctioning test strips or an uneven combination of the particles in the solution. The resulting outliers affected the calculations of average glucose per minute, so they likely altered the results of the experiment. To improve the experiment, one could conduct more trials to create more reliable data and offset the impact of outliers. Additionally, the scientist could test more sucrose concentrations to increase their understanding of how the independent variable impacts the dependent variable. Overall, the results showed that higher concentrations of sucrose generally led to greater rates of hydrolysis; however, outliers largely impact the data and therefore many trials are needed to develop a complete conclusion.

Chemistry

9 CH 431

Williams, Reagan

Yorktown High School

The Effect of the Brand of Bottled Water on the Amount of Microplastics Detected

Microplastics are tiny plastic particles found throughout the environment, including in drinking water. Studies show that about 93% of bottled water contains microplastics, which is concerning because they have been linked to potential health issues such as inflammation, weakened immune systems, and cell damage. Many people choose bottled water because they believe it is safer than tap water, making it important to understand how much microplastic contamination exists in different water sources.

Microplastics can enter bottled water through the breakdown of plastic bottles during manufacturing, transportation, or storage. Heat, light, and handling may increase plastic degradation. Some bottled water brands also use purified tap water, which may already contain microplastics.

The purpose of this experiment was to compare microplastic levels in different bottled water brands and tap water to determine which had the least contamination. Five water sources were tested: Dasani, Fiji, Smart Water, Deer Park, and tap water. Each sample was tested three times. Water was filtered using a 0.45 μm membrane, stained with Nile Red dye, and examined under blue light to count microplastic particles.

Results showed a statistically significant difference among samples ($p = 0.042776$). Dasani had the highest number of microplastics, while Fiji had the lowest. Tap water also showed relatively high levels. These findings suggest that bottled water is not always free of microplastics and highlight the need for improved production methods and greater awareness of drinking water quality.

Chemistry

9 CH 432

Wondimagegn, Beza

Alexandria City High School - King Street

Caught Red-Handed

Blood detection can yield false results, and the Kastle-Meyer test is an example of that. The Kastle-Meyer test is a presumptive and sensitive test, which is what was tested in this experiment. It was hypothesized that as the test reacts with hemoglobin found in real blood, a bright pink hue will appear almost immediately. To test this hypothesis, 8 substances were swabbed, and drops of ethyl alcohol, hydrogen peroxide, and phenolphthalein were placed on the swab site. The results showed that the hypothesis was indeed supported; however, false positives were recorded in the process. The cow blood, chicken, and beef juice yielded true positive results, with a bright pink reaction immediately. While it took slightly longer, the potato and horseradish swabs had a subtle pink hue. Others, like the ketchup and red dye, did not react to the chemicals, as expected. These findings support the idea that the Kastle-Meyer test is a presumptive test. While it does detect blood, not all positives are necessarily true ones. These findings of my research can help put limitations on our understanding of presumptive tests. While they do detect blood, they are not confirmatory tests and will need higher levels of forensic investigation when it comes to true crime scenes. My findings also help demonstrate the importance of understanding false positives to avoid inaccurate blood detection.

Chemistry

9 CH 433

Garg, Diya; Amos, Charlotte

Washington-Liberty High School

The Effect of Different Amounts of Lighting on the Fruit Ripening Process by Measuring Glucose Concentrations in Bananas

This experiment was conducted to test the effectiveness of different concentrations of light on the ripening of bananas. The hypothesis for this experiment was that if the bananas are put under different amounts of lighting, then the one with the most light will ripen the fastest because bananas ripen faster under heat, and brighter lights reflect more heat than dimmer lights. The tested groups were bananas treated with different amounts of lighting such as bright light (100%), medium light (50%), dim light (25%), and the control which is no light (0%). The bright light has been shown to increase the ripening of the bananas the most. 10 trials of each light concentration were conducted, and we obtained data by using a Brix meter to measure the glucose concentration in the bananas (°Bx), because the more glucose is in them, the further they are in the ripening process. The results of the ANOVA test showed no significant difference, so the null hypothesis had to be accepted. Observational data presented color changing from green to yellow, and the stage of the bananas in the ripening process. This experiment can help save money, and time when keeping bananas. This could also be expanded to other fruits and will have a similar effect.

Chemistry

9 CH 434

McDonnell, Taylor; Meyer, Sophie

Washington-Liberty High School

The Effect of Temperature on Battery Voltage

This project was conducted to determine how storage temperature affected the voltage of AA and AAA batteries. The research question addressed the effect of the temperature at which a battery was kept in on its voltage. It was hypothesized that batteries stored in colder environments would show the greatest decrease in voltage compared to those stored at room temperature.

 To test this hypothesis, ten AA and ten AAA batteries were labeled for each temperature setting: -17.78°C, 7.22°C, 18.56°C and 18.89°C. Each battery's starting voltage was measured and recorded before exposure to the set environment. The batteries were then placed in their assigned environments for one and a half hours. After this period, the final voltage of each battery was measured and recorded. All data was entered in a raw data table for analysis. The results indicated that the mean change in voltage for both AA and AAA batteries was negligible across all temperature conditions. The greatest observed mean change was only 0.01V , and standard deviations were extremely low, indicating almost no variability. The hypothesis was not supported by these findings; colder temperatures did not cause a significant decrease in battery voltage.

In summary, short-term storage of AA and AAA batteries at different temperatures did not significantly affect their voltage. It was concluded that, within the tested time from and temperature range, storage temperature had little impact on battery voltage, providing useful information for everyday battery storage.

Chemistry

10 CH 435

Cordero, Annabelle

Washington-Liberty High School

The Effect of Variations of Lemon Juice on the Preservation of Apples

This experiment was conducted to test the effectiveness of variations of lemon juice on the preservation of honeycrisp apples. It was hypothesized that bottled lemon juice with sugar would slow the browning of the apples due to the constant level of acidity and the preserving effects of the citric acid and sugar. The tested groups were bottled lemon juice (BLJ), bottled lemon juice with sugar (BLJ/S), squeezed lemon juice (SLJ), squeezed lemon juice with sugar (SLJ/S), and water as a control.

Ten half-cut apples in each group were sprayed with their respective liquid or mixture and placed into plastic bags. Over a week, the brownness of the apples was recorded once per day. An ANOVA test was conducted and showed statistically significant differences with a p-value of 0.0201. Two t-test comparisons were significant, between groups BLJ/S & SLJ and BLJ & SLJ. The experimental data does not support the hypothesis, instead showing BLJ as slightly more effective with a mean value of 2.2 than BLJ/S with a mean value of 2.3. It should be noted that the water control group had a mean value of 3 and preserved the apples more effectively than SLJ/S with a mean value of 3.5 and SLJ with 4.5.

This experiment should be redone with a color value app which can pull the RGB value from photos. More research should be done on the possible preserving effects of water and on bottled juice without artificial preservatives.

Chemistry

10 CH 436

Cuthbertson, Katherine

Yorktown High School

The Effect of Different Concentrations of Nitric Acid on the Average Mass Loss of Marble Slabs

I researched "The Effect of Different Concentrations of Nitric Acid on the Average Mass Loss of Marble Slabs." The independent variable was the concentration of nitric acid, and the dependent variable was the average mass loss of the marble slabs. Nitric acid makes up about 30–40% of acid rain. Many famous historical buildings and monuments are made of marble, making them vulnerable to acid rain damage. It is important for Generation Z to study the effects of acid rain on historical architecture because vehicle emissions in industrialized cities are increasing the likelihood of severe acid rain. Understanding how acid rain affects marble can help scientists develop ways to slow the deterioration of historical sites.

My hypothesis stated that the highest concentration of nitric acid (1.0 M) would cause the greatest average mass loss in the marble slabs. To test this hypothesis, I soaked eight small marble slabs in solutions of 1.0 M nitric acid, 0.5 M nitric acid, or 60 mL of reverse osmosis (RO) water as a control. The slabs soaked for 24 hours, were rinsed with RO water, and placed in a fume hood. After another 24 hours, I measured the mass of each slab in grams using a digital balance. The marble slabs exposed to 1.0 M nitric acid lost the most mass on average, while the control group lost the least. A scatter plot showed that as nitric acid concentration increased, the mass loss of the marble slabs increased steadily.

Chemistry

10 CH 437

Hossain, Nusrat

Wakefield High School

The Most Effective Antacid

This topic was chosen to compare the effectiveness of three different antacids at neutralizing stomach acid. Comparing antacids will help determine which one works best to relieve acid discomfort in the digestive system.

Procedure

1. Put on personal protective equipment, wear gloves and goggles before beginning the experiment.

2. Label three clean beakers with the name of each antacid: Tums, Alka Seltzer, Pepto and Bismol.

3. Using a graduated cylinder pour 50ml hydrochloric acid in each labeled beaker.

Measure the initial pH of hydrochloric acid and note it down.

4. Place the corresponding antacid tablet into the corresponding labeled beaker.

Allow the tablet to react for 30 seconds.

5. After 30 seconds, measure the solution and record the final pH.

Repeat these steps until you have recorded the pH of each antacid tablet 3 times.

The data table shows the effectiveness of each antacid in neutralizing stomach acid after a 30 second duration, in 3 trails. The bar graph shows that the most antacid was the tums with a pH level of 5. The Alka Seltzer had an average pH of 4.66. The Pepto Bismol had an average pH of 2.66. During this experiment, it was observed that the tums had the most effectiveness in neutralizing stomach acid.

Chemistry

10 CH 438

Kerr, Hailey

Alexandria City High School - Minnie Howard

The Effect of Soil pH on the pH of Water

A problem seen frequently nowadays is pollution, specifically in water; a common form of water pollution is soil pollution, the contamination of water sources by soil leaking in from farms. Due to this, it's good to know what types of soils do less damage to the environment. This project's hypothesis was that if water was to be surrounded by alkaline soil, then it will have a higher pH than water surrounded by potting soil made for acid-loving plants because alkaline soil contains carbonates that increase water alkalinity while acidic soils make water more acidic. To test this, three bowls were filled with one cup of soil, each soil having a different pH (a pH of around 6 for the more acidic soil, a pH of around 7 for the neutral soil, and a pH of around 8 for the more alkaline soil), and five cups of water were added to each bowl. After five days, the pH of the water from each bowl would be tested; this experiment was done three times for more accurate results. The data was collected in a table along with the averages for all pHs. The hypothesis was correct, the average pH of the water with the acidic soil was 6.67, an average of 7 for the water with the neutral soil, and an average pH of 8 for the water with the alkaline soil.

Chemistry

10 CH 439

Park, Thomas

Yorktown High School

Optimizing Photocatalysis: The Effect of Titanium Dioxide on the Degradation Kinetics of Methylene Blue Dye

Methylene Blue is a synthetic dye which poses a significant threat to aquatic ecosystems with its toxic effects and resistance to biodegradation. My experiment investigated the efficacy of Titanium Dioxide (TiO_2) photocatalysis as a remediation method. It analyzed how various concentrations of my catalyst could affect reaction rate kinetics. I hypothesized that increasing the amount of TiO_2 would increase the pseudo first-order rate constant (k) for dye degradation. I utilized four experimental groups with varying levels of TiO_2 concentrations: 0 g/L (control), 0.2 g/L, 0.4 g/L, and 0.8 g/L. I exposed each concentration to UV-A light irradiation for 15 minutes, and extracted aliquots at 5 minute intervals. I then measured the absorbance units (AU) with a spectrophotometer and used the data to construct a linear model of pseudo first-order kinetics. My results supported my hypothesis. The 0.8 g/L trial experienced the greatest degradation efficiency (~68.7%) compared to the 0.2 g/L group at ~50.3%. The rate constant (k) increased significantly from 0.0439min-1 in the 0.2 g/L group to 0.0733min-1 in the 0.8 g/L trial. I ran a one-way ANOVA to determine if the results were statistically significant. These confirmed that an increase in concentration resulted in an increase in reaction rate. These statistical findings show that optimizing the catalyst dosage is significant in wastewater treatment.

Chemistry

10 CH 440

Saperstein, Margaret

Washington-Liberty High School

The Effect of Different Rapidly-Composed Biodegradable Hydrogel Formulations on Adhesion, Fire Retardation, and Viscosity

Today, wildfires are increasing in prevalence and size. Biodegradable fire retardants are the solution to protect human property facing wildfire, because they eliminate environmental threats from fluorinated "forever" chemicals in traditional foams. Demonstrations last year showed that particle-polymer hydrogels are a promising biodegradable retardant solution. After water evaporation, they form aerogels to extend fire protection duration to >10x water alone. The principal drawback of these gels is the multi-hour formulation time that prevents creation with local water supply at the point of immediate need. This continuation science fair project evaluates hydrogels after a single minute of curing, marking a 100x decrease over earlier demonstrations. This speed ensures fabrication is consistent with using fire hydrants or natural water supplies close to the fire's edge. The aim of this paper is to identify the most functional, rapid, biodegradable hydrogel formulation in terms of adhesion, viscosity, and fire retardation. To test adhesion, a vertical lift test is used. Viscosity is tested with a dip-type viscosity cup. Fire retardation is tested using a butane torch and popsicle sticks as fuel. Hydrogel formulations include polymer at 1% to 3% by weight, colloidal silica particles (CSP) at 5% by weight, and water. Biodegradable polymers under test include: Methyl 2-hydroxyethyl cellulose (MHEC), chitosan, kappa-carrageenan, and konjac glucomannan. Water alone serves as control. A formulation of 0.75% kappa-carrageenan, 0.25% konjac glucomannan, and 1% MHEC with 5% CSP demonstrates the most compelling balance of performance attributes with a flame retardation of 20x water alone.

Chemistry

10 CH 441

Wilson, Alex

Yorktown High School

The Effect of the pH of a Daniell Cell's Solution on Its Voltage Production

The aim of this project was to discover new accessible and eco-friendly energy sources. This was done by altering the pH of a galvanic cell's solution to determine if this could increase its voltage output. A Daniell cell battery was built using zinc and copper strips in solutions of ZnSO4 and CuSO4, and a multimeter was used to measure the DC voltage produced. An RO water-citric acid mix with pHs of 1, 2, 3, 5, and 6.5 were added to the solutions. The hypothesis stated that the voltage would increase as the pH decreased, and this hypothesis was supported due to the pH 1 battery producing the highest voltage. The collected data had a p-value of <0.01, and it showed a noticeable difference in the mean voltage of the IV levels. However, the difference in the ranges was higher. This is because low pH solutions contain a surplus of H+ ions, which bond with electrons produced by the zinc anode due to their opposing charges. Because H+ ions are extremely small (0.000001 nm), they move through the Daniell cell's solution extremely quickly. When they bond with electrons, they carry the electrons through the solution at a faster rate, increasing the speed of the electric current. This slightly increases the voltage produced, and it greatly stabilizes the current by preventing electrons from forming concentration gradients that restrict current flow. Therefore, solutions with a lower pH and more H+ ions produce higher voltage with a significantly lower range.

Chemistry

10 CH 442

Fiel, Kilian; Muniz Diaz, Mia

Arlington Tech and Career Center

Bleach vs. Beauty: A Hair Science Study

This experiment investigated how different developer strengths, processing times, and added heat affect the amount of lightening and damage in human hair. Human hair swatches were treated with bleach mixed with 10-, 20-, 30-, 40-, and 50-volume developer for 10, 20, and 30 minutes. Additional tests examined how direct heat from a handheld hair dryer influenced bleaching speed and damage. Results showed a clear trend: higher-volume developers and longer processing times produced greater lightening but also increased dryness, roughness, and structural weakening. Heat accelerated the reaction, causing faster lift but significantly more damage. These findings support the hypothesis that stronger chemical reactions break down more pigment while also compromising the hair's cuticle and cortex.

Chemistry

10 CH 443

Kaufman, Caden; Netto, Sofia

Arlington Tech and Career Center

How Food Preservatives Interact with Chemiluminescence

Chemiluminescence is a chemical reaction that produces light without heat and is driven by oxidation. In this experiment, a chemiluminescent reaction was used to model oxidation and study how food preservatives interact with an antioxidant: vitamin C. Multiple food preservatives were added to the reaction (one at a time), and different concentrations of vitamin C were tested for each preservative. Changes in glow brightness, color, and duration were used to see how oxidation was affected. Videos of each trial were used to measure peak brightness and how long the glow lasted. As the amount of vitamin C increased, the glow became dimmer and did not last as long, showing that oxidation was reduced. However, this did not happen the same way for every preservative, and 50mg of vitamin C produced the longest glow. Some preservatives caused the glow to stay brighter even when vitamin C was added, while others showed a larger decrease in brightness and duration. This shows that different preservatives can affect how well vitamin C reduces oxidation. Overall, this experiment helped model how food preservatives and antioxidants can interact in food systems.

Chemistry

10 CH 444

Kelly, Catherine; Garneski, Magdelena

Wakefield High School

The Effect of pH on Water Temperature and How pH Effects Marine Life

This experiment explored how changing the temperature of water affects its pH level. The goal was to see whether water becomes more acidic or more basic as it gets hotter or colder. The hypothesis predicted that increasing the temperature would slightly lower the pH, making the water more acidic, because heat influences how water molecules break apart into ions.

To test this, distilled water was heated and cooled to four temperatures: cold, room temperature, warm, and hot. A digital pH probe measured the pH at each stage, and it was carefully calibrated before testing to ensure accurate readings. Multiple trials were performed and averaged to make the results more reliable.

The results showed a small but consistent pattern: as the temperature increased, the pH decreased, while cooler water had a slightly higher pH. This supports the idea that temperature plays a role in pH measurements and should be controlled during scientific testing. This connection is especially important in marine ecosystems, particularly for coral reefs. Corals depend on stable pH levels to build their protective calcium carbonate skeletons. When water becomes more acidic, their ability to grow and remain strong is reduced, leaving reefs more vulnerable to stress and damage. Understanding how temperature influences pH can help scientists better protect coral reefs as ocean conditions continue to change.

Chemistry

10 CH 445

Stouffer, Audrey; Edmonson, Carly

Alexandria City High School - Minnie Howard

Is Your Water Safe?

This experiment answers the question of "How does the displacement of a house from a water plan impact the chlorine concentration in tap water?" This procedure looks at the approximate distance from the Alexandria power plant, Virginia American Water (independent variable) to people's homes and the chlorine levels of tap water (dependent variables). To find this, we inserted a pH strip in a total of 33 samples of water from 11 different households. Each of these homes are located varying distances from the source. We then gathered the results found when removing the pH strip from the water after comparing it to the image on the packaging which determines the chlorination of the water. When measuring this, there is seen to be a relationship between the proximity to the water plant and the chlorination of water. Prior to experimentation, it was hypothesized that if chlorine concentration of drinking water is tested, it will decrease as the distance increases. This hypothesis was found to be rejected by our data.

After experimentation concluded, it was made clear that chlorine concentration actually increases as the distance from the water plant decreases. There were many potential errors in our experiment, such as air temperature, issues with the pH strips or effects from person filtration.

Chemistry

10 CH 446

Ziadah, Lim; Taha, Retal

Arlington Tech and Career Center

From Tradition to Science: Creating Long-Lasting Natural Black Henna Without Harmful Chemicals

Henna is a natural plant dye that has been used for centuries to decorate the skin especially in Sudan and other Afro-Arab countries. It is commonly used during weddings, Eid and other special celebrations. However, natural henna usually creates a reddish-brown color and does not last as long. Many people use black henna which contains a chemical called paraphenylenediamine or PPD.This chemical can cause serious reactions to the skin like inflammations, irritations, burns, allergic reactions, and permanent scars. Because of these risks, this project focuses on finding a safer, natural effective alternative to chemical black henna.

The purpose of this experiment was to test whether natural additives like charcoal and indigo powder and different acidity levels would make henna darker and longer-lasting without harmful chemicals. Three henna mixtures were prepared: plain henna (control), henna mixed with activated charcoal, and henna mixed with indigo powder. Different amounts of limes were added to create different acidity levels, including zero limes, one lime, two limes, three limes.The pH of each mixture was measured to determine how acidic it was. Each mixture was applied to a piece of wool or cotton to act as skin. After drying, stain darkness was measured using photographs. The samples were washed with soap to test the durability.

The results helped determine which natural additive and acidity level produced the darkest and most durable. This project is important because it may help create a safer alternative to chemical black henna and reduce harmful skin reactions.

Chemistry

11 CH 447

Zhu, Yiran; Chen, Houxi; Fu, Justin

Veritas Collegiate Academy

A Multiscale Computational Framework for mRNA Vaccine Delivery: Linking Lipid Nanocarrier Self-Assembly, Membrane Receptor Encoding, and Spike-ACE2 Molecular Recognition

Lipid vesicles and lipid nanoparticles (LNPs) are central to mRNA vaccine delivery, yet rational design remains challenging because assembly physics, receptor-mediated uptake, and antigen-level molecular recognition are often studied in isolation. Here we present a multiscale computational framework that integrates (i) coarse-grained molecular dynamics (CGMD) simulations of mixed lipid–surfactant vesicle self-assembly, (ii) structural and conformational analysis of lipid-sensitive hydroxy-carboxylic acid (HCA) receptors as representative class A GPCRs that can couple membrane physicochemical cues to signaling and endocytosis, and (iii) all-atom molecular dynamics (MD) simulations with binding free-energy decomposition of SARS-CoV and SARS-CoV-2 Spike receptor-binding domain (RBD) recognition of ACE2, including a representative interface mutation (N501Y) and an ACE2 conformational-modulation case using the inhibitor MLN-4760. CGMD shows that vesicle closure kinetics and size distributions depend strongly on effective concentration and more moderately on lipid-to-surfactant ratio. GPCR structural comparisons reveal conserved activation hallmarks across the HCA family, highlighting key residues and microswitch motifs that can translate lipid-environment perturbations into intracellular conformational states. The differences in flexibility of loops and interaction patterns of residues in SARS-CoV-2 versus SARS-CoV-RBD-ACE2 complexes from all-atom simulations further show significant differences in flexibility of loops and interaction patterns of residues in SARS-CoV-2 versus SARS-CoV-RBD-ACE2 complexes. In addition to this, by integrating nanotransporter assembly, receptor-encoded uptake, and antigen-receptor recognition in a single workflow, this work presents a mechanistic blueprint for lipid mRNA vaccine development as a guide for enhancing vaccine efficacy and robustness against mutations.

Chemistry

6 EN 500

Duong, Victor

Patrick Henry K-8 School

Angled Solar Panels

The purpose of this experiment is to help people get the maximum power from solar panels. I did this project to learn more about solar panels and their ability to get power from the sun. My hypothesis was if the solar panel was tilted at 45 degrees, then the lightbulb would stay on the longest, because the sun hits earth at an angle.

How I did this experiment is that I used a solar panel and a lightbulb to generate electricity from the sun using different angles of solar panels. I placed the solar panel in an exposed spot to the sun and put a lightbulb next to it. Then, I started a timer for 25 minutes. After the 25 minutes were done, I unplugged the wire and put the panel and the bulb in the house. Next, I turned on the lightbulb and started a stopwatch immediately. Then, when the lightbulb turned off, I stopped the stopwatch and recorded the time on the data chart. Finally, I repeated these steps for the following trials and degrees.

My results were that the 90 degree angle was the worst, the 180 degree angle was the 2nd best, and the 45 degree angle was the best angle as it produced the most power. In conclusion, the 45 degree angle got the best results out of all of them because sunlight hits the earth at an angle, the 90 degree angle was the worst, and the 180 degree angle was the 2nd best.

Engineering

7 EN 501

Dang, Owen

Kenmore Middle School

The Effect of the Amount of Weight on the Load Carrying Strength

Arches are used every day and everywhere in our modern and old world, such as in bridges, masterpieces like the Colosseum. Knowing why and how they are used can completely change people's view of design and durability. Which type of arches can actually support the most weight though? The arches tested in this project were: Flat platform, semi-circular arch, pointed arch and a segmental arch. All types of arches had 5 different weights (453.6g grams, 907.2 grams, 1,360.8 grams, 2,268 grams and 3,628.7 grams) tested on them. We tested them by putting the weights on top of the arches until they collapsed. The hypothesis was that the pointed arch would hold more weight than the other types of arches because it could distribute the weight more evenly. The hypothesis was not supported by the experiment because the semi-circular arch actually held the highest weight(3,628.7g) 4 out of 5 times tested while the flat platform fell short of only holding the heaviest weight 3 out of 5 times. This shows that a semi-circular arch can hold and distribute more weight without collapsing.This project contributes to better understand how arches can be an important part of architecture and design.

Engineering

7 EN 502

Klapmust, Wesley

Kenmore Middle School

The Effect of Mirror Direction on Solar Panel Voltage

Currently, the United States depends primarily on fossil fuels for energy, making the need for alternative clean energy sources much needed. This experiment studies how adding mirrors at different Cardinal directions affects the amount of voltage produced by a solar panel. A mirror array was built and positioned adjacent to a solar panel which was facing south. The voltage was tested with a multimeter after positioning the mirrors in each of the following directions: north, east, and west. The voltage was also measured at three different times of day per direction. The readings show that when mirrors are facing west, solar panels produce the most voltage. Specific data includes the following: control = 23.29v, west = 23.46v, north = 23.37, east = 23.40. Knowing that mirrors increase the energy output of a solar panel can help lower energy costs so that it is more efficient, affordable, and accessible for people and businesses across the U.S.

Currently, the United States depends primarily on fossil fuels for energy, making the need for alternative clean energy sources much needed. This experiment studies how adding mirrors at different Cardinal directions affects the amount of voltage produced by a solar panel. A mirror array was built and positioned adjacent to a solar panel which was facing south. The voltage was tested with a multimeter after positioning the mirrors in each of the following directions: north, east, and west. The voltage was also measured at three different times of day per direction. The readings show that

Engineering

7 EN 503

Leaning, Jonathan

Gunston Middle School

Magnet Trains: Magnet Configurations and Force

This experiment tested the amount of force required to pull a magnet train across a track with different configurations of magnets on the train. It was hypothesized that as more magnets were added, the force needed to pull the train would increase. The procedure was to line up the train with the track, then add weights incrementally to a pulley system to pull the train until it went at least most of the way down the track. The track consisted of a magnetized rail at the bottom, with a guiding slot at the top. The pulley system consisted of a string, a wheel, and a bag to hold weights. Five configurations ranging from two to five sets of three magnets were assessed. The configurations were also tested with and without magnetized side rails on the track. The data supported the hypothesis, because configurations with more magnets required more pulling force. This was likely caused by the train becoming less stable, which created more friction with the track.

Engineering

7 EN 504

Pereira, Alejandro

Williamsburg Middle School

The Effect of the Type of Instrument on the Spectral Centroid of the Note Played

The purpose of the experiment is to determine what makes instruments sound the way they do. The independent variable is the type of instrument and the dependent variable is the spectral centroid of the note played. The levels of IV were the sine wave (control), trumpet, piano, guitar, recorder, harmonica, and voice. Each level was tested five times. A musical instrument produces multiple frequencies and the combination of these frequencies creates a unique sound for each instrument. By measuring the average of all the frequencies (spectral centroid), instruments are compared mathematically. Using Librosa python coding, the computer can translate the sounds picked up by each instrument and convert them into sets of frequencies which can then be used to calculate the spectral centroid. These measures can then be compared to determine what makes instruments sound the way they do. The hypothesis is: If the type of instrument is the trumpet then the spectral centroid will be the highest because the trumpet's sound is the brightest (especially when played loud) out of these instruments, and a brighter and higher sounding instrument generally leads to a higher spectral centroid. The hypothesis was rejected because the harmonica had the highest spectral centroid. Major findings include wind instruments generally have higher spectral centroids and that out of the wind instruments, the ones made of metal performed highest.

Engineering

7 EN 505

Reisman, Julian

Gunston Middle School

The Effect of Light Bulb Color on Perceived Brightness

This three-phase experiment investigated how the color (wavelength) of light from a bulb affects how bright it appears to the human eye. This matters because lights that look brighter can improve visibility for signs and screens. Based on items like red stop signs and orange traffic cones, my hypothesis was that warmer colors would be brighter. The independent variable was the light color: blue, cyan, green, orange, red, and purple. A PAR meter measured physical (objective) light energy. A lux meter measured brightness based on human vision. Remote sensors and a color-changing LED bulb were placed inside a matte black box. I controlled the bulb's color and light output with an iPad app and recorded measurements in a spreadsheet. In Phase 1, physical light was constant for all colors and perceived brightness (lux) was measured. Phase 2 confirmed that wavelengths were accurate. In Phase 3, lux was held constant to determine the physical light needed for each color to look equally bright. The hypothesis was incorrect. Perceived brightness depends on wavelength, but it was the cooler colors that appeared brighter at the same physical light. Red required three times more physical light to appear as bright as green. Red likely stands out in daily life because long wavelengths scatter less in the atmosphere, contrast strongly with surroundings, and we learn to associate red with emergencies. This suggests a color can be highly noticeable without being brighter, and designing lighting for signage involves more than perceived brightness.

Engineering

8 EN 506

Baldi, Alex

Swanson Middle School

How Far Will It Go?

The purpose of this project was to figure out what the outcome of the bunt would be based on the type of bat. I tested and compared the distance of a baseball travel bat, baseball rec bat, baseball wood bat and the softball bat. My hypothesis stated that a baseball bat would bunt a baseball the farthest compared to the others. The procedure consisted of making a wood structure to hold up the bats. My dad helped me cut the 2x4s into pieces and use an electric drill to screw them together. We set up on the baseball field to complete the data sampling. We used metal stakes to secure the wooden stand at home plate. Next, we zip-tied the first bat to the wooden stand and used the pitching machine to pitch balls to the bat. After the experiment the data showed that the baseball bat traveled farther than others. My data shows it had the highest combined total distance bunted out of all 10 trials with 74.5 meter, and has the farthest bunt recorded out of all four bats. My data shows it has the smallest range and deviation out of all four bats. Based on the data. I would hit the ball the same distance consistently if I bunted with this bat. The data shows that the softball bat bunts the ball the shortest distances with an average of 6.24m and has a median of only 5.67m.

Engineering

8 EN 507

Carter, Sarah

Williamsburg Middle School

The Effect of the Location of the Washers on the Distance Traveled by a Pinewood Derby Car

This project's purpose was to determine whether the specific location of the weights (washers) changed the distance traveled by a Pinewood Derby Car. The rationale for this was that in a real car, weight distribution must be done properly, otherwise a multitude of problems could happen. These problems include safety hazards, costly maintenance problems, and the decrease in efficiency of the car in general. To measure this, the experiment involved having a Pinewood Derby Car go down a ramp, with weights placed on screws that were located in 3 places: the front of the car, the middle of the car, and the back of the car. The car was placed in a track on a ramp, and the weight was moved to locations on the front, middle, and back. There were multiple trials for each level. As a control, the car also went down the ramp without any weights attached. In addition, the car went down the ramp with weights on all 3 screws. Ultimately, the data showed that when the weight was on the middle screw from the front it went the farthest. While the results did not support the hypothesis of , they did demonstrate the location of the weights did have an impact on the distance traveled. Although this would need to be proven with further experimentation, and iterations of this experiment for more data.

Engineering

8 EN 508

Chu, Teddy

Thomas Jefferson Middle School

Chasing The Sun

Solar panels are most efficient at generating maximum electrical output when they are oriented optimally with sunlight. However, real-world conditions frequently prevent precise alignment due to environmental and structural restraints. This project investigated the impact of angular misalignment on solar panel output voltage. The hypothesis was: If a solar panel is misaligned from its optimal orientation, then its output voltage will decrease constantly as the angular offset increases. An automated tracking system was put to use. Two photoresistors, separated by a thin flap of cardboard, were used to find and lock the panel into its optimal orientation. The panel was then intentionally offset by 0°, 5°, 10°, 20°, and 30° by the tracking algorithm from this position, and then the output voltage was measured. The experiment was repeated three times. Results showed that output voltage decreased consistently as the angular offset increased, supporting the hypothesis, but with a sharper decline from 5° to 10° of offset. The voltage values recorded corresponded to a reduction of about 20–25%. The results show that even small misalignments of the panel can lead to noticeable losses in solar panel output, especially in misalignments of 5° or greater. In conclusion, these findings suggest that maintaining precise panel orientation, optimal placement, maintenance of panels, and precision engineering of solar panel design is critical for maximizing the efficiency and effectiveness of solar systems going forward.

Engineering

8 EN 509

Lamothe, Jaxon

Thomas Jefferson Middle School

Unraveling the Mysteries of Airfoils

I conducted this experiment to find out how air flows over different airfoils. The independent variable of this project was the different airfoil shapes. The dependent variable was how the air flowed over the airfoils which was observed by blowing fog at the shape. Finally, the control was the angle, speed, and density of the fog blown at the airfoils.

I was interested in testing this subject because I aspire to be an aerospace engineer. I enjoy aircraft and aerodynamics. I would like to work for Lockheed designing aircraft. Wing shape and stability are crucial to aircraft design driving the need for a broad understanding of things related to aerodynamics. This is why I decided to do my project on airfoil shapes and how they move through the air.

My hypothesis was that if an airfoil has an under-cambered shape, then it will produce smoother and more attached airflow compared to a reflex-cambered airfoil, because the under-cambered airfoil promotes lower-pressure flow adherence while the reflex-cambered airfoil is more prone to earlier flow separation and increased turbulence.

I tested my hypothesis by simulating a wind tunnel using a fog machine to visualize airflow around the airfoil models. My results showed that the reflex-cambered airfoil performed the worst at having connected airflow, whereas the symmetrical-biconvex airfoil performed the best. This shows my hypothesis was only 50% correct, as I predicted the under-cambered airfoil would have the most connected airflow.

Engineering

8 EN 510

McGeorge, John

Williamsburg Middle School

The Effect of the Material of Pipe on Heat Insulation

My project was "The Effect of the Material of Pipe on Heat Insulation", or in simpler terms, what type of pipe has the best ability to insulate. The independent variable was the material of the pipe, and the dependent variable was the water temperature measured in degrees Celsius. To do this experiment I used Copper, Cpvc, and PEX pipes. I would plug one end of each pipe, fill it with hot water, let it sit for 10 minutes, come back and record the water temperature. This was done for 5 trials. I hypothesized that Cpvc would have the best insulation because it is a plastic which isn't conducive. Unfortunately my hypothesis was not supported by the data. Out of the 3 pipes Copper had the highest mean temperature of 48.58°C followed by Cpvc at 46.3°C and lastly PEX at 43.88°C. The total temperature range between the 3 pipes was 4.7°C. A general trend noticed was that the average water temperature increased alongside the density of the pipe's material. Copper had the highest density and water temperature of the pipes, followed by Cpvc with the second highest density as well as temperature, and finally PEX with the lowest density and water temperature. This makes sense because a material with more atoms in a given space will take more time to heat than a material with less atoms in a given space. This experiment serves a real life purpose by determining the best pipe to retain water temperature.

Engineering

8 EN 511

McKenzie, Marie

George Washington Middle School

Round and Round We Go: The Creation of a Vertical Axis Wind Turbine

For this project I created a functional VAWT (vertical axis wind turbine). It turned when it had two fans on it and generated electricity. Once it was started it turned at a relatively fast pace and had a ratio of about 56 minutes (time turning) to 5 minutes (time it was powered by the battery). This shows that the project was successful.

Engineering

8 EN 512

Sellers-DuBray, Rowen

Dorothy Hamm Middle School

Effect of Rotations on Top Bike Speed

My experiment is what is the effect of rotations per minute on top speed (whilst keeping at 100 watts.)? I chose this experiment because I love road biking and learning how to get faster is a personal challenge. Originally, my hypothesis was that higher rotations of the bottom bracket (gear area) would increase my top speed. In my investigations I used a peloton (stationary bike) to simulate being outdoors without hills, friction and other factors. I had 4 different levels of IV (Rotations per minute) which were 60, 70, 80, 90, 100, and for each I biked 2 miles per trial and had 3 trials per level. My data did not support my hypothesis. The data shows that there is a sweet spot of rotations per minute to hit the top speed which is around 80-90 rotations per minute whilst around 60-70 RPM is too slow to produce high speeds and 90-100 RPM is too high of RPM's to produce high speeds. I am so glad that I did this experiment. I have already started applying what I've learned in my bike rides and seen improvement in my use of energy.

Engineering

8 EN 513

Mergler, Katherine; Hsu, Amelia

Dorothy Hamm Middle School

Sliding Snow: What is the Effect of Roof Angle on Amount of Weight Able to Be Held, Stimulating Snow Accumulation

Our experiment was conducted in order to find out what degree of roof slant is the most effective at bearing weight from snow. This is important because in areas with heavy snowfall yearly, research on snow accumulation is crucial for people's safety. Our hypothesis was "If a roof is slanted at 45⁰, then it will be able to withstand the weight of snow better because the slant will result in gravity being able to act on the snow with more force than on the roof angled at 0o." To conduct our experiment we first built cardboard models. We cut out cardboard squares then using skewers added the "roof". Half the models had roofs at a 45⁰ slant and the other half had a 0⁰ slant. We made "snow" using a snow cone machine and ice. We then added the snow onto the models in 10 gram increments. We found that the models with a 45⁰ roof slant supported weight much more effectively than the models with a 0⁰ slant. The 45⁰ models had an average of 383 grams of snow added before collapsing. While the 0⁰ models on average only supported 120 grams of snow before collapsing. These results did support our hypothesis. In conclusion, models with a 45⁰ roof slant can withstand weight at a better rate then a 0⁰ roof angle.

Engineering

8 EN 514

Mohd Rapik, Xora; Ogonji, Wanjiru

Gunston Middle School

Always Use Protection

Our hypothesis is "the price of heat protectant is less relevant to its effectiveness on human hair than on synthetic hair because synthetic hair has a higher melting point than human hair." We chose this project because there is a need for hair to be taken care of. This need is created from the emission of chemicals. The people who have this need are the people who have synthetic or human hair." Our research questions are, should I buy a high-end heat protectant or a low-end one, and is there even a difference?" We primarily researched the types of emissions released and the precautions to take when handling these chemicals.

Our independent variable was the price of heat protectant, and our dependent variable was how long it took to produce smoke.

Our procedure was simple. First, we glued 10 wefts of hair (5 human and 5 synthetic). We then put 5 ml of different types of heat protectants on each, leaving 2 without for a control. Then we held them on a straightener until it started smoking. After conducting the experiment, we found that the higher we go in price, the less effective it was on synthetic hair. On the other hand, with human hair, it only increased in quality. Sadly, our evidence does not support our hypothesis. The difference in effectiveness was roughly the same despite the price. One error in our experiment could have been the brand of heat protectant we used or the independent variable.

Engineering

8 EN 515

Rubin, Jack; Henry, Benjamin; Porter, Caden

Thomas Jefferson Middle School

The Effects of Thermal Energy On Electrical Resistance

The purpose of this experiment was to study how thermal energy affects electrical resistance. This experiment was done to better understand how temperature changes can affect the movement of electricity. This information could help large companies choose better temperatures for servers so systems like artificial intelligence can run more efficiently and save time and resources.

The independent variable in this experiment was the thermal energy the resistor was exposed to. The dependent variable was the electrical resistance measured. The control was the resistance of the resistor at room temperature.

The hypothesis was that if the thermal energy of a resistor decreased, then the electrical resistance would also decrease. It was also predicted that if thermal energy increased, electrical resistance would increase as well.

To test this, electrical resistance was measured after exposing the resistor to temperatures of 0°F, 38°F, 72°F, and 175°F.

The results showed that lower thermal energy caused higher electrical resistance. This disproved the hypothesis. Even though the hypothesis was incorrect, the experiment helped improve understanding of how temperature affects electrical resistance.

Engineering

9 EN 516

Chistolini, Michael

Arlington Tech and Career Center

The Effect of the Type of Parachute on the Rate of Descent

The main goal of the project was to find which of the main types of parachute has the slowest and fastest rate of descent. Also, the experiment tested whether or not the type of parachute saved the egg. I constructed each parachute by scaling the average size of the following kind of parachutes Ram-Air, Cruciform, Round, and Rogallo down to 1/16 of the average size. I then glued on strings onto the parachutes trying to be specific about the location and amount of strings on each parachute. The main findings were that the cruciform had the slowest rate of descent and saved all eggs that I dropped from the balcony and the quickest rate of descent other than the control was the rogallo parachute which broke all of the eggs I dropped with it. All of the eggs were secured to the parachute strings by a wire basket that I tried to cover the least amount of the egg possible so the egg wouldn't break. I then found the rate of descent by taking a video of the parachute from the second I dropped it to the second the egg first touched the ground. The significance of the project was to see if different uses for parachutes such as civilian, military, and first responders were using the correct type of parachute for their job. They would need a different parachute if they needed to be more accurate, fast , slower, or more maneuverable.

Engineering

9 EN 517

McNally, Lucy

Washington-Liberty High School

The Effect of Natural Wave Defense Structures vs. Man-made Wave Defense Structures on the Amount of Wave Overtopping

Potential damage to the world's coastal communities is anticipated in the coming years due to rising sea levels. For this reason, more research on effective coastal defense structures is required. Therefore, the experiment tested man-made structures vs. natural structures in a wave tank to determine which was more effective. The independent variable was the type of structure, and the dependent variable was the amount of wave overtopping measured in milliliters. The independent variable levels included a curved wall, rock armor, mangrove roots, Ludwigia repens (kelp forest), and the slope, which was the control. The research hypothesis stated that "If the type of structure deflecting waves is changed then the slope/incline with a curved wall will have the least amount of wave overtopping, because the crest of the wave will take the shape of the curve and be deflected back into the water without letting any gaps of water come through." A custom-built wave tank was built to test each structure's effectiveness. The results support the research hypothesis, because the curved wall had the lowest average milliliters of wave overtopping (curved wall = 1.2 mL). The slope had the highest mean amount of wave overtopping, which was 203.0 mL. After statistical analysis was conducted, the experiment was determined to show a statistically significant difference. These data show that the curved wall was the most effective at preventing wave overtopping, and when applied to real life, is the most effective in protecting coastlines from tsunamis and waves.

Engineering

9 EN 518

Upham, Daniel

Alexandria City High School - King Street

Mechanical to Electrical

The purpose of this project is to find out if this generator can produce 12 volts. My goal is to produce 12 volts within the designated testing RPM range? I will build a homemade generator using a template kit for my 3D printer. I will put magnets in the 3D printed flywheel and hand wind coils with copper wire. I'm going to use diodes to create a bridge rectifier that will convert the raw alternating current from the generator to direct current for the output. I will hand crank the handle to drive the generator. I will use a multi-meter to read off the direct current voltage. I was able to produce a maximum of 6.8 volts at 120 RPM. My research was geared towards methods of converting potential energy into kinetic energy; ways to spin the generator. In conclusion I should have gone with the thicker wire from the start in order to expedite my building process and provide more time to test, additionally I should have expanded my testing range in order to find what RPM generates 12 volts.

Engineering

9 EN 519

Watkins, Henry

Alexandria City High School - Minnie Howard

What is the Strongest FDM (Fused Detriment Manufacturing/3D Printing) Infill Pattern for Bending Force?

FDM (Fused Deposition Manufacturing) 3d printers are slow, and plastic can be expensive. To save time and money, parts are not printed completely solid. A hollow part would be too weak, so 3d printing software allows users to put a grid-like structure called infill inside of the part for strength. There are many different patterns of infill that have different properties. Selecting the right infill pattern can be very important for the strength of a part. In this experiment, 4 different infill patterns were tested for strength: aligned rectilinear, cubic, grid and lightning. 5 test beams were printed out with each infill pattern, and a bucket was hung from the middle of the beam. Water was added until the beam broke to test for strength. The beams with the aligned rectilinear pattern were the strongest, holding an average of 20.4 kg. Grid came in second with an average of 11 kg. Cubic was very close with 10.2 kg, and lightning came in last with 4.6 kg. Aligned rectilinear was the clear winner, holding almost twice as much mass.

Engineering

9 EN 520

Hunter, Aiden; Negusse, Sara

Alexandria City High School - King Street

Digital Phenotyping For The Detection of Parkinson's Disease

Digital Phenotyping for the Detection of Parkinson's Disease was conducted by Aiden Hunter and Sara Negusse of Alexandria City High School in Alexandria, Virginia, USA.

Parkinson's disease is a progressive neurodegenerative disorder that is often diagnosed only after noticeable motor symptoms appear, limiting opportunities for early intervention. The purpose of this research was to determine whether publicly available digital phenotyping data, including speech and fine motor behavior, could be used by artificial intelligence (AI) to identify patterns associated with Parkinson's disease and to evaluate which AI fusion strategy provides the highest classification accuracy.

An anonymized, balanced dataset consisting of 24 individuals with Parkinson's disease and 24 healthy controls was analyzed using three AI fusion strategies: Early Fusion, Late Fusion, and Hybrid Fusion. All data processing, model development, and evaluation were conducted.

The Early Fusion model achieved an accuracy of 77%, the Late Fusion model achieved 83%, and the Hybrid Fusion model performed best with an accuracy of 85%, demonstrating improved identification of Parkinson's cases while maintaining reliable classification of healthy individuals. Feature analysis indicated that speech instability and fine motor irregularities were the most influential indicators in model predictions. These results suggest that multimodal digital phenotyping combined with Hybrid AI fusion strategies offers a promising and cost-effective approach for early Parkinson's disease detection and supports further research into AI-based screening tools for neurological conditions.

Engineering

9 EN 521

Neufer, Jacob; Painter, Liam

Alexandria City High School - Minnie Howard

The Power of Water

We chose to study gear ratios with water wheels because hydroelectric generation is becoming more useful in areas with fewer resources. We used a simple setup, comprising a small DC motor, a waterwheel, and a variable set of gears that were 3d printed. The DC motor, along with the water wheel, served as a turbine, and we used a pump setup to cycle water through the system. Our results proved our hypothesis correct, it being that a larger gear on the waterwheel would allow the motor to generate power more efficiently. Our data showed large improvements with the larger gear over the smaller gears, by a factor of almost 4_. However, these differences were minimal, as our motor generated a maximum of approximately 450 millivolts. In the real world, scaling this up could mean megawatts of difference in power generation for a community, low-impact desalination, and more reliable irrigation systems in desert areas. It can also mean lower emissions, which can reduce the likelihood of more severe weather and hurricanes. Hydroelectric generation is also considerably cheaper than other generation methods like coal, natural gas, and nuclear plants. If we were to do this experiment again, or continue it in some way, we would test the efficacy of different gear ratios in applications like wind power and test in a real-world environment, such as a river.

Engineering

10 EN 522

Malatesta, Gavin

Washington-Liberty High School

The Effect of Water's Starting Height on the Electrical Voltage Output of a Hydroelectric Generator

This experiment was conducted to see the effect of water's starting height above a hydroelectric generator on the voltage output of said generator. This experiment's hypothesis was that the testing groups with water starting higher would cause greater voltage readings because the water would have more potential energy, and in turn, more kinetic energy, which would spin the turbine faster, causing the magnets in it to pass through the wire coils at a faster rate, which would generate a greater voltage output. The five tested groups were the vertical height above the top of the generator from 50cm to 150cm, with each group being 25cm apart.

Experimental groups were tested 10 times at 10-second intervals. An ANOVA test of the data resulted in a p-value of 1.39×10^{-23}, meaning results were significant. A t-test between the 75cm and 100cm groups, however, had a p-value of 0.305, meaning that the results were not significant between the two groups. The experimental data supported the hypothesis, with the 150cm group having the highest average AC millivolt reading at 24.6. The data then follows with the ACmVs decreasing as the height decreases. 125cm had an average reading of 21.8 ACmVs, 100cm had 19.9 ACmVs, 75cm had 19.8 ACmVs, and 50cm had 17.8 ACmVs.

The importance of the experiment is found in providing some insight on more effective ways to build a hydroelectric generator. Having water start higher will likely increase the efficiency of the generator.

Engineering

10 EN 523

O'Neil-Vira, Ishaan

Alexandria City High School - Minnie Howard

Project Lift: DIY Wind Tunnel and Airfoil

A wind tunnel is a device that produces a controlled stream of air, often to study the flow of air over surfaces. Wind tunnels are most commonly used in the study of aerodynamics, often in Aerospace or Automotive engineering. Generally, wind tunnels follow the same concept: Air is pushed or pulled through a wind tunnel via a fan. The air often goes through a straightener of some kind to remove large eddies. The air is compressed using some form of contraction cone to make it faster, then blown through the test section, then out through the diffuser. Some form of smoke is utilized to visualize the flow.

This project attempts to create a wind tunnel at home. Cardboard acts as the frame of the tunnel, including a contraction cone, test section and diffuser. A small box fan serves to pull the air through the tunnel. Honeycomb packing sheets serve as the flow straightener. Incense creates smoke for visualization. An airfoil on a kitchen scale creates measurable lift.

This project had two engineering goals: Create a wind tunnel with visual stable air flow, and measure lift with an airfoil inside the wind tunnel. Both goals were successfully completed. Although some problems occurred, originating from unstable air around the wind tunnel and a lack of sufficient flow straighteners, stable flow was still observed. The airfoil was 3d printed and mounted onto a kitchen scale. The weight decreased while the wind tunnel was running, implying lift.

Engineering

10 EN 524

Parikh, Sophie

Yorktown High School

The Effect of Helical Groove Pitch on the Flight Distance of a Model Rocket

Rockets are stabilized to increase flight distance and fuel efficiency. One method of stabilization is spin stabilization, which may be induced using helical surface grooves. The purpose of this experiment was to determine the effect of helical groove pitch on the flight distance of a model rocket and to evaluate whether this method could provide effective passive stabilization.

Model rockets were 3D-printed from PLA and launched using a compressed-air PVC pipe launcher. Rockets with varying helical groove pitches were launched multiple times, and the horizontal flight distance from the launcher was measured and recorded.

The rocket with a helical groove pitch of 0.25 turns per centimeter traveled the greatest average distance, flying approximately 70 centimeters farther than the second-farthest rocket. The second-farthest rocket had the highest groove pitch tested, 0.5 turns per centimeter. The third-farthest rocket had no grooves, while the rockets with the lowest tested groove pitches (0.125 and 0.0625 turns per centimeter) traveled the shortest distances.

These results indicate that helical grooves do affect rocket flight distance and that a moderate groove pitch may provide optimal stabilization. Among the tested designs, 0.25 turns per centimeter produced the greatest flight distance. Future experiments could further refine the optimal groove pitch and compare helical groove stabilization to traditional fins, surface textures, and other passive stabilization methods.

Engineering

10 EN 525

Slapar, Charlotte

Arlington Tech and Career Center

The Effect of Truss Bridge Material on Weight Bearing Capacity

The purpose of this experiment is to test which truss bridge material has the highest weight bearing capacity. This is important as it demonstrates how material properties like tensile and compressive strength influence weight bearing capacity, and simulates real world engineering, where choosing the right material is crucial for safety, cost effectiveness, and structural integrity. To conduct the tests 4 bridges were made out of three different materials; cardboard, wood, and acrylic. The bridges then were tested, by placing half pound sandbags every ten seconds on top of the bridges until they broke. This process was repeated until all the bridges were tested. After the experiment had concluded, the results for each bridge were averaged. The cardboard held the least amount of weight, at 1375 grams. Then came wood at 7000 grams. The acrylic truss bridge had an average of 9187.5 grams. The results were then put into an Anova: Single Factor test, and the P-value was found to be 0.0000027744. As the P-value was less than 0.05, the data was significantly different. This meant that the null hypothesis was rejected, and the alternative hypothesis was accepted. In conclusion, the experiment ended with the acrylic truss bridge having the highest weight bearing capacity, and cardboard with the lowest. The reason the acrylic performed the best was due to it having a tensile MPa of 80 and a compressive MPa of 120 compared to the tensile and compressive MPas of wood and cardboard which ranged from 3-71.

Engineering

10 EN 526

Dementi, Kye; Silva, Christian-Delfin

Alexandria City High School - Minnie Howard

Which Airfoil Generates The Most Lift?

Many people take flying for granted, unaware that a secret science is happening right beside them. This secret is explained by Bernoulli's Principle, which states that when air moves faster over a curved surface on top than underneath, it creates a difference in pressure that generates lift. The purpose of this experiment was to test which type of airfoil generates the most lift, Flat-bottomed, Symmetrical, or Reversed Flat-Bottomed. To test the experiment, we created a Flat-bottomed, Symmetrical, and Reversed Flat-Bottomed airfoil out of cardboard and paper. We then made a wind tunnel to create laminar air flow. We attached each airfoil to a stand that was also attached to a scale. We then let the fan run on full speed for 10 seconds, allowing the airfoils to lift for a short period of time decreasing its overall weight on the scale. We gathered the data by recording the weight of the airfoil and subtracted it with the decreased weight we measured while our fan blew wind on it. The hypothesis was, if a Flat-bottomed airfoil is used, then it will produce the highest lift. The results showed that the Reversed Flat-bottomed airfoil on average flew the highest out of the 3 and the Flat-bottomed flew the lowest. In conclusion, the Reversed Flat-bottomed Airfoil generated the most lift while the Flat-bottomed Airfoil generated the least amount of lift.

Engineering

10 EN 527

Madha, Mahasin; Ambaye, Christine

Alexandria City High School - Minnie Howard

Water Wheels

The water wheel is a renewable and sustainable source of energy due to its ability to produce energy without the use of fossil fuels. This experiment investigated how the number of paddles on a water wheel affects the brightness of LED lights from the energy generated by the wheel. The hypothesis states that a water wheel with eight paddles would generate brighter LED lights than a water wheel with four or six paddles. To test this, the water wheel with three different paddle counts (4,6 and 8) were placed under the same water flow conditions. Each wheel was connected to a generator that powered LED lights, and the brightness of the LED lights was observed and compared. The results showed that the water with six paddles produced the brightest LED light, and this was accounted for with the Luminous Meter. This suggests that increasing the number of paddles allows the wheel to generate more water energy. However, If there are too many paddles, it will make the weight of the water wheel heavy and therefore make it difficult for it to flow. Consequently, the hypothesis was not supported, demonstrating that the paddle number plays an important role in the efficiency of a water wheel.

Engineering

11 EN 528

Cohen, Gabriel

Yorktown High School

A LiDAR Haptic Interface for Blind Navigation

This project presents an iPhone-based navigation aid for blind and visually impaired users that uses the phone's built-in LiDAR depth sensor to communicate spatial information through haptic feedback. The app is designed to mimic the intuitive "feel" of a white cane by translating depth measurements into vibration patterns that increase as the user approaches an object. A central region of the LiDAR depth map is continuously averaged to generate a proximity-dependent rumble, while a separate edge-detection pipeline produces short haptic "clicks" when the sensor passes over depth boundaries (e.g., steps, corners, and surface disturbances). The system is intended primarily for indoor navigation in uncrowded environments, but could possibly be used outdoors. The user is intended to sweep the phone back and forth in front of them. The final product demonstrates the feasibility of real-time, discreet obstacle avoidance using commodity smartphone hardware. To test the application, white cane users are recruited from local blind nonprofits, and asked to navigate through a short obstacle course using the app. A post-survey is conducted, involving Likert questions surrounding usability and functionality. There are also opportunities for the participant to give suggestions, which are integrated into a new version of the app. Likert responses are analyzed with medians, interquantile ranges, and simple bar charts. Usability questions are aggregated and a score is calculated on a scale from 0-100. At least 5 participants will be surveyed by February 28th.

Engineering

11 EN 529

Shomali, Yara

Arlington Tech and Career Center

Garage Guard: Preventing Carbon Monoxide Poisonings Using Short Term Exposure Limit and Time Weighted Average Analysis

Carbon monoxide (CO) is a gaseous chemical that can be lethal to humans in certain concentrations, resulting in over 400 documented fatalities every year (CDC, 2024). In order to protect individuals from CO poisoning, a device was created to measure the gas at ppm (parts per million) and to respond accordingly to the measured results based on established limits by various agencies. Levels below 10 ppm are generally recognized as safe to humans by organizations such as the WHO and NIOSH and the unit will display the actual reading and a green status light (Lemon, 2024). Once reaching 10 PPM, the device will enter the "caution" mode, and at 50 ppm, the device will enter a "warning" mode signifying a higher threat level. At 200 ppm, the device will enter "alarm" mode. Actions based on detected concentrations include displaying gas level reading, visual status indicators, turning on/off an external exhaust fan, and ultimately opening the garage door when the short term exposure limit (STEL) has been detected (Lemon, 2024). The sensor was tested multiple times using calibration check gas to ensure accuracy, and a formula was derived using the results to convert a voltage output to digital counts and ultimately ppm readings. A smoke generator was used to visualize air flow patterns in the confined space and identify the best position to locate the device.

Engineering

11 EN 530

Vasisht, Janak

H-B Woodlawn Secondary Program

Optimization of Wind Turbine Performance: Integrating Evolutionary Based AI-Assisted Genetic Algorithms and XGBoost with Blade Element Momentum and Aero-Servo-Hydro-Elastic Simulations

This work applies surrogate-assisted genetic algorithms (SGAs) to enhance the aerodynamic performance of the NREL IEA 15-MW offshore wind turbine blade. The optimization objective is to maximize the power output of the wind turbine by improving the shape of its blade. Given the objective, the novel approach comes from optimizing each airfoil subsection in the blade across a range of angles of attack (AOA). The reason for evaluating the airfoils at a range of AOAs is to represent realistic operating conditions, as true wind direction is variable. The airfoils are parameterized using Class Shape Transformation (CST) functions, and a surrogate model is used as the fitness function for the genetic algorithm to decrease execution time and computational costs. An XGBoost based surrogate model was used to predict the scalar performance metric in favor of computationally expensive simulations. The optimized airfoils at each blade subsection were subsequently combined, forming the full wind turbine blade. This was done by referencing the same shape specifications as the original NREL IEA 15-MW blade while incorporating the optimized airfoil shapes. The shape construction was performed in QBlade, where aero-servo-hydro-elastic simulations were conducted to analyze the performance of both the original and optimized turbines at varying wind speeds and directions. The final airfoils were able to produce a three times greater Cl/Cd than the standard airfoils; subsequently, the full blade was able to produce as much as 214% more power under certain conditions while averaging 50% more power under all tested conditions.

Engineering

11 EN 531

Locke, Sawyer; de Rulet, Henry; Jiang, Rocky

Episcopal High School

Rocket Plane

This project investigates a hybrid launch and flight system designed to bridge the physical differences between rocket ascent and powered airplane flight. Our team—Sawyer Locke, Rocky Jiang, and Henry De Rulet—designed and built an experimental aircraft that launches vertically like a rocket with its wings folded, then transitions into horizontal, powered flight after reaching apogee.

During launch, the aircraft ascends using a detachable booster containing Estes F15 solid rocket motors. The wings remain folded to minimize drag and maintain stability in a high-acceleration, low-control rocket flight regime. At apogee, when vertical velocity approaches zero, a mechanical deployment system causes the wings to swing outward and lock into place. After deployment, the wings slide along a guided track to adjust their position, compensating for the shift in aerodynamic forces that occurs when transitioning from rocket dynamics to airplane aerodynamics.

Simultaneously, the booster separates and falls away, carrying with it a sleeve that includes one of the four stabilizing fins used during ascent. This is to avoid damage when proforming a belly landing. This separation also removes a protective intake sleeve, allowing airflow into a 90 mm electric ducted fan (EDF), which provides propulsion during sustained airplane flight.

This design demonstrates how a single vehicle can be engineered to operate efficiently across two fundamentally different flight regimes. The project highlights principles of aerodynamics, Newtonian mechanics, propulsion, and mechanical systems design, and explores practical solutions for controlled transition between vertical launch and horizontal flight.

Engineering

7 EV 600

Brownback, Teddy

Francis C. Hammond Middle School

The Effects of Rainfall on Pollution in Holmes Run

Are there more pollutants in the creek when it rains heavily? After testing I found that there are higher concentrations of pollutants within the creek water after heavy rainfalls, specifically nitrates, which are harmful to the aquatic ecosystem. The data shows an increase in nitrates within the creek following heavy rain fall, signifying the entrance of pollutants into the water table. This is likely to be true for many creeks as well as other water bodies.

Environmental and Earth Sciences

7 EV 601

Caparas, Kamden

Williamsburg Middle School

The Effect of the pH Level of the Salt Solution on the Amount of Current Produced by a Saltwater Battery

Saltwater batteries (SWBs) are an environmentally friendly alternative to lithium batteries for energy storage. Unlike lithium batteries, SWBs contain no toxic heavy metals, last longer, and lessen waste. This experiment tested how pH levels of salt solutions affect current output in SWB's to optimize performance.

The hypothesis was that a pH level of 7.0 would produce the highest current because in neutral environments, electrode reactions stay stable and ions allowing current flow aren't highly influenced by H^+ or OH^- ions present in acidic or basic solutions. Five pH levels (3, 6, 7, 8, 9) were tested with five trials each, maintaining constant salt concentration, temperature, containers, and battery runtime. Current output was measured using a multimeter.

The results accepted the hypothesis: pH 7.0 produced the highest average current of 16.3 mA, significantly greater than pH 3 (7.4 mA), pH 6 (9.9 mA), and pH 8 (10.2 mA), pH 9 (9.0 mA). Data revealed that pH levels lower and higher than 7.0 had decreased current outputs.

This experiment showed neutral pHs optimizes SWBs efficiency, giving ideas for developing a sustainable energy storage solution. Future experiments could test seawater performance, temperature effects, and space-efficient membrane materials to advance SWBs renewable energy applications.

Environmental and Earth Sciences

7 EV 602

Dang, Maya

Kenmore Middle School

The Effect of a County's Wealth on Its Drinking Water Quality

The goal of this project is to find the effect of the wealth of the county on the county's drinking water quality in the DMV area. The water samples (independent variable) will be tested for pH (measure of how acidic or basic the water is), the hardness (measure of how much magnesium and calcium is in the water), and alkalinity (measure of how much water can buffer out minerals like copper and lead) (dependent variable). All of the samples are from different counties in the DMV area. The counties are Montgomery County, Prince George's County, Arlington County, and D.C. The wealth of those counties will be measured by the general fund per capita of each county. The hypothesis was if the county's wealth increases, then the drinking water quality will increase because the county has more money to spend on treating and filtering their drinking water. The hypothesis was not supported because all of the water samples fell into the healthy guidelines that came from the EPA and other credible sources (control variable). All the drinking water samples fell into a pH range of 6.5 to 8.5, a hardness range of 0-120ppm, and an alkalinity range of 30-100ppm. This helps the people in those counties know how healthy their drinking water is based on how wealthy their county is.

Environmental and Earth Sciences

7 EV 603

Griffin, Peyton

Francis C. Hammond Middle School

The Effect of the Environment on the Degradation of Bioplastic

The purpose of this research was to investigate which common environment would facilitate the fastest degradation of a cornstarch-based bioplastic material. For this project, bioplastic material was created using cornstarch, distilled water, glycerin, and distilled white vinegar. Identical samples of that bioplastic material were placed into three distinct environmental conditions-distilled white vinegar, simulated salt water, and fresh topsoil, as well as a control environment of pure distilled water. The success of each environment in degrading the samples was measured in time (hours/days) as the experiment was conducted over 7 day and progress was checked regularly over that time. My prediction was that the soil environment would produce the most rapid rate of degradation due to its unique microbial composition and moisture level.

Environmental and Earth Sciences

7 EV 604

Hawkins, Astrid

Thomas Jefferson Middle School

The Effect of pH on Galvanized Metal

The purpose of this experiment was to determine how the pH level of different liquids affects the rate of oxidation (rusting) on galvanized iron nails. I was interested in this topic because oxidation can damage metal objects, and understanding how environmental conditions affect rusting can help prevent corrosion. My hypothesis was that if a nail was placed in a liquid with a lower pH level, then the oxidation rate would increase. To test this hypothesis, identical galvanized nails were placed in liquids with different pH levels, including water, saltwater, and vinegar. The nails were observed over time, and the amount of rust that formed in each nail was recorded and compared. The results showed that the liquid with the lowest pH level, vinegar, produced the most rust, while liquids with higher pH levels produced less oxidation. These results support the hypothesis and demonstrate that lower pH levels accelerate the oxidation of galvanized nails.

Environmental and Earth Sciences

7 EV 605

Pastinica, Alexandra

Kenmore Middle School

The Effects of Soil Amendments on Moisture Retention

This experiment assessed the effects of soil amendments on moisture retention using a small, controlled laboratory experiment. Four scenarios were tested to determine the most effective moisture retention amendment; unamended soil, soil with peat-moss, and soil with leaf mulch and with wood mulch. Samples were prepared with equal amounts of (amended) soil and were saturated with equal amounts of water then monitored for 45 days. Containers used did not allow drainage, therefore, all moisture loss was through evaporation.

All samples experienced a rapid moisture loss in the initial 5-day period, followed by progressively lower evaporation rates. The unamended soil samples experienced the fastest moisture loss, with complete evaporation of added water after 22 days. The soil and peat-moss showed the most moisture loss in the first five days, but slowed drastically afterwards, reaching complete evaporation of added water after 30 days. Both surface applied treatments demonstrated significantly better moisture retention, with complete evaporation occurring after 45 days for leaf-mulch and an estimated 57 days for wood mulch. Wood mulch proved to be the best at retaining moisture, with the slowest moisture loss rate over the entire monitoring period.

These results indicate that surface applied treatments were more effective at reducing evaporation, compared to incorporated treatments (peat-moss). However, these findings are based on a bench-scale indoor study, and these conditions are different from those found on large farms or gardens. Condition changes could alter each amendment's performance, therefore, this experiment was conducted to give us a starting point for further research.

Environmental and Earth Sciences

7 EV 606

Patterson, Leo

George Washington Middle School

Fantastic Fossilization: The Science Behind Dinosaur Bones

It has been a long-standing mystery in the paleontology community as to why some locations on Earth are abundant in fossils and others aren't. This project attempted to figure out what conditions create the most accurate trace fossils. My experiment used plaster to create molds of a shell in different materials (dry sand, wet sand, and topsoil) and see which one was the most accurate. I discovered that the dry sand created the best cast of the clamshell. I met my goal of discovering what conditions were the best, but my hypothesis was incorrect.

Environmental and Earth Sciences

7 EV 607

Artigas, Sebastian; Ammagunta, Chatresh; Khan, Al Nahiyan

Thomas Jefferson Middle School

How Can the Design of a Boat and the Weight It Can Hold Affect Global Warming?

The purpose of our experiment was to create a boat with an efficient design that would help reduce pollution and global warming. Our independent variable in the experiment was the design of the boats: the Neoliner Origin, the raft, and the aircraft carrier. The control was the order in which the US coins were placed. (From quarters to nickels to then dimes if needed) The dependent variable was the weight each of the individual boat models could hold. Based on our prior knowledge and the research we did, our hypothesis was that the aircraft carrier boat design would hold more weight than both the Neoliner Origin and the raft because the weight could be distributed more evenly across the surface. This experiment is extremely important because finding a possible solution to decrease pollution caused by oceanic vessels, engineers, and experts alike can produce the best model on a much bigger scale, benefiting life on Earth. Three different boat models were placed in a container filled with tap water and had weight added to them to see how much they could hold. The results showed that the aircraft carrier held the most weight out of the three boat designs, while the Neoliner Origin boat model held the least. The data we collected supported our hypothesis that the aircraft carrier would hold the most weight.

Environmental and Earth Sciences

7 EV 608

Hogg, Ava; Dementi, Vivienne

Francis C. Hammond Middle School

Which Water Type Helps Plants Grow Best?

This experiment tested how different types of water affect plant growth. Plants were watered with tap water, spring water, sugar water, and purified water. Plants were placed in the same conditions (temperature, soil depth and sunlight). Plant growth was measured over time. The tests showed that plants watered with spring water and tap water grew the best, while sugar and purified water grew the least.

Environmental and Earth Sciences

7 EV 609

Onyike, Ikenna; Hossain, Shakur

Thomas Jefferson Middle School

How Clean Is the Water Around Us?

I conducted this experiment in order to determine the effect of public water availability on water contamination. The independent variable in this experiment is how public the water source is. The dependent variable in this experiment was water cleanliness, measured using four chemical components. The water sources were refrigerated, bottled, filtered, and from a public pool. I decided to conduct this experiment because the water at school tastes so different compared to the water at home. This gave me the idea, "Hey, for the science fair, why not compare water cleanliness levels across various sources?" I hypothesized that if the water source is more public, then the water will be more contaminated. To test my hypothesis, I used Varify water testing strips that allowed me to see many different factors of water cleanliness, such as pH levels, chlorine levels, lead levels and more! I collected water from four different sources: from the tap at home, from Thomas Jefferson Middle School, filtered water, and from the Longbridge community pool. After weeks of testing, I can conclude that pool water from Longbridge was the most contaminated. Overall, my hypothesis was supported since the pool water, also the most public water source, was the most contaminated.

Environmental and Earth Sciences

8 EV 610

Curry, Elizabeth

Swanson Middle School

Affect of Location on Water Quality

Four Mile Run is a river in Arlington, Virginia, that is a part of the Chesapeake Bay watershed. Rivers are vital to local ecosystems and help species thrive and survive. Two indicators of the health of a river are its pH and dissolved oxygen levels. The ideal pH to maintain aquatic life is 7, while the ideal dissolved oxygen to maintain aquatic life is 10. This study tested the pH and dissolved oxygen levels at three locations along Four Mile Run (upstream, middle, and downstream) to evaluate which was better to maintain aquatic life. Ten samples were taken and tested at each of the three locations using pH test strips and a dissolved oxygen test kit. After the experiment was conducted, the dissolved oxygen was found to be the highest at the middle location, with an average dissolved oxygen of 9.35, and the pH was the highest at the downstream location, with an average pH of 6.5. The upstream findings were lower than the other two, with an average pH of 5.85 and an average dissolved oxygen of 5.95. The pH was too low at all three sites that were tested, and the dissolved oxygen was below recommended levels. This means that there is a real threat to Four Mile Run and the species that rely on it. Our local rivers are vital to the ecosystem. However, if we do not care for them, they could become polluted and toxic.

Environmental and Earth Sciences

8 EV 611

Hart, Laura

Dorothy Hamm Middle School

The Relationship Between Water Sources in Arlington and Their Water Quality

Understanding the water quality of various water sources throughout Arlington is significant because whenever one may visit the water source, one can think before acting in a way that may further contaminate the water. For instance, one taking their dog out to drop fecal matter should reconsider doing so, as it will eventually enter the water. In my experiment, I investigated which water source in Arlington had the purest water or with a pH closest to 7, where I predicted that the Potomac River would be the dirtiest. To approach the problem, I traveled to various waterside locations and gathered samples. After I arrived at home, I dipped pH testing strips in the water to gather the results. In the end, my hypothesis was proved, with the Potomac River being the dirtiest and having an average pH of 7.8. However, Gulf Branch and Donaldson Run were the cleanest water sources, having a pH of 7.2 and 6.8. Overall, conducting the experiment contributed a new perspective on Arlington's water sources and thinking more about the effects of simple actions on local water supplies.

Environmental and Earth Sciences

8 EV 612

Jackson, Elsa

Swanson Middle School

The Effect of Distance from Ground on Radon Concentration

The purpose of this experiment is (1) to determine how floor level affects radon concentration, and (2) to evaluate whether radon concentrations at Swanson Middle School are safe. Radon is a naturally-occurring radioactive gas that can cause lung cancer. I hypothesized that the radon concentration would be highest in the basement.

To conduct this experiment, I placed two sets of three radon tests on each floor of Swanson. The test kits were left in place for four days to collect radon. Afterwards, the tests were sealed and sent to a laboratory for analysis.

The results showed that the highest average radon concentration was on the main floor, not the basement as anticipated. The radon concentration for each floor was well below the EPA's action level of 4.0 pCi/L. This indicated that radon concentrations at Swanson Middle School do not pose a health risk to students or faculty.

In conclusion, the data showed that my hypothesis was incorrect due to the radon concentration on the main floor being the highest. Follow-on research would include evaluating whether the results were affected by (1) preexisting radon remediation, (2) basement doors opening frequently during testing, and/or (3) recent renovation to the basement kitchen HVAC improving air circulation.

One benefit of this experiment is raising awareness of the risk of radon and the importance of testing. This research demonstrates how radon concentrations can vary within a building, and thus how the risk of radon can also vary within a particular building.

Environmental and Earth Sciences

8 EV 613

Lipitz, Henry

Williamsburg Middle School

The Effect of the Angle of a Storm Barrier on the Inundation of a Tsunami

This project, The Effect of the Angle of a Storm Barrier on the Inundation of a Tsunami, can provide useful insights to improve the design of ocean and sea-side defense systems against tsunamis and large waves. Using a sizable clear tub filled with water, the project simulated a tsunami approaching land and being stopped by a barrier, which was adjusted to eight different angles (the independent variable) starting at zero degrees (parallel to the surface of the water) and moving counterclockwise in 22.5° increments up to 157.5°. The hypothesis stated that the 135° storm barrier angle would block the most water, with the barrier halting most of the tsunami's water flow. For each of the eight storm barrier angles, the experiment recorded and averaged 15 "tsunami events". This was achieved by pushing water with a piece of corrugated PVC and measuring the water flow up a backboard (simulating the land) next to a ruler. Measurements were documented by reviewing slow motion footage of the ruler. Results of the experiment included that the inundation dropped as the degree of the storm barrier increased, reaching the lowest point of inundation on the second to last angle (135°). Secondary results included the range of data decreasing as the angle increased. Ultimately, the hypothesis was supported by the experiment. This investigation can be taken further by changing the material of the barrier or by executing this experiment on a larger scale to best determine ways to protect ocean-side societies.

Environmental and Earth Sciences

8 EV 614

McQuillan, Gabriela

Williamsburg Middle School

What Is the Effect of the Density of the Basal on the Speed of the Pyroclastic Flow?

The purpose of this experiment was to find the density of the basal that would allow the pyroclastic flow to go faster or slower.This experiment will benefit volcanologists as well as other scientists such as hazard scientists. The water-salt solution poured down a 6ft ramp with a 30* degree slope. The time it took for the solution to reach the bucket fully was recorded and calculated. The density of 1000 kg/m^3 had the greatest mean value of 15.17 in/s. The next fastest density was 1100 kg/m^3 with a mean value of 10.78 in/s. Finally, the density of 1200 kg/m^3 had the slowest mean value of 8.01 in/s. The level of IV with the highest variation was 1200 kg/m^3 with a range of 3.88 in/s. The experiment is proving that the higher the density the slower the flow will travel. This will benefit in the future to calculate the speed and how far the flow could travel, or how much damage it'll cause.

Environmental and Earth Sciences

8 EV 615

Pearson, Amelia

Swanson Middle School

How Do Fertilizers Affect Carbon Dioxide Consumption in Algae?

Rising greenhouse gas emissions can largely be attributed to anthropogenic activities. Not only this, but the growing agricultural industry is producing an increasing amount of nutrient-rich runoff. Algae could be a solution to both problems. Algae are able to consume CO_2 at a rate 10-50 times higher than of terrestrial plants. If agricultural runoff could be pumped towards algae farms, then the algae could use the nutrients to grow and more efficiently consume CO_2. This experiment had a multi-factorial design, with three fertilizers (nitrogen, phosphorus and potassium) and a control (no fertilizer), as well as two light levels (high and low). Dissolved oxygen was measured on three different days (day 0, day 3, day 9), to show the CO_2 consumption between treatments and the results were statistically analyzed. The algae that received phosphorus fertilizer showed the most growth overall. The high light was found to show rapid growth, however there seemed to be a limiting factor, possibly due to the lack of other nutrients. Phosphorus is usually the limiting factor in aquatic ecosystems. Due to the high concentration of phosphorus fertilizer in the jars the algae displayed growth. However, in the treatments containing other fertilizers without phosphorus, there was no visible growth. Algae could definitely be a solution to the growing greenhouse gas problem and the eutrophication effects of agricultural runoff. Further testing could involve a treatment containing all three nutrients, as well as fertilizers with different ratios of nutrients to explore the optimization of algae growth.

Environmental and Earth Sciences

8 EV 616

Singleton, Madeline

Swanson Middle School

The Effect of Water Desalination Methods on the Salinity of Water

Around the world the issue of not having access to clean water is affecting millions daily. There is no universal solution and it is up for big dispute. The hypothesis for this experiment is that if you use the thermal technique of desalinating water, then it will work the best, because it is more effective, efficient, and consistent than other techniques. Using the four Independent Variable levels solar, freeze, thermal, and the constant no testing it was concurred that thermal worked best. Solar desalination had little change, while freeze desalination had enough but not an overwhelming amount, and thermal desalination worked amazingly. The average for the control was 31.26 ppt, for solar it was 29.6 ppt, for freeze it was 23.2, and for thermal it was 0.0648 ppt. An interesting thing found with the testing was how prone to human error the experiment was. When looking at the data table it can be seen that only some of the Independent Variable levels had a mode since I was making the salt and water solution by hand. One way this experiment could be taken further is also factoring in how much desalinated water each Independent Variable produced since that is part of the big problem where some methods make more than others. Going back into the real world impact I think this experiment is so adaptable because of the variability that can occur to still use these methods and can be applied very easily due to this.

Environmental and Earth Sciences

8 EV 617

Mercer, Everett; Kiss, Riley

George Washington Middle School

The Effect of Mussel Presence on Potomac Water Turbidity

Water pollution is a serious problem. It affects people from all neighborhoods, incomes, and backgrounds. The NRDC says, "Unsafe water kills more people each year than war and all other forms of violence combined." Our DMV local water sources are known to be polluted. The D.C. Department of Energy and Environment says the District of Columbia's local water sources routinely fall below water quality standards. The demand for local clean water sources is only growing. We think there is a solution to this problem: mussels.

Our goal is to determine the effect of mussels on the Potomac's turbidity. The Minnesota Department of Natural Resources (MDNR) says, mussels, when in the right environment, can live multiple decades or even more than a century filtering multiple gallons of water per day.

Mussels are filter feeders which means they clean the water by feeding on food particles or smaller organisms like bacteria and algae. They help to remove the nitrogen from the water which would kill many other aquatic organisms.

Sadly, according to the Chesapeake Bay Foundation (CBF), mussels are "the most threatened class of organisms in the United States." Some species are already extinct due to pollution, diseases, and climate change. Furthermore, the CBF later states "A report estimates that we've lost 90 percent of mussels in the Bay watershed." This puts in perspective how much climate change is destroying the earth. If we can re-introduce mussels into the Potomac River, that can go a long way to preserving our planet.

Environmental and Earth Sciences

9 EV 618

Graham, James

Arlington Tech and Career Center

The Effect of the Type of Soil on the Amount of Runoff

Coastal communities, particularly along the Virginian coast, are at risk from property damage and loss of life due to soil erosion from water runoff. This study addressed the problem of identifying a soil type that could mitigate this risk by controlling runoff more effectively. The testable question was, "How does soil type affect the amount of water that runs off a hillside?". It was hypothesized that potting soil, due to its organic matter and particle size, would result in the least amount of runoff. To investigate this, four different soil types (neighborhood soil, clay, sand, and potting soil) were placed into separate aluminum pans set at a constant 30-degree slope. A controlled amount of water (three cups) was sprinkled over each soil type, and the amount of runoff collected was measured. The procedure was repeated three times for each soil type.

Results indicated significant differences in water retention capacity among the soils tested. Clay soil produced the highest average runoff at 616.67 mL, while potting soil yielded the least at 413.33 mL. Sand and neighborhood soil produced intermediate results, averaging 565 mL and 566.67 mL, respectively. The initial hypothesis was supported; the experiment successfully demonstrated that soil type significantly impacts water runoff. These findings suggest that implementing soils with high organic content, like potting soil, could be an effective strategy for minimizing erosion and protecting coastal properties from water runoff.

Environmental and Earth Sciences

9 EV 619

Rowlands, Efa

Yorktown High School

The Effect of the Type of Erosion Restricting Method on the Amount of Erosion That Occurs

Soil erosion is a natural process that can negatively impact ecosystems, agriculture, and water quality through the loss of fertile topsoil and the promotion of eutrophication. This experiment investigated the effect of different erosion-restricting methods on the amount of soil that erodes when exposed to simulated rainfall. The independent variable was the type of erosion-restricting method used: bare soil (normal soil), soil covered with dead leaves, and soil containing living ground cover in the form of radish plants. The dependent variable was the mass of soil eroded, measured in grams.

Equal amounts of soil were placed into bread pans prepared with each treatment. A consistent volume of water (1.5 L) was applied to each pan to simulate rainfall, and eroded soil was collected and measured. This procedure was repeated over five trials for each treatment. Data were analyzed using a one-way ANOVA to determine statistical significance.

Results showed that bare soil experienced the greatest erosion, with a mean of 364.4 g of soil lost per trial. Soil covered with dead leaves had significantly less erosion, averaging 52.6 g, while soil containing radish plants showed the least erosion, with a mean of 27.4 g. Statistical analysis revealed a significant overall difference between treatments ($p < 0.0001$).

These findings support the hypothesis that living vegetation is the most effective erosion-restricting method, as plant roots and surface cover stabilize soil and reduce runoff. The experiment demonstrates the importance of vegetation in reducing soil erosion and protecting ecosystems.

Environmental and Earth Sciences

9 EV 620

Surleg, Sugar-Ochir

Washington-Liberty High School

The Effect of Cornstarch Based Biodegradable Plastic Compared to Petroleum Based Plastic on the Rate of Decomposition in Soil Over Eight Weeks

This experiment investigated whether cornstarch-based biodegradable plastic decomposes faster in soil than petroleum-based plastic. The purpose of the study was to compare two cornstarch bioplastics, one from Brand A and one from Brand B, with petroleum plastic to determine which type decomposes fastest over an eight-week period. Cornstarch-based plastics break down through microbial activity, while petroleum-based plastics persist in the environment for decades and contribute to microplastic pollution. It was hypothesized that both cornstarch plastics would lose more mass than the petroleum plastic because microorganisms break down starch faster than synthetic polymers.

Five samples from each group were buried in identical soil containers under the same conditions. All containers received the same volume of water weekly and were exposed to the same temperature and light conditions. The plastics were weighed in milligrams before and after eight weeks to measure mass loss. The results showed that Brand A lost 0.5 grams and Brand B lost 0.4 grams, while petroleum plastic lost 0.1 grams. ANOVA test resulted in a p-value of 0.000000000105 and t-tests confirmed statistical differences.

Overall, both cornstarch bioplastics decomposed faster than petroleum plastic, supporting the hypothesis. Brand A and B showed slight differences in rates of decomposition, suggesting that differences in brand formulation, such as thickness or material composition, influence how quickly cornstarch plastics break down. These findings support cornstarch-based bioplastics as environmentally friendly alternatives to petroleum plastics and provide useful information for manufacturers and policymakers seeking sustainable packaging solutions.

Environmental and Earth Sciences

9 EV 621

Cordts, Gemma; Sweet, Harper

Alexandria City High School - Minnie Howard

Mealworm Bioconversion vs. Standard Composting - An Eco-Friendly and Sustainable Strategy for Waste Management

The world produces over 2 billion tons of solid waste each year, most going to landfills that release greenhouse gases that harm the environment. Without faster, more efficient waste disposal, our environment will continue to be harmed. Surprisingly, one promising eco-friendly solution might be crawling in your backyard or hiding in your flour - mealworms! Recent research suggests composting methods involving bacteria, insects, or worms (such as entomo composting, vermicomposting, and bioconversion) can process food waste more efficiently than standard composting. This experiment was designed to determine how effectively and quickly mealworms reduce household food waste as compared to standard composting. An identical weight and mixture of common household food items (oats, Cheerios, and apples) were placed into bins. Five bins contained mealworms and five did not. The rate of decomposition was measured by weighing the food each third day in a 30 day period. The hypothesis was that if equal masses of food are processed by mealworms and by standard composting under the same conditions, then the mealworm bins will have faster mass reduction because mealworms directly consume and fragment the waste, accelerating breakdown, unlike standard composting. Our data supported our hypothesis. We observed that the mealworm bins had an average rate of decomposition of 1.43 grams per day during the experiment, while the standard composting (bins without mealworms) had an average rate of decomposition of 0.09 grams per day. This data demonstrated that mealworms were able to accelerate decomposition of household food items quicker than standard composting.

Environmental and Earth Sciences

9 EV 622

MacCleery, Maya; Hoxha, Mishel

Washington-Liberty High School

The Effects of Acidification on Seashells

It is imperative that we not only acknowledge the changes that are happening in our oceans, but also take action against the destruction that ensues our planet. Man-made pollution was first recognized as a threat to our oceans in the late 1960's, and yet nearly 60 years later our society has made little progress when it comes to marine life restoration and rehabilitation. Today's youth must educate themselves on environmental problems in order to ensure progress, and pursue the restoration of our aquatic life. The purpose of this study was to test how increased levels of carbon dioxide affected the structural integrity of common marine life (shells), and the pH level of the solutions they were submerged in. The hypothesis for the experiment was that if the acidification in the environment is increased, then the shell will become damaged and start to break down, because the increased carbon dioxide makes it harder for carbonate ions in the shell to produce and create a barrier of protection. The tested groups were water, salt water, carbonated water, carbonated salt water, lemon juice, and white vinegar. In addition, the three types of shells tested were abalone, sand dollar, and scallop. The experiment was conducted by placing one of each type of shell into each solution and collecting the pH, along with qualitative data. The results proved our hypothesis right, and we concluded that as acidity levels of the solution rise, and visual acidification of the shells increases, the pH of the solution decreases.

Environmental and Earth Sciences

10 EV 623

Carpenter, Kylie

Yorktown High School

The Effect of Ferrofluid Concentration on Magnetic Oil Removal

Oil spills pose a serious threat to aquatic ecosystems, yet many existing oil removal techniques are expensive, time consuming, or environmentally damaging. This experiment investigates how ferrofluid concentration affects the efficiency of magnetic oil removal, with the goal of identifying the optimal ferrofluid-to-oil ratio that could be applied to future removal strategies. A controlled oil–water solution was created using 2.5 mL of oil and 14.5 mL of water in a petri dish. Varying volumes of ferrofluid were added to the solution, and a neodymium magnet was passed over the surface to remove magnetized oil. The remaining oil volume was measured to determine removal effectiveness. Results showed that oil removal efficiency increased with ferrofluid concentration before decreasing, forming a parabolic trend. Zero drops of ferrofluid removed 1.35 mL of oil, one drop removed 2.24 mL, and two drops removed 2.11 mL. Further statistical analysis revealed a maximum P-value of 0.01657702 between zero and two drops, allowing rejection of the null hypothesis and indicating a significant effect of ferrofluid concentration. While no major experimental errors were identified, the study is limited by its small scale and inability to model real-world conditions. These conditions include water currents, wildlife interaction, and depth. Despite these limitations, the findings suggest ferrofluids may offer a promising, controlled method for oil spill management.

Environmental and Earth Sciences

10 EV 624

Cha Fong, Sophie

Washington-Liberty High School

The Effect of Different Water Sources on the Presence of Coliform Bacteria

The purpose of this experiment was to test the levels of coliform bacteria in different water sources around Arlington County. The hypothesis was that if water from Four Mile Run is tested for coliform bacteria, then it will have the most coliform bacteria because Four Mile Run is the most densely populated, which leads to more waste entering water sources. The tested groups were 4 water samples from different sources in Arlington County: tap water (control), Four Mile Run, Donaldson Run, and Windy Run.

10 trials per group were tested by using a testing kit and recording the color over 3 days, which indicated the amount of coliform bacteria in the water. Each sample was 50 mL. An ANOVA test yielded a p-value of 2.52×10^{-8}, showing statistically significant differences in the amount of coliform bacteria between groups. A T-Test also showed a statistically significant difference with a p-value of 7.25×10^{-4}. The concentration of coliform bacteria was measured with a color scale provided in the testing kit, which was that yellow (1) was no bacteria, green (2) was a low level, and blue (3) was a high level. The hypothesis that was supported by observed data, as Four Mile Run was blue (2.70), Donaldson Run was green (1.80), and Windy Run was yellow (1.10), indicating that Four Mile Run had the most coliform bacteria. The experiment could be expanded to examine other metrics of water quality and compare them to coliform bacteria.

Environmental and Earth Sciences

10 EV 625

Leaning, Alexandra

Wakefield High School

Rainfall Routes: Moisture Source and Isotopic Signatures of Extreme Rainfall in the Washington, D.C. Area

The Washington, D.C. area is located at the intersection of multiple air masses, which fuel the intensity of storms and make this region vulnerable to extreme rainfall events. Previous studies have identified four major storm types in this area: general storms, tropical storms, hybrid storms, and local storms. However, the relationship between moisture sources and these storm types, as well as their isotope signatures in rainfall, remains poorly understood. Here, we use Hybrid Single Particle Lagrangian Integrated Trajectory Model to track the moisture origins of extreme rainfall events from 2023 to 2025 and investigate their relationship to storm types. We identified the top 10% of extreme rainfall events during the summer (June-August) and winter (October-December) months, based on meteorological data. Multiple statistical methods were applied to investigate backward moisture trajectories related to these rainfall events, including backward ensemble trajectories, frequency analysis, and cluster analysis. We found that summer rainfall was primarily sourced from the Gulf of Mexico, the Mid-Atlantic Ocean, and land transport from the Northern Pacific. Main winter moisture sources showed more diverse moisture origins, including the North Atlantic, the Great Lakes region, and the North Pacific. Such seasonal shifts in the dominant sources are generally consistent with the monthly average of sparse existing rainwater ^{18}O observations, which show more enriched (positive) values during the summer months. Moreover, the rainwater ^{18}O values from individual events exhibit significant variability, underscoring the need for more rainwater isotopic analysis to better understand the link between storm types, moisture sources, and isotopic composition.

Environmental and Earth Sciences

10 EV 626

Pfautz, Faraday

Washington-Liberty High School

The Effect of Methods of Degradation on PET and Sugarcane Bagasse

Consumer products commonly employ PET (polyethylene terephthalate), a major source of plastic waste. Increasingly, sustainable materials such as sugarcane bagasse have gained popularity. The purpose of this experiment was to test methods for degrading such materials: burying them in soil, exposing them to UV light, and using them to grow Oyster mushrooms. The hypothesis was: if the method is using mushrooms, then the sugarcane bagasse will have more quantitative loss in mass because the laccase enzymes involved will facilitate degradation. If the method is exposure to UV, then PET will lose more mass as its weaker bonds are susceptible to light. The null hypothesis was: if the method of degradation is changed, then there will be no quantitative loss in mass in either material. In the experiment, all degradation methods were applied to PET and sugarcane bagasse samples, in addition to a control condition, and change in mass was measured after 28 days.

An ANOVA demonstrated statistical significance across the conditions. Results revealed that mushrooms had the largest effect on sugarcane bagasse and soil had the largest effect on PET. The mushroom trial resulted in full degradation (100%) of the sugarcane bagasse from a starting mass of 0.24g. The soil trial for PET resulted in an average loss of 0.007g (or 0.64%). Overall, this experiment demonstrated the importance of developing methods to degrade commonly used materials to help reduce plastic waste.

Environmental and Earth Sciences

10 EV 627

Rehman, Alina

Washington-Liberty High School

The Effect of Organic Fibrous Sorbents on the Efficiency of Oil Removal from Water

This experiment was conducted to compare the effectiveness of organic fibrous sorbents in absorbing oil from water. The hypothesis for the experiment was that, among cotton fiber, corn husk fiber, and banana peel fibers, cotton fiber would remove the most oil from water due to its low density and fibrous structure. Water-oil samples were tested with four independent variables: no fiber added, cotton fiber, corn husk fiber, and banana peel fiber. Ten samples per group were tested, and each sample contained 250 mL of water and 5 mL of vegetable oil. An ANOVA test showed that using any type of sorbent is better than leaving the oil in water, because all sorbents effectively skimmed off the oil from the water. Therefore, the differences were not statistically significant and the experimental data did not support the hypothesis that cotton fibers would absorb the most oil. It is important to note that the sorbents lacked a differentiating mechanism that filters between oil and water; it is doubtful to assume that the absorbed liquid was solely oil. Following treatment, cotton fibers had a mean of 4.3 grams. The control had a mean of 0 grams, followed by banana peel fiber with a mean of 4 grams, and then corn husk fiber, with a mean of 3.9 grams.

The experiment is important in determining the effectiveness of fibrous sorbents in removing oil from water. It could be expanded by manipulating sorbents with chemicals to improve oil-only absorption from water.

Environmental and Earth Sciences

10 EV 628

Alamri, Hanan; Galindo, Diana

Washington-Liberty High School

The Effect of Different Carrier Fluids on Microplastic Removal

Microplastic pollution is a concern in environmental and public health. It has been increasing because tiny plastic particles continue to be present in aquatic environments. Traditional filtration methods often fail to capture these particles which makes an alternative removal method necessary. This experiment was conducted to look into how different carrier fluids used in ferrofluids would influence the effectiveness of microplastic removal from contaminated water. The hypothesis was, if the carrier fluid in a ferrofluid is changed from the standard vegetable oil to grapeseed oil, then the efficiency of microplastic removal will increase, because grapeseed oil contains high levels of linoleic acid that enhances nanoparticle dispersion and stabilizes iron oxide nanoparticles more effectively than vegetable, palm, or mineral oil.

Ferrofluids were prepared using magnetite powder, stearic acid, and one of four carrier oils: vegetable (control), palm, grapeseed, or mineral oil. Each ferrofluid was added to water containing five microplastic pieces. A magnet was used to remove any attracted pieces from the mixture. Each oil type received ten trials, the number of microplastic pieces removed were recorded. The results showed clear differences among the carrier fluids. Grapeseed oil had the highest mean in microplastic removal (4.9 out of 5 pieces), followed by palm (4.5), mineral (4.0), and vegetable oil (2.5). ANOVA and t-tests showed that these differences were statistically significant.

Overall, grapeseed oil proved to be the most effective carrier fluid for microplastic removal. These findings support the hypothesis and suggest that grapeseed oil based ferrofluids may offer a more efficient

Environmental and Earth Sciences

10 EV 629

Andress, Charlotte; Combs, Juliana

Wakefield High School

The Effect of Caffeine on Plant Growth

Caffeine is a naturally occurring alkaloid found in plants such as coffee, tea, and cacao. In nature, caffeine acts as a chemical defense that protects plants from herbivores and competing plant species. When caffeine enters the soil through decomposing plant matter or human waste (such as discarded beverages), it can act as an allelochemical, meaning it affects the growth and development of nearby plants.

Previous research in plant physiology and allelopathy has shown that caffeine can slow seed germination, inhibit root elongation, and reduce a plant's ability to absorb nutrients (Rice, 1984; Kato-Noguchi, 2002). Because roots are responsible for water and mineral uptake, damage to early root development can lead to reduced plant height and overall growth.

This research is important because caffeine is widely consumed and may enter the environment through runoff or waste disposal. Understanding how caffeine affects plant growth can help scientists better understand environmental contamination and its potential impact on agriculture and ecosystems.

Environmental and Earth Sciences

10 EV 631

McGlinchey, Callum; Sawyer, Turner

Alexandria City High School - Minnie Howard

Filtering the Flow

What if the health of entire ecosystems were dependent on a wetland? In a lot of areas, this is the case. Our project aimed to explore and understand how wetlands affect water quality. We went to a local wetland called Huntley Meadows and tested five different qualities of water. We started at the entrance of the wetland and then moved to the exit of the wetland and collected lots of samples. We tested for nitrate levels, magnesium, calcium levels, dissolved oxygen, and pH. Our data showed positive results where unhealthy levels of nitrate dropped and dissolved oxygen levels rose which shows that wetlands are doing a great job as nature's kidneys.

Environmental and Earth Sciences

10 EV 632

Snipe, Amelia; Wilkoff, Annabelle

Alexandria City High School - Minnie Howard

From Starch to Structure: A Temperature Analysis on Biodegradable Plastic's Performance

The purpose of the experiment is to investigate how the temperature the bioplastic is exposed to affects the strength and flexibility of the bioplastic. The scientists chose this topic because of the relevancy and importance. Plastic pollution is a huge problem currently, and finding environmentally-friendly plastic is urgently needed. Plastic is able to withstand many elements and temperatures, making it widely used, and the scientists wanted to determine how bioplastic would be affected by different temperatures, mocking different global environments/climates. To start, the scientists created the bioplastic with vinegar, water, starch, and glycerin. After the bioplastic fully dried, it was cut into 20 strips and 20 squares. The scientists tested tensile strength by attaching clamps to the material and continuing to hang weights from it until the material broke. The scientists tested flexibility by attaching a strip of bioplastic to two sturdy supports and applying a controlled weight. They then measured the bend in centimeters of the bioplastic. The data supported the tensile strength hypothesis because the bioplastic exposed to colder temperatures supported more weight. Specifically, the data shows that the bioplastic exposed to -5℃ held the largest amount, 2620g. Furthermore, the hypothesis for the flexibility trials were partly correct. The bioplastic exposed to 75℃ bent an average of 1.7cm. However, the highest temperature, 125℃, only bent an average of 1.2cm. Displaying, the bioplastic exposed to 125℃ had bonds broken, leading to a brittle and less flexible material.

Environmental and Earth Sciences

11 EV 633

Brooke, Josephine

Yorktown High School

Will It Take The Bait? (The Effect of Type of Bait on Number of Fish Caught)

My project investigated the effectiveness of sustainable meat alternatives as substitutes for chicken in blue catfish fishing, an invasive species. Ten fishing rods were used: two baited with chicken, two with shad, two with plant based hotdog, two with plant based sausage, and two with an artificial blood bait. The baited rods were cast into the Potomac River at various locations. If no fish were caught within 15 minutes, we moved to a new location. We moved locations several times over a 2.5-hour period. The number of catfish caught on each bait was recorded, the catfish were released, and the lines were rebaited and cast back into the river. During the experiment, we caught 5 edible fish with the plant based sausage and 4 with the chicken. Based on this data, the plant based sausage is an effective alternative to chicken. Using plant-based bait could reduce poultry pollution as fewer poultry are needed as bait, and assist with getting the catfish out of the water. Blue catfish are an invasive species that has impacted the blue crab population. More investigation is needed to determine what made the plant based sausage so effective and if it can be made even more effective.

Environmental and Earth Sciences

11 EV 634

Lehn, Rachel

Wakefield High School

The Effect of Water Source on Adult Daphnia magna Survivability

For this experiment the research question that was asked was what is the effect of water source on adult Daphnia Magna survival. For this experiment, six water sources, to include one control, were used. Pond water from a pond in Pennsylvania, river water from the Potomac river, well water from a well in Pennsylvania, stream water from a stream in Pennsylvania, and tap water from a tap in Virginia. The control was the water that the Daphnia Magna were shipped in. There were 2 trials, so a total of 12 water samples. The research hypothesis was that if the type of water source affects the amount of water toxicity in the water, then more Daphnia Magna will die in the Potomac River water sample, because the Potomac River has more pollution recorded than the other samples. During the experiment, Tap water had the most immediate deaths with all Daphnia Magna dying by the second day of testing (72 in trial 1 and 77 in trial 2), compared to only 9 dying on the second day in the Potomac sample of trial 1, and 8 dying in trial 2. Additionally, as the experiment progressed to the end at 21 days, in trial 1 the Potomac sample had 23 alive and trial 2 had 0 left alive while the tap samples still had 0 alive. Thus, making the hypothesis incorrect

Environmental and Earth Sciences

11 EV 635

Amundson, Clara; Abdelbagi, Amna

Yorktown High School

Assessing Soil Microbial Response to Various Fertilizer Treatments

Soil microbial biomass is an important indicator of soil health, as microorganisms are essential for water and nutrient recycling. While synthetic fertilizers are prioritized over organic fertilizers because of its low cost, accurate nutrient quantities, and wide availability, treating soil with organic fertilizers replaces the organic matter microorganisms rely on for sustenance. Therefore, It was hypothesized that if soil is treated with organic manure, it will yield a higher microbial organism count than soil treated with synthetic urea. This project tested the impact of various fertilizer treatments (untreated, manure, urea) on the number of microbial colonies found in soil. Wheatgrass was grown for 3 weeks to stimulate rhizodeposition (the main source of organic matter), simulating a farm. Microbes were extracted using a serial dilution method: 1g of soil shaken in 10mL of sterilized water. 0.1mL of the solution was inoculated onto agar petri dishes with a micropipette. The plates were incubated for two days to allow for bacterial colonies to form, before being hand counted by marking with a sharpie. A Chi-square test resulted in a value of 14.64, higher than the critical value of 5.991. The null hypothesis was rejected, meaning there is sufficient evidence to conclude that mean number of colonies between the three groups is statistically different. Soils treated with synthetic fertilizer resulted in the highest mean quantity of bacterial colonies at 169, while soil treated with organic fertilizer had a mean of 162, and the control had the smallest mean of 109 colonies.

Environmental and Earth Sciences

11 EV 636

Hao, Alvin; He, Ran; Ye, Lian

Veritas Collegiate Academy

Pre-binding State (PBS): Bridging Viral Immunogen Design and Enzymatic Plastic Degradation

Computational methodologies, including quantum mechanics (QM), molecular dynamics (MD) simulation, and QM/MM simulation, have become essential for investigating enzyme catalysis and facilitating protein engineering. The intrinsic structural complexity of enzymes and the extensive conformational space of biomolecular interactions necessitate significant computational resources. We present a comprehensive framework termed protein pre-binding state (PBS), which encapsulates the transition state configuration facilitating molecular identification and catalysis. We have formulated a PBS technique to efficiently find geometries with catalytic properties without requiring extensive QM/MM sampling, so alleviating the computational load while preserving the interpretability of the mechanism. We proposed two distinct case studies: (i) the stability of the SARS-CoV-2 S2 immunogen prior to fusion, wherein pbs-guided mutations augment the stability and epitope presentation of trimers; (ii) the design of bio-based pyrrolidone-containing polyesters, which exhibit effective enzymatic polymerization under mild conditions to facilitate closed-loop recycling. These applications demonstrate the versatility of PBS in linking molecular-level mechanistic insights with practical outcomes in public health and sustainable polymer degradation, illustrating its promise as a broadly utilized tool for catalysis calculation and enzyme design.

Environmental and Earth Sciences

11 EV 637

Wang, Xiaohan Sophie; Gu, Zihan; Xie, Yicheng Ethan

Veritas Collegiate Academy

From Waste to Win-Win: A Novel Modified Biochar Technology for Synchronized Soil Antibiotic Remediation and Nitrogen Retention

The primary focus of current soil remediation is the development of an in-situ technology for removing soil antibiotic pollution and simultaneously providing nitrogen nutrients to the soil. In this project, we used commercial cow dung and corn straw as the original biochar (which were pyrolysed at 600 °C and were considered to be harmless) to synthesize MgFe-LDH engineered biochar, and used it to activate UHP to remove antibiotic contaminated soil. Results from this work showed that the removal rate of sulfamethoxazole could reach 98.03% under the effect of $^1O_2$, $\bullet O_2^-$, and $\bullet OH$. ESR and DFT calculations indicated that $^1O_2$ is the dominant oxidative species. In addition, biochar from different sources has different effects on the removal of antibiotics. The MgFe-LDH engineered biochar made from corn straw showed a strong adsorption capacity, while the MgFe-LDH engineered biochar made from cow dung showed a strong catalytic degradation ability. The persistent free radicals and oxygen-containing functional groups on biochar also influence the degradation of sulfamethoxazole. The pot and leaching experiments showed that LB/UHP could increase the degradation of soil antibiotics by 69.61%, reduce the leaching loss of nitrogen by 56.68%, and improve soil enzyme activity and lettuce growth. This project successfully developed a green soil remediation technology, and provided theoretical support for the reuse of agricultural and forestry waste.

Environmental and Earth Sciences

7 MC 700

Souryal, Elijah

Kenmore Middle School

The Effect of Training Data and Training Cycles on the Efficiency of a Machine Learning YOLOv8 Face Detection Model

As the world becomes more dependent on AI technology, increasing numbers of data centers around the world generate heat that ruins local environments. The purpose of this experiment is to calculate the optimal parameters for a machine learning (ML) model that detects faces, while requiring the least time and resources during training. In order to gather data to find these optimal parameters. I took a video of my face moving around on a camera, and parsed the video file to get individual frame images, after that I used annotation software to put a box around my face every saved frame. I then tested out different combinations of IV levels to get a smooth graph in a simulation to prepare the experiment parameters. When I acquired parameters, I ran my python script that trains all of the models. Then, I extracted the raw numbers such as the mAP50 score which is a standard scoring metric for object detection models. With the data gathered I wrote and ran another python program that visualizes the data with 3d graphs using the python module matplotlib. My hypothesis was that if either epochs (number of training cycles) or the amount of image data increases, then the performance scores will increase. The experimental results supported my hypothesis by showing that model performance did increase significantly with an increase in either epochs or amount of image data, however that also increased training time.

Mathematics and Computer Sciences

7 MC 701

Zelenovic, Alec

Gunston Middle School

Stats and Bats: How to Win a 12U Travel Baseball Game

Baseball enthusiasts love stats, but not every stat tells you how to win (especially at the 12U level). Runs scored and runs allowed are known to be decent predictors of winning at higher levels (often called the "Pythagorean" idea in baseball). But what works for kids?

My project clarifies what creates impact. This matters because it can give simple, practical targets for 12U coaches and players that may boost their chance to win. This has a positive impact because it promotes player development over just chasing RBIs or batting average.

If we can show clear evidence using real 12U data, then teams can practice smarter and reduce pressure by focusing on the stats that move the scoreboard. This would help limit kids' frustrations with the game and allow them to enjoy the sport more.

This project asked: Which game-level stats best predict whether a 12U team wins? I collected 82 total games from the app, GameChanger, box scores (68 games for the model and 14 new games for testing) from several 12U teams. I organized each game into one row of data and used correlation and multiple linear regression (math tool that finds which stats matter most and gives them "weights") to predict Win Probability (%).

The model showed that winning at 12U is strongly linked to earning free bases (walks), avoiding hitter strikeouts, and pitching strike-heavy innings. The result is a simple message for players and coaches: Win by more walks, more balls in play, and throwing more strikes.

Mathematics and Computer Sciences

8 MC 702

Nigal, Ayush

Thomas Jefferson Middle School

DNA Mutation Alarm: Simulating Quantum Proton Tunneling to Predict Genetic Instability in DNA Base Pairs

DNA replication is one of the most precise processes in biology in general, but mutations can still occur and might even lead to harmful diseases and effects, such as cancer, genetic disorders, and a faster aging rate. Recent research trends suggest that quantum mechanics, even more specifically proton tunneling, may play a role, whether it's big or small, in creating these mutations. In proton tunneling, a proton may cross an energy barrier without the energy required to pass it, alternating the structure of DNA base pairs and eventually leading to incorrect pairings. These quantum derived events mainly occur on timescales of femtoseconds, making them impossible to detect with current scientific tools. Other traditional methods, such as DNA sequencing and CRISPR, can only reveal mutations after they have done their job: becoming a permanent change in your body, highlighting the need for real time detection.

This project contains the design of a future predictive DNA mutation alarm system which combines quantum biology with artificial intelligence. Using Python to simulate and train the AI models, it will learn to recognize even the slightest changes in tunneling events, predicts the probability of genetic mispairing, and outputs a "success rate" for the probability of a mutation occurring. If this computational prototype is successful, this new approach could possibly create a base for quantum biological screening, and monitoring, which could possibly provide a new strategy to prevent mutations before they even occur and transform this simple prototype into a professional clinical tool in the future.

Mathematics and Computer Sciences

8 MC 703

Sivakumar, Jeevesh

Thomas Jefferson Middle School

A Mathematical Analysis of Urban Heat Islands in Arlington, Virginia through Computer Science: A Policy and Community-Based Approach.

The core of the project involved a sophisticated computational workflow developed in Python. This included using the GeoPandas library for complex spatial joins and Scikit-learn for the implementation of a multivariate linear regression model. The algorithm was designed to evaluate the predictive power of three distinct independent variables: impervious surface percentage, tree canopy coverage, and median household income.

The mathematical analysis revealed a dominant positive correlation coefficient ($r = +0.94$) between impervious surfaces and heat retention, while establishing that each 1% increase in tree canopy coverage correlates with an approximate 0.05°C temperature reduction.

Furthermore, the computational model identified a critical "thermal gap," revealing that high-vulnerability communities—defined via the Community Vulnerability Index Map (CVIM)—experience surface temperatures up to 10°F higher than wealthier, well-resourced tracts. These results mathematically demonstrate that urban heat exposure is a measurable indicator of socioeconomic inequity. The study concludes with algorithm-based policy recommendations, advocating for prioritized green infrastructure and high-albedo materials in disproportionately affected zones. By merging physical, computational, and social datasets, this research provides a robust framework for enhancing community resilience and achieving environmental justice in Arlington.

Mathematics and Computer Sciences

8 MC 705

Seggerman, Oliver; Pletcher, Gavin

Dorothy Hamm Middle School

What is the Effect of Different Openings on a Grandmaster's Win Rate?

We chose this for our science project because we both have a passion for chess and are curious about the best opening moves to play. Our testable question was, what is the effect of different opening moves on a grandmasters win rate. To conduct this experiment we went on the chess.com (http://chess.com/) database and played the main lines from these openings: The London, the Vienna Gambit, and the Ponzini. The database will tell us the win rates when these openings are played. Our results show that the Vienna gambit had the highest firm rate with 58% and The London had the lowest win rate with a win rate of 42%. This helps other chess players know what openings grandmasters win with.

Mathematics and Computer Sciences

9 MC 706

Goldman, Ellora

Arlington Tech and Career Center

Decryption Times Compared Mapped to Exact P-values in RSA Encryption

RSA encryption is one of the most widely used encryption algorithms. This project examines its weaknesses by looking at the relationship between RSA key factoring time and key strength. The hypothesis is that as the small factor increases in bit depth the decryption time will increase exponentially, as predicted by the prime number theorem. A numerical experiment was conducted by generating 240,000 factor pairs with a small factor of varying size and then running a brute force attack on each of their factors and recording the time. Experimental results support my hypothesis by showing that there is an exponential relationship between the size of the small factor and the total factoring time.

Mathematics and Computer Sciences

9 MC 707

McCracken Marquis, Georgiana

Alexandria City High School - King Street

Bias in AI

My science fair project was about analyzing bias in AI. This is very important nowadays, due to AI being prevalent almost everywhere. People should have at least a basic understanding of how AI works. To create this experiment, I started with a pre-built large language model, called dolphin3 (using the package Ollama in python). I settled on dolphin3 after testing many different models, due to its ability to recall basic facts and pieces of information. I built a simple chat interface to interact with the agents, running it all locally. From there I built them different "personalities", based on different political biases. (Left-leaning, neutral, and right leaning.) I fed them 20 different news articles on varying subjects. I then asked all three to summarize the articles, putting personality in their answers. I analyzed all 60 summaries based on reliability and bias. (How accurate to the original article, and connotations of words, especially towards certain subjects.) The data I collected proved that the bots stayed in the low 40s range for reliability. This means that, while not fabricating information, the AI did miss a few details. For bias, the AIs struggled to show active opinions, being very straight to the point. Agents designed to be right-leaning struggled to show biased output in the majority of examples, whereas the neutral agent excelled at maintaining a neutral bias. The left-leaning agent was able to show bias in the outputs, though very minimally.

Mathematics and Computer Sciences

9 MC 708

Schreiber, Gabriella

Yorktown High School

The Effect of AI Image Generator on Believability of Photo

The goal of this experiment was to find the AI image generator model that could create the most realistic, believable images. This was done by finding real images, creating a prompt from them through the use of AI, then inputting that prompt back into four AI image generators. The AI models made similar images that were used in a survey, along with the original image. There were four AI image generators tested: GPT-Image-1, Midjourney v6.0, Gemini2.5 Flash (Google), and Flux. 1. During the survey, participants were asked to rate these images on a scale of 1 to 5; 5 being the most believable (least likely an AI generated image) and 1 being the least believable (most likely an AI generated image). At the end the Gemini Image generator was proven to create the most believable images out of these four AI image models .

Mathematics and Computer Sciences

9 MC 709

Sibley, Kayla

Yorktown High School

The Effect of Different Computer Algorithms on Performance in the Iterated Prisoner's Dilemma

The Iterated Prisoner's Dilemma is a game theory problem used to study cooperation and strategic decision-making over repeated interactions. Previous research, most notably Axelrod's tournaments, demonstrated that simple cooperative strategies, such as Tit-for-Tat, consistently outperform more aggressive approaches. This experiment investigated whether supervised machine learning models could learn to outperform existing strategies in the Iterated Prisoner's Dilemma. Three neural network-based strategies were developed and trained using different input information: opponent move history, opponent strategy name, or a combination of both. These neural networks were tested against a set of strategies across multiple iteration lengths. Performance was measured by the total accumulated score. Results showed that neural networks trained on opponent move history consistently performed above the average but did not surpass top-performing cooperative strategies such as Generous Tit-For-Tat or Tit-for-Tat. Neural networks trained only on opponent names produced mixed results, while the neural network trained on both history and name consistently performed the worst, likely due to overfitting. Statistical analysis confirmed significant performance differences between the neural networks. Overall, the findings suggest that while neural networks can learn to mimic the behavior of top-performing strategies and outperform average strategies, supervised learning alone is insufficient to outperform the best cooperative strategies in the Iterated Prisoner's Dilemma.

Mathematics and Computer Sciences

10 MC 710

Parikh, Kara

Yorktown High School

How Do Extreme PID Controller Values Affect the Movement of a Floating Axle?

A PID (Proportional-Integral-Derivative) controller maintains a target state by continuously calculating the error between a desired setpoint and the current measured position. The system applies three distinct mathematical corrections: the Proportional term reacts to the current error, the Integral term corrects for accumulated past errors, and the Derivative term predicts future error based on the current rate of change. One main usage of PID controllers is in motor accuracy. I wanted to test what it would look like for an isolated and overly large PID value to decrease accuracy, as it can often be difficult to distinguish what exactly is causing issues with motors when testing.

My experimental setup involved a stepper motor being rotated 180º clockwise then 180º counterclockwise, incrementing the isolated PID value by 0.5 until it began to worsen the accuracy. Afterwards, I multiplied the resulting value by 5 to get my "too-high" value, which I then had ten trials of the same rotation pattern as with testing for each PID value.

To analyze the data, I calculated the residuals and created sinusoidal regressions to test for oscillations and used the Coefficient of Determination to measure fit. Common patterns I found were that the proportional value generally had some immediate overshoot and then small and sustained oscillations. With the Integral value, there was a moment of waiting, then extreme acceleration into very large oscillations. Finally, with the derivative value, I found that it started moving and then stopped moving despite being told to do otherwise.

Mathematics and Computer Sciences

11 MC 711

Yoo, Andrew

H-B Woodlawn Secondary Program

Willans-Style Functions

We analyze C. P. Willans' 1964 formula for generating primes and discuss a generalization. We also present a similar "Willans-style" closed-form function for generating the deficient numbers (i.e., the natural numbers n for which the aliquot sum $s(n) < n$) along with a proof. To our knowledge, no closed-form expression has previously been published.

11 MC 712

Lu, Haotian; Cheng, Nianyi; Huang, Yijia

Veritas Collegiate Academy

Multiscale Characterization of WGX-50 as a Multitarget Modulator of Serotonin Transporter and Aβ Oligomers in Depression and Dementia

Depression is a prevalent, disabling neuropsychiatric condition that often coexists with dementia. First-line antidepressants, serotonin reuptake inhibitors (SSRIs), have delayed onset and other side effects and cannot fully fix these causes. Computing technology was used to study WGX-50, a naturally occurring hydroxylamine derivative, as a multi-target regulator for depression and dementia pathways. Long-scale molecular dynamics modeling, docking, and MM/GBSFree energy calculations demonstrate that WGX-50 binds well to the orthomorphic (S1) and heteromorphic (S2) binding pockets of human 5-hydroxyserotonin transporter (hSERT), with thermodynamic preference for S1. Key polar and hydrophobic residues that stabilize the above binding mode were found by per-residue energy breakdown and noncovalent interaction analysis. Results confirm WGX-50's SSRI-like but distinct 5-HT reuptake modulation. Simulations indicate that WGX-50 can significantly diminish β-amyloid 1-42 (Aβ1−42) oligomer (dimer-pentamer) folding structures and disrupt the easy-to-aggregate interface, similar to its capacity to block early hazardous oligomers. According to quantum chemical calculations, WGX-50 forms a mild electrostatic coordination complex with copper ions ($Cu^{2}+$), which may reduce metal-induced oxidative stress without excessive chelation. Results indicate WGX-50 is a promising lead drug for treating depression and dementia complications, as it interacts with SERT, inhibits Aβ oligomers, and decreases Cu^{2+}-linked redox stress.

Mathematics and Computer Sciences

7 ME 800

Donnelly, Anna; Cho, Nora

Thomas Jefferson Middle School

"Eggs"periment

The purpose of this project was to learn how different drinks can affect your teeth. Eggshells were used to represent teeth because they are similar to tooth enamel. In this experiment, hollowed eggs were placed into six different drinks: coffee, Red Bull, Gatorade, Fanta, water, and chocolate milk. The eggs stayed in the drinks for one hour and were checked and photographed every 15 minutes.

Our hypothesis was that drinks with high sugar and many chemicals would harm teeth the most. The independent variable was the type of drink used, and the dependent variable was how much the eggshells were stained. Controlled variables included using the same type of eggs, the same amount of liquid, and the same amount of time in each drink.

The results showed that Gatorade and Fanta caused the most staining, while water caused little to no change. These results supported our hypothesis. This experiment helped us understand how certain drinks can affect oral health and why it is important to choose drinks that are better for your teeth.

Medical and Health Sciences

8 ME 801

Gallardo-Velez, Viviana

Williamsburg Middle School

The Effect of Adding Sugar on Food Preservation

Historically, sugar has been used as a food preservative because, like salt, it prevents the growth of mold and bacteria. However, in the last century, the amount of added sugar in processed foods has increased dramatically. This is important because eating too much sugar negatively affects people's health. The purpose of this experiment was to find out the minimum amount of sugar needed to preserve a fruit, in this case a fresh, peeled apple. To accomplish this purpose, different quantities of sugar were added to puréed apples to measure the number of days it takes for mold to appear. The hypothesis was that the more sugar is added to puréed apples, the more time it takes for mold to grow. This is because sugar preserves fruit by dehydrating it through osmosis, which is the process in which sugar molecules attract water and pull it out of microbial cells. This creates an environment too dry for bacteria and mold to thrive. For this purpose, a set of 25 plastic cups with 20g of apple purée each were set. For each set of five cups, the following amounts of sugar were mixed in: 0g, 7g, 14g, 21g, and 28g. Then, the 25 cups were checked every day for mold for five weeks. The experiment showed that 14g were sufficient to prevent the growth of mold in 20g of apple purée, and additional grams of sugar were unnecessary for preservation.

Medical and Health Sciences

9 ME 802

Patel, Anya

Washington-Liberty High School

Wavelength and Dose-Dependent Effects of Photobiomodulation on Planarian Survival

This experiment was conducted to test the constraints and parameters of the upcoming and currently used regenerative medicine therapy, Photobiomodulation on Planarian worms. The hypothesis for this experiment was that green light (520 nm) applied for 2 minutes a day for approximately a week would cause the Planaria to undergo lysis the quickest, since research has shown that green light can have more harmful effects compared to beneficial effects. The tested groups were treated with red light (660 nm) for 2 minutes a day, red light (660 nm) for 4 minutes a day, and green light (520 nm) for 2 minutes a day. Green light has sometimes been shown to stress Planarian cells and interfere with their normal regeneration, sometimes leading to lysis and tissue breakdown.

6 Planarian tails per group were treated separately in their respective labeled dishes. They were each administered their respective treatments daily. T-tests were conducted comparing the G1 Control and each of the three IV groups. The statistical analysis was not however proven significant.Qualitative data observed included the scrunching and curling of the Planarian which increased throughout the experiment.The experimental data supports the hypothesis that green light(520nm) administered for 2 minutes a day 2-3cm away from the petri dish would cause the Planarian to undergo lysis the fastest. The control had a mean length of 3.516mm, and G2 which was treated with red light(660 nm) for 2 minutes had a mean length of 3.56mm, G3 which was treated with red light(660 nm) for 4 minutes

Medical and Health Sciences

10 ME 803

Caramanica, Madison

Washington-Liberty High School

What is the Effect of Different Treatment Temperatures on the Swelling of a Simulated Injury?

The purpose of this experiment was to find the best first treatment for a sprain, strain, bruise, or other injury that produces swelling. It was intended to help athletes or anyone who endures these injuries. The hypothesis was if the temperature of the applied treatment decreases, then the swelling of the injury will decrease because ice is recommended to treat swelling while heat is generally used to stimulate circulation and relieve pain in the affected area for chronic issues (Britannica 2024). The data showed that heat reduced the balloon's circumference by around a centimeter. On the other hand, the cold treatment reduced the circumference of the balloon only by half a centimeter. This did not support the hypothesis. This can be explained by the elasticity of the balloon. The heat caused the elasticity to increase, leading to the water becoming more diffused throughout the balloon. This meant the circumference of the balloon decreased, highlighting the limits to the experiment. This experiment used a model and not an exact replica. In the future, measuring the volume rather than the circumference of the balloon could solve this systematic error. When doing statistical analysis, an ANOVA test proved that the data was statistically significant. However, T-Tests proved that the data was not statistically significant and the null hypothesis could not be rejected. It can be concluded that in this experiment, If the temperature of the applied treatment changes, then there will be no effect on the swelling of the injury.

Medical and Health Sciences

10 ME 804

Dorsey, Ben

Alexandria City High School - Minnie Howard

Extreme Exercise: What Warmup is Best for Lifting

The purpose of this experiment was to test to see which kind of warmup will allow me to do an exercise known as overhead press to the greatest extent. The importance of this experiment lies in the fact that almost everyone is either lifting weights, or wants to get into lifting weights; without a good warmup, this task would be far more dangerous. The problem of this experiment was that it wasn't clear what the best kind of warmup was. The hypothesis was that a warmup using lighter weights would be best, but one could never know for sure. The procedures followed in this experiment were eating honey for energy, completing the warmup, doing a set of exercises, resting five minutes, and then repeating this three times. The next day, the tester would do the same thing but change the warmup; repeating this process until all five of the warmups were completed. This experiment brought unexpected results, the walking warmup caused the tester to complete an average of about 14 reps over the three trials. A very expected result was that doing no warmup (the control) brought the worst results; an average of only nine reps were completed for the control warmup. In conclusion, this science fair project provided key information not only to the person doing this experiment, but also everyone who studies the experiment as well. The science project met its original purpose by uncovering the truth of the problem using concrete evidence backed by data.

Medical and Health Sciences

10 ME 805

Malovany, Caleb

Arlington Tech and Career Center

The Effect of a Fast-Food Diet on Meeting Daily Nutritional Requirements

This fast food experiment's purpose was to discover if eating "healthy" at fast food is posible. So, this experiment was designed to take into account macro nutrients, 6 vital micro nutrients, and calories, to see if they would align with guidelines and recommended intake numbers for a full day. After the idea and background info was procured, the project started by making different subjects. Live participants weren't allowed, so 5 imaginary subjects were created. They had different exercise levels, weights and weight goals, ages, and genders. This was to diversify the subjects, mimicking real subjects. Then the 4 levels of independent variable were decided: Level 1 - regular fast food, Level 2 - high protein fast food options, Level 3 - healthier and greener menu options, Level 4 - carefully curated options from the menu options. The dependent variable didn't require significant research; the dependent variable is the calorie, macro, and micro nutrient intake. Constants included the same criteria for evaluating adequacy (≥100% of daily value considered sufficient,) the same number of meals, and no supplements. Then the restaurants were randomly picked for each person and each level. Then, the menus were evaluated per the level of IV, and finally, the nutrients were calculated. By level 4, the findings suggested that fast food cannot support a healthy day of calorie, micronutrient, and macronutrient intake, which does not support the hypothesis. So, fast food is not, in any form, a healthy option in terms of food options.

Medical and Health Sciences

10 ME 806

Seyran, Zeynep

Washington-Liberty High School

The Effect of gRNA Sequences Synthesized to the c.311_312delinsAGGTTTGCA Position of the BRCA1 Gene on the Predicted Success Rates of Mutation Correction with a CRISPR Simulation

This digital CRISPR engineering project developed novel candidate sgRNAs that could potentially cleave the 311_312 location of the BRCA1 gene, where a delit mutation often associated with cancer appears, and then run diagnostics in Benchling to evaluate those sgRNAs for on target and off target score probability to see which would be most viable. The hypothesis that at least one candidate would yield a high on target and low off target score was supported by the results.

This experiment yielded 4 candidate sgRNAs of 20 base pairs which all had varying proximity to the mutation site. Generally, HDR repair will take better the closer a break happens to the intended site, yet most CRISPR repairs tolerate breaks ~3-10 bp within target. This was reflected in the results as out of 4 candidate sgRNAs the one that was predicted to cut at 313, only two base pairs off from the exact location, yielded a 62.8% on site score whereas sgRNAs 314, 304, and 321 averaged 40-45% for both off and on site scores. However, using STEMCELL institutions guidelines of at least 40% on site and no more than 67% off site scores, all these gRNAs would be considered biologically reasonable. Yet, as it is in closest proximity to the target, there was a significant increase in repair probability with HDR when it was the 313 position gRNA guiding the cleave, this would be the most successful candidate and accepted sgRNA of this experiment.

Medical and Health Sciences

11 ME 807

Bergmann, Paige

H-B Woodlawn Secondary Program

Statistical Analysis of Vaginal Birth After Cesarean Section

Vaginal birth after cesarean section (VBAC) is a crucial birthing option for people who have had prior cesarean sections. VBAC can reduce surgical risk, shorten recovery time, and lower the likelihood of placenta accreta and other complications in future pregnancies. However, access to and success rates of VBAC vary widely across the United States, and disparities in trial of labor after cesarean (TOLAC) remain a pressing public health concern. This project examines how VBAC rates, TOLAC success rates, and TOLAC failure rates differ across major demographic factors, including maternal age, race, education level, state of residence, and degree of urbanization. Using data from the CDC Natality Public Use Files, I identified births to people with a prior cesarean and created variables for VBAC, TOLAC attempted, and TOLAC failed. Pivot tables were used to calculate VBAC rate (VBAC / TOLAC attempted), TOLAC success rate ((attempted − failed) / attempted), and TOLAC failure rate (failed / attempted) for each demographic group. Results showed modest differences by age and education, but more meaningful variation by race. VBAC rates were lowest among Black mothers and highest among American Indian/Alaska Native mothers, while urbanization differences were unexpectedly small. These findings highlight persistent inequities in VBAC access and underscore the need for more equitable obstetric care policies and further research across multiple years and with additional clinical variables.

Medical and Health Sciences

11 ME 808

Choi, Caden

Episcopal High School

Metabolic Biomarker Discovery of Parkinson's Disease via Sequential Deep Learning Model

Parkinson's disease (PD) is one of the representative neurodegenerative disorders and has become a significant public health concern with global aging. To slow the progression of PD and reduce caregiver burden, early detection of biomarkers is important. Delays in the current diagnostic methods for PD detection limit the effectiveness of treatment, which is significantly more successful when the disease is caught early. To overcome limitations of current diagnostic tools, we present a machine learning-based framework combining Deep Feature Selection (DFS) and Graph Neural Networks (GNN) for early biomarker discovery using metabolomics data from PD patients and healthy controls. The proposed model in this study exhibited higher robustness than the DFS-only model and lower computational cost than the GNN-only model, indicating that the proposed model effectively integrates the strengths of both approaches and demonstrates complementary advantages in biomarker selection and classification performance. This approach improves the reliability and interpretability of metabolic analyses and could enhance the early detection of disease. Detecting metabolite-based biomarkers may enable PD diagnosis at early stages, when treatment is most effective, ultimately supporting earlier intervention and improved patient outcomes.

Medical and Health Sciences

11 ME 809

Tarpley, Michael

H-B Woodlawn Secondary Program

Artificial Intelligence Vision-Guided Robotic Prosthetic Arm Prototype: Integrating Low-Cost 3D Print, Arduino Control, and Deep Learning for Autonomous Grasping

Limb loss affects approximately 5.6 million Americans and over 500 million individuals globally, yet advanced prosthetic solutions remain financially inaccessible for most. Current commercial models often suffer from unintuitive user interfaces and high costs. This project addresses these barriers through the development of a cost-effective, proactive prosthetic arm integrated with Artificial Intelligence. By utilizing Computer Vision, the limb autonomously perceives and identifies environmental context, allowing it to adapt to user preferences and predict intended movements. Driven by a single microcontroller and a high-torque servo array, the prototype achieves a balance between precise fine-motor control and significant load-bearing capacity. This research demonstrates a scalable path toward affordable, intuitive bionics that enhance user autonomy.

Medical and Health Sciences

11 ME 810

Ni, Xuanqi; Tang, Botao; Wu, Chenfan

Veritas Collegiate Academy

Optimizing Low-Dose Synergistic Neuroprotection by Tea Constituents Using Orthogonal Design in a Rotenone-Injured Neuro2a Model

Neurodegenerative disorders call for preventive approaches that are both accessible and able to hit multiple targets. Tea, Camellia sinensis, contains different bioactives, such as epigallocatechin-3-gallate (EGCG), theaflavin, and L-theanine, that have been linked to neuroprotection but their combined effect in low doses has not received any attention. We therefore merged mixture design with an orthogonal layout to quantify and optimize combinatorial neuroprotection. Rotenone-injured Neuro2a cells served as a model of mitochondrial dysfunction and oxidative stress. EGCG, theaflavin, and L-theanine were assayed singly and in low-micromolar mixtures, monitoring cell viability, intracellular ROS, and mitochondrial membrane potential. Each compound remained non-toxic across the range and attenuated rotenone damage. Notably, a ternary mix of 20 μM L-theanine, 20 μM theaflavin, and 10 μM EGCG outperformed the individual agents, even at higher concentrations, by improving cell viability and mitochondrial function, while lowering ROS. A multivariate quadratic polynomial fitted to the orthogonal data yielded an explicit equation that predicts efficacy from component ratios. Feeding published tea compositions into this equation produced a ranked neuroprotective index that closely matched our experimental order. The findings endorse low-dose, multi-component tea formulations as a feasible means to stabilize mitochondria and curb oxidative injury, and they supply a transferable, data-driven tool for screening and rationally designing neuroprotective tea products; validation in further disease-relevant models is still needed.

Medical and Health Sciences

7 MI 900

Moore, Delilah; Johnson, Elby; Warren, Sophia

Thomas Jefferson Middle School

Natural Antibiotics

We conducted this experiment in order to find out the effect of natural antibiotics on the growth of fungi. The independent variables were the tea tree oil, the lavender, the turmeric, and the honey. The dependent variable was the growth of the fungi. Our control group was three agar plates that only had the yogurt culture but onto them with no natural antibiotics.

 We were interested in testing this because we wanted to find out if natural antibiotics were effective against fungi or if that was a myth. Our hypothesis was 'if yogurt culture bacteria is put onto agar plates and introduced to 4 natural antibiotics(honey, turmeric, lavender essential oil, and tea tree essential oil)for three trials, then the antibiotics will resist the bacteria, and the area around the natural antibiotics will be clear of fungi because the natural antibiotics will have resistance to the fungi.'

To test this hypothesis, we made yogurt culture to act as a fungus and smeared it onto an agar plate using cotton swabs, and then we put the natural antibiotics on top of the yogurt culture. We left them under a warm light for 2 weeks and then observed the growth of the yogurt culture. Our results from our experiment were partly true to our hypothesis, the turmeric and honey were totally unsuccessful, the lavender was partially successful, while the tea tree oil was very successful at resisting the fungi.

Microbiology

8 MI 901

Mahapatra, Arhan

Swanson Middle School

The Effect of Bacterial Environment on Peptide Antibiotic Gene Clusters: A Comparison of Oral and Fermented Food Bacteria

Antibiotic resistance is a growing crisis, and new antibiotics are hard to find. Many bacteria naturally make peptide antibiotics to stop or slow down competing bacteria. I asked whether bacteria living in more competitive environments have more peptide antibiotic gene clusters than bacteria from more stable environments. My hypothesis was that bacteria from the human mouth, where many species compete for resources, would have a higher density of peptide antibiotic gene clusters than bacteria from fermented foods, which face less competition. To test this, I compared 30 bacterial genomes from the human oral cavity and 30 genomes from fermented foods. For the analysis, I used antiSMASH 8, a tool that searches genomes for antibiotic gene clusters. Human mitochondrial DNA was used as a negative control, and Lactococcus lactis, which makes the peptide antibiotic nisin, was used as a positive control. My results show that oral bacteria have nearly four times higher median peptide antibiotic cluster density than fermented food bacteria. One bacterium, Streptococcus mutans, has the highest cluster density, with five predicted clusters. This bacterium lives in the competitive environment of dental plaque. It has been shown in previous work to contain many antibiotic gene clusters. My project shows that bacteria in competitive environments contain more peptide antibiotic genes than bacteria in stable environments.

Microbiology

9 MI 902

Hengst, Vivienne

Yorktown High School

The Effect of Dandelion Root Extract Compared to Penicillin on the Growth of E. coli

The purpose of this project was to determine whether dandelion extract could act as a substitute for synthetic antibiotics. It was hypothesized that the dandelion extract would have a significant zone of bacterial inhibition, but the penicillin would have a larger zone of inhibition because while dandelion extract has been shown to be a strong antimicrobial substance, antibiotics are still more substantiated. Dandelion extract, penicillin, and water (the control) were administered via tablets onto nutrient agar plates inoculated with Escherichia coli K-12, with ten trials per independent variable. After 48 hours of incubation, the zones of inhibition were measured and compared. The results showed that the penicillin inhibited the bacterial growth more effectively than the dandelion extract, which had little to no inhibition. It was found post-experimentation that water-based dandelion extract has little to no effect on bacterial growth, which explains these results because the dandelion extract used in the experiment was water-based. The penicillin also had a less significant effect than expected, most likely due to using old tablets.

Microbiology

9 MI 903

Hirschfield, Leyla

Arlington Tech and Career Center

The Effect of Disinfecting Substances on Escherichia coli K-12 Growth

When you clean a surface, do you think about the product you are using? The purpose of this project is to determine which disinfecting substance has the greatest effect on Escherichia coli K-12. A disinfectant is an active chemical compound which can "combat microorganisms on nonliving surfaces" (Torabi & Zahra, 2022). This is important to know because we need to be able to know if we are effectively removing bacteria from surfaces that need to be clean. The zone of inhibition after 24 and 48 hours was measured for eight different substances, which were distilled water, 10% bleach solution, lemon juice, distilled white vinegar, 3% hydrogen peroxide, 91% isopropyl alcohol, melaleuca (tea tree) oil, and tomato juice. There were five trials for each substance. The average area of the zone of inhibition for each substance was used to determine results. The hypothesis was that if the 10% bleach solution is used, then the zone of inhibition will be the greatest. The result of this experiment did not support the hypothesis because after 24 hours, the greatest zone of inhibition was hydrogen peroxide with a zone of inhibition of 2.61 cm2. After 48 hours, the greatest area was vinegar with a zone of inhibition of 2.26 cm2. This data was not significant because the p-value after 24 hours was 0.74629459, and after 48 hours it was 0.68499995. This data can still be beneficial to determine the best disinfectant substance to ensure that we are properly cleaning surfaces.

Microbiology

9 MI 904

Capiaux, Flora ; D'Ambrosio, Veronica

Washington-Liberty High School

What is the Effect of Antimicrobial Agents in Anti-Acne Solutions on Staphylococcus epidermidis?

The goal of this study was to test common active ingredients in acne medications and measure which one had the greatest effect on the growth of bacteria found on the face. The hypothesis was that if Staphylococcus epidermidis is treated with acne medications, then Salicylic Acid will be the most effective at removing acne and killing the bacteria, due to its ability to unclog pores and reduce redness on the body. The variables tested were the control (water), benzoyl peroxide, salicylic acid, and resorcinol. Each level was diluted into a 10% solution, and each of the 16 agar plates, four plates per IV, was divided into quadrants. Benzoyl peroxide was shown to best eliminate the bacteria. Following incubation, the control group had a mean zone of inhibition size of 0 centimeters, the resorcinol group had a mean size of 2.3 centimeters, the salicylic acid group had a mean size of 0.9, and the benzoyl peroxide group had the largest zone of inhibition, 2.9 centimeters. The T-tests between groups were substantial, though the ANOVA test showed no significance. The data collected throughout this experiment did not support the hypothesis that salicylic acid is the most effective treatment, but rather showed that benzoyl peroxide was the most reliable option. This experiment is important because it aids in determining the most effective acne treatment, as well as those that do not work as well as advertised. Future experiments can build on this project.

Microbiology

10 MI 905

Baba, Nina

Washington-Liberty High School

The Effect of pH on the Growth of Escherichia coli

Escherichia coli (E. coli) causes 73,000 illnesses annually in the United States. Studying how environmental factors affect E. coli growth can allow scientists to minimize E. coli contamination in fields such as food safety and wastewater treatment. The purpose of this experiment was to determine the effect pH has on the growth of E. coli. The independent variables tested were different pH levels (3, 5, 7, and 10). The dependent variable was the area of E. coli growth measured in cm^2. It was hypothesized that if E. coli is exposed to a neutral pH of 7, it will exhibit the most growth, because extreme pH conditions can cause damage to bacterial cells and disrupt cellular processes, lowering its capability to survive. The null hypothesis was that if E. coli is grown in agar with different pH levels, there will be no difference in the growth of the E. coli between groups. The data from the pH 10 group, which shows the most growth (37.2 cm^2), disagrees with the research conducted, which largely concludes that bacteria grow best at a neutral pH because extreme levels interfere with cellular functions such as metabolism, enzyme activity, and the production of ATP. However, data from the pH 3 and 5 groups show minimal growth, supporting the research that extreme pH conditions result in less bacterial growth. An ANOVA test conducted showed that the p-value was 2.02 x 10^(-15), which is less than the critical value of 0.05, meaning that the null hypothesis was rejected.

Microbiology

10 MI 906

Ghosh, Sid

Yorktown High School

The Effect of Plant Species on the Antibiotic Production Viability of Bacteria in Loosely Adhering Soil: A Spatial Microbial Analysis

Antibiotic resistance is a huge problem in modern medicine, so new antimicrobial compounds need to be found in soil. This study assessed the antibiotic production potential of bacteria in the loosely adhering soil of plant roots, which surrounds the root-adjacent rhizosphere. Bacterial colonies were isolated from the loosely adhering soil of two plants, Morus rubra and Catalpa speciosa, and bulk soil. The colonies were grown on agar plates with lawns of Escherichia coli, Pseudomonas putida, and Staphylococcus epidermis to measure zones of inhibition. The S. epidermis plates were contaminated and did not have complete lawns, so contamination, colony, and lawn size on those plates were measured to determine what factors influence lawn growth. The main hypothesis stated soil bacteria from M. rubra would produce the greatest inhibition zones. The null hypothesis was accepted because there was no inhibition, potentially indicating that loosely adhering soil does not possess the same antibiotic production potential as rhizospheric soil. For the S. epidermis plates, Morus rubra had the largest colonies, and the bulk soil plates had the most contamination. For differences between soil samples, an ANOVA test produced p-values of 0.192408 for lawn size, 0.024757 for colony size, and 0.001391 for contamination size, the latter two being statistically significant. Logarithmic and decision tree regression was used to determine the effect of colony and contamination size on lawn growth, producing respective R^2 values of 0.687 and -41.213 and indicating a correlation, but not causation, between colony and lawn size.

Microbiology

10 MI 907

Shipley, Amalia

Washington-Liberty High School

The Effect of Different Water Purification Methods on the E. coli Growth and Turbidity Levels of Potomac River Water

This experiment tested the effectiveness of different water purification methods on turbidity and E. coli growth of river water. Water-born illness and unclean water are responsible for approximately 3.5 million deaths each year. The hypothesis was if river water is boiled for 5 minutes, then it will show the least amount of E. coli growth because boiling the water for a long period of time will ensure that all the bacteria within the water is killed. The independent variables included: normal Potomac River water, purification tablets, boiling for 5 minutes, boiling for 1 minute, using a filtration pump, and lastly, using a UV purifier pen. Each independent variable was used to determine the E.coli growth and turbidity within each group. Five trials were run for each level of independent variable for turbidity, while 12 trials were run to test for E. coli growth. Several trials were done to ensure that results are consistent and that the measurements/measuring system is working properly.

The data showed consistent evidence showing the water treated with the purification tablet having the highest turbidity, with an average of 144.5 NTU's (Nephelometric Turbidity units). Based on the data collected from the E. coli growth tests, the UV light pen had the highest growth rate.

This experiment is significant because knowing how to properly purify water and what the best method is to do so, can ultimately save someone's life in a survival situation.

Microbiology

10 MI 908

Dong, Norah; McCabe, Elianna

Washington-Liberty High School

The Effect of Different Concentrations of Manuka Honey on E. coli K-12

This experiment was conducted to determine the effectiveness of different concentrations of Manuka honey on E. coli (K-12). The hypothesis was that a solution with 100% concentration of honey would be most effective in killing E. coli (K-12), because Manuka honey with 100% concentration has the most osmolarity (sugar content), high concentration of methylglyoxal, acidity, and hydrogen peroxide, which are known for their antibacterial properties. The IV levels were 100% concentration of honey, 75% honey and 25% water, 50% honey and 50% water, and 100% water (control).

16 petri dishes were inoculated – 4 petri dishes per IV, each dish with 4 trials. An ANOVA test was done to determine if a statistically significant difference existed among the means for the tested groups. The calculated p-value was 4.13E-06 which means that the null hypothesis could be rejected. However, an ANOVA test was also done to determine if a statistically significant difference existed among the means for the tested groups of 100% concentration, 75% concentration, and 50% concentration of Manuka honey. The calculated p-value was .398 which means that there is not a statistically significant difference between the IVs that had Manuka honey in them. Though this experiment showed that Manuka honey is an effective antibacterial agent, the varying IV levels do not have a significant difference.

In the future, this experiment could be expanded by using higher differences in concentrations of honey or using small concentrations of honey to see what the smallest effective amount of Manuka honey would be.

Microbiology

7 PH 1000

Dobronogov, Artem

Kenmore Middle School

The Effect of the Radius and Temperature of a Star on Its Habitable Zone

Astronomers and astrophysicists have been researching the habitable zone of a star, but there are still a lot of unknowns. For example, what are its limits? What affects its size and distance from the star? The goal of this experiment is to help answer these questions by testing how the temperature and the radius of a star affect where that habitable zone starts and how wide that star is. The researcher chose levels for the first independent variable, radius, while the second variable, temperature, was dependent on both the solar radius and the luminosity of the star. It was calculated using the Stefan-Boltzmann Law for Luminosity, rearranged to find the temperature of the star instead of the luminosity. The hypothesis predicted that as the radius and the temperature of the star increased, the width and the inner radius of the habitable zone would also increase. The results of the experiment proved this hypothesis by showing that as the radius went from 0.1 solar radii to 1,000 solar radii, the width went from about 0 to over 5,000 astronomical units (AU) and the distance of the inner radius went from 0.02 AU to over 11,000 AU. The experiment also showed that temperature is an important factor, because the rise in width is not always linear and can be exponential when temperature is included, and the relationship between the star's temperature and the width and the inner radius of its habitable zone is exponential.

Physics and Astronomy

7 PH 1001

Gross, Thomas

Gunston Middle School

Rising Temperatures, Rising Radon?

In a world with a rapidly changing climate, it is imperative that we understand how ambient temperature impacts the release of radon.

Radon is the 86th element in the periodic table. It is the only radioactive noble gas, and it is typically found in soil. However, radon is periodically released, which can lead to serious health problems if enough radon accumulates in one spot, such as in a basement. According to the United States Environmental Protection Agency, "EPA estimates that about 21,000 lung cancer deaths each year in the U.S. are radon-related... For most people, radon is the single greatest environmental source of radiation exposure"(https://www.epa.gov/radiation/calculate-your-radiation-dose) As temperatures become more extreme across the globe, we need to know what effect this changing climate will have on the release of radon.

Physics and Astronomy

7 PH 1002

Schiffer, Molly

Williamsburg Middle School

The Effect of the Brand of Violin on the Overtones

My experiment tested whether the brand of violin affected the overtones for each violin. Overtones are the other sounds you hear while you play a string on any stringed instrument, which means that they make the sound more complex. I hypothesized that if the brand of violin changes, then the overtones are different, causing a different sound because the violin is made out of different wood, finish, and minor other things. I did this project because I wanted to know more about the violin since I play the violin and I'm in the school orchestra. To conduct my experiment, I borrowed violins from the music store I go to, I tuned the violins, and I played the fundamental A string while I recorded the overtones with the spectrum analyzer. Some data and major results showed that the Voigt violin had the highest and strongest overtones with a mean of -792 dBFS, while the Eastman violin had the strongest fundamental string. The variation analysis showed that the violin with the highest variation was the Gafiano with a range of 86 dBFS. In the end, my hypothesis was supported because according to the data, the overtones were different for each violin. My data can be helpful for when I get to buy my own violin because the results can lead me to decide whether I want a violin with shrill overtones, muddy overtones, or warm overtones.

Physics and Astronomy

7 PH 1003

Ali, Baheya; Matthews-Carter, London

Jefferson-Houston PreK-8 School

Does the Color of Water Change the Color of the Laser?

We are researching lasers and how the different types of colored water alter the appearance of the laser. A problem that we encountered was that in our first experiment we failed to calculate how many drops of dye we put, we quickly fixed that in our next experiment by measuring the amount of dye we put in each beaker.

A laser is a device that emits light through a process of optical amplification. Lasers play an important role in modern technology through surgery, dermatology. Lasers can help heal bones faster, assisting with getting rid of acne as well as helping reduce wrinkles. Did you know that lasers can read cds and dvd players? Lasers also produce intense, focused, and coherent light used for precise cutting & welding.

Our hypothesis was that we will be able to disclose every water color through the beaker while using the red laser beam. Our hypothesis was only about 45% correct because we used four colors and only two colors showed on the ceiling. However one color only showed up ⅔ times.

Using lasers and lights helped improve our community by showing how lasers are used to help improve peoples lives.

Physics and Astronomy

8 PH 1004

Berhanu, Ruth

Jefferson-Houston PreK-8 School

How Does the Surface Affect the Distance a Soccer Ball Travels

The purpose of this experiment was to determine how different surfaces affect the distance a kicked soccer ball travels. My hypothesis was that the ball would travel furthest on concrete due to lower friction. A size 5 soccer ball was rolled from a consistent starting point across three different surfaces: turf, concrete, and grass. Five trials were conducted on each surface, and the distance traveled was measured. The results indicated significant variation. On grass, the ball traveled an average of 2.50 meters. On turf, the average distance was 4.43 meters. On concrete, the ball traveled the furthest, with an average distance of 11.80 meters. The results support my hypothesis that the surface material significantly impacts travel distance, with smoother, lower-friction surfaces allowing for greater distances. This research demonstrates the importance of surface type in sports and physics.

Physics and Astronomy

8 PH 1005

Carpenter, Kara

Williamsburg Middle School

The Effect of the Amount of Water on Solar Panel Energy Production

The Effect of the Amount of Water on Solar Panel Energy Production is a project created to determine whether a solar panel is capable of producing energy efficiently when water accumulates on its surface. This project is designed to assist people in determining the cost-effectiveness of solar panels based on climate and to ensure that the locations of solar panels generating power worldwide are optimized for proficiency. Carrying out this project involves spraying water evenly on the surface of a solar panel and using a multimeter to calculate watt-hours. By testing three different amounts of water, it is possible to determine whether there is a negative trend in energy generation. The results showed that 0 milliliters of water produced the most energy (3.57 watt-hours), followed by 10 milliliters (3.55 Wh), 20 milliliters (3.38 Wh), and 30 milliliters (3.25 Wh). The data clearly display a negative correlation between increasing amounts of water and energy production, supporting my hypothesis. An additional experiment that builds upon this one could involve changing the angle of the solar panel and recording the resulting change in energy output. The results of this experiment could provide useful insight into the weather-dependent success of solar panels for both individuals and businesses.

Physics and Astronomy

8 PH 1006

Cobb, Daylen

Williamsburg Middle School

The Effect of Open Windows on Deceleration in a 2016 Audi S6

This study examined the influence of opening the sunroof or windows on the aerodynamic drag of a family sedan. This was done by driving on a flat road at 55 mph, shifting into neutral, and recording the time it takes to decelerate to 50, and then 45 mph. Surprisingly, the hypothesis was not supported. The 3 levels of independent variable used were sunroof closed with windows open, everything closed, and the sunroof open with windows closed. The car's drag with the sunroof open may be reduced as a result of less downforce being created. Having less downforce means less drag; downforce is great for cornering but slows down the car in a straight run. Three ways this experiment could be changed would be to change the car used in the study, the study could modify its shape differently, or take 2 different cars, and compare the results.

Physics and Astronomy

8 PH 1007

Guzman, Lucy

Francis C. Hammond Middle School

Knocked Out!

This experiment was conducted to determine whether the weight of a bowling ball affects how many pins are knocked down. The hypothesis stated that if the bowling ball is heavier, then it will knock down more pins because the ball has more force when it hits the pins. To test this, bowling balls of different weights of 6 lbs, 10 lbs and 14 lbs were rolled down with the same force, a ramp and bumpers for each trial to keep the experiment fair. Three games were played with three different bowling ball weights. The average number of pins knocked down for each weight was calculated and recorded at the end of the games. The data was compared at the end to see if heavier bowling balls knocked more pins down rather than lighter ones. The results showed that heavier bowling balls generally knocked down more pins than lighter ones supporting the hypothesis that if a heavier bowling ball was used more pins would be knocked down.

Physics and Astronomy

8 PH 1008

Hazlett, Owen

George Washington Middle School

D(on't) B(lock) M(y) S(ignal)

Wi-Fi connects millions of people and provides infinite possibilities for knowledge sharing and creativity. But what if it doesn't work? Many materials can block Wi-Fi and slow it down. So what materials block modern Wi-Fi the least? Based on research, I hypothesized that brick would block Wi-Fi signals more than other materials. I tested that hypothesis by blocking my home Wi-Fi router with structures made of various materials (brick, ceramic tile, metal, plexiglass, and plywood) and using a Wi-Fi speed test app to measure the upload and download speeds while the router was blocked. I tested the Wi-Fi speed twice a day over a three week period. After the first week, my results were unexpected because the structures had little effect on speed and, in some cases, the speed was actually higher with the covering over the router. At this point I increased my distance from the router, turned off the Wi-Fi booster, and introduced a new material (aluminum foil). After nine more days of testing I concluded that the materials that blocked Wi-Fi from least to greatest in the upload category were brick and plywood, ceramic tile, plexiglass, aluminum foil, and metal, which was most effective in blocking the signal. The materials that blocked Wi-Fi from least to greatest in the download category were almost identical: plywood, brick, ceramic tile, plexiglass, aluminum foil and metal again being the most effective. Overall the structures I built blocked the signal less than I expected and my hypothesis was proven incorrect.

Physics and Astronomy

8 PH 1009

Pathak, Sita

Swanson Middle School

The Effect of Salinity on Dye Traversal Time

One may question why the water temperature decreases when moving farther from the shore at the beach. It is due to a thermohaline current driven by convection named the "global ocean conveyor belt". The purpose of my experiment was to gather research that indicates the impact of salt on convection currents. For my experiment, I created solutions with water and varying amounts of salt (independent variable: 0g(control), 3.5g, 7g). Afterwards, I poured those solutions into a tube and added a single drop of dye into the solution. Simultaneously, I placed a Bunsen burner exactly 1.5 cm away from the tube. Last, I recorded the duration required for the dye to traverse to the opposite side of the tube in seconds (dependent variable). My hypothesis anticipated that increasing the amount of salt would increase dye traversal time because of higher viscosity. My results were supported to a limited extent. Although the average greatly increased from 0g to 3.5g of salt (51.38 seconds to 83.24 seconds), adding more salt to reach a total of 7g of salt decreased the mean by about 2.6 seconds most likely because of separate variables. The discrepancies in the experiment were directly correlated to experimental errors. For instance, temperature changes from the Bunsen burner and evaporation over time. These factors affected dye speed and consistency. In real-life, ocean circulation is altered by changes in salt concentration and convection which retain the ability to disturb nutrient delivery and marine life populations.

Physics and Astronomy

8 PH 1010

Sadowsky, Alister

Dorothy Hamm Middle School

The Effect the Throwing Angle Has on How Far the Football Travels

Do you want the secret to throwing farther? Do you think it is the strongest arm, the best athlete, or a lucky wind gust? Those may have an impact, but there is a more reliable technique to throwing the farthest. I was interested in the science behind the throw, like the throwing angle.

Testable question: What is the effect the throwing angle has on how far the football travels?

To find out, I obtained a manual launcher to perform the experiment and attached it to a long table. I launched a mini football at 15, 30, 45, 60, and 75 degrees for 3 trials each. For each launch, I measured the distance the ball landed and recorded the results in a data table.

The results showed that if you set the launch angle to 45 degrees, then the football will go the farthest. If you set the launch angle too much above or below 45 degrees, it will not go as far. For example, 15 and 75 degrees went the shortest distance.

I accomplished my objective by finding out the best angle for a long distance football throw. My research is scientifically important because launch (one of the most important factors of the flight of a football) is a big part of flight and space travel, like sending out satellites.

Physics and Astronomy

8 PH 1011

Hornish, Nicholas; Shackelford, Charles

George Washington Middle School

How Does Tire Pressure Affect the Speed of a Road Bike?

The purpose of this experiment is to investigate how the air pressure in a bike's tires affects the bike's speed. The speed of a bike is influenced by the friction between the tire and the road. Without friction the tires would spin without moving the bike forward, but too much friction will slow the bike down. Air pressure impacts how much of the tire contacts the ground, thus increasing or decreasing the amount of friction between the tire and the ground. We hypothesized that If the tire pressure decreases below the recommended amount, 60-80 pounds per square inch (PSI), then the bike will move slower. Specifically, we expect when the tires on a road bike are filled to the recommended pressure (65 PSI), the bike will go faster than when the bike tires have less air in them (40 PSI) because the higher the PSI of the bike tires, the more rigid the tires are, leading to less friction between the bike and the road To examine our hypothesis we measured the maximum speed of a bike travelling downhill at three different tire pressures. We selected a tire pressure that was above, within, and below the recommended tire pressure for the bike. We conducted five replicates for each tire pressure. The data support our hypothesis because the bike went faster as the higher tire pressure increases. Based on the finding we conclude that increasing air pressure in bike tires increases the bike's speed.

Physics and Astronomy

8 PH 1012

Kravetz, Jordan; Phillips, James

Gunston Middle School

The Effect of Different Surfaces on How Fast Ice Melt Works

In our project, we used six different surfaces: marble, wood, cardboard, dirt, brick, and stone. First, we did the control trial. We put 30mL of water into equal size petri dishes and froze them into ice. We put the ice on each surface and started a stopwatch. After that, we recorded how long each surface took to melt its ice. For the regular trials, we did the same thing, except we also put 1 tsp of calcium chloride ice melt on each of the different surfaces to see how well it melted the ice compared to without the ice melt. We did this trial three times. The results were very interesting. For every trial, the ice in the marble took the least amount of time. After that, the brick and stone finished less than 15 minutes apart. Now, the next three materials took a while to melt. However, the ice melt consistently changed the order in which the ice on the cardboard, wood, and dirt melted. During the control trial without ice melt, wood finished 30 minutes before dirt and cardboard, yet an hour and a half after the ice on the rock, brick, and marble all melted. After that, dirt fully melted its ice two minutes before cardboard did, putting cardboard in last place. However, in the trials with the ice melt, cardboard tended to melt the ice 5-30 minutes faster than dirt and wood, which means the ice melt affected it much more than the other materials.

Physics and Astronomy

8 PH 1013

Strauss, Charlotte; Perez-Lopez, Miriam

George Washington Middle School

A Daily Dilemma: Soundproofing a Room for Music

Much of the global population lives with other people or in communal living spaces. While we do our best to keep quiet, sometimes the noise from our lives escapes our living areas and invades others' spaces. For our experiment, we tested which of three soundproofing materials keeps sound inside a model room the best. Acoustic cotton, acoustic foam, and closed cell foam were tested. We also tested a bare foam core model room without soundproofing materials on it as the control. To do this experiment, we first built 4 cubic model rooms out of foam core board. Next, we insulated three of the boxes with each of the different soundproofing materials. We then played a song inside each model room, recording the max decibel (dB) level outside the room each time. We repeated this until each box had been tested 10 times. We hypothesized that closed cell foam would trap the sound in the room the best, since it is a sound insulator. However, the acoustic foam worked the best in our experiment. The averages of our experiment are as follows: acoustic foam's mean was 62.48 dB, closed cell foam's was 65.53 dB, acoustic cotton's was 69.21 dB, and foam core board's was 69.69 dB. We think this happened because the acoustic foam absorbs sound, and if there is less sound inside, less sound can travel outside. In the field of sound engineering, this project shows that acoustic foam keeps sound inside a room the best.

Physics and Astronomy

9 PH 1014

Ayalew, Maedot

H-B Woodlawn Secondary Program

Fusing Deep Learning and Magnetohydrodynamic Modeling for Probabilistic Real-Time Coronal Mass Ejection Propagation and Impact Prediction

Every day, satellite operations, power grids, and communication systems on Earth are disrupted, negatively affecting the general population. These disruptions are caused by space weather events, primarily coronal mass ejections (CMEs), large plasma outbursts from the Sun's corona and among the most significant space weather phenomena. Since space weather was declared a national security concern in 2019, mitigating its impact through accurate forecasting has become increasingly important. However, existing models are often prone to errors due to the inherent variability of CMEs. This study presents a hybrid framework fusing machine learning techniques with magnetohydrodynamic (MHD) modeling to maximize prediction efficiency and accuracy. The approach integrates a physics-informed neural network (PINN) with MHD modeling techniques to generate faster, more accurate plasma behavior predictions than traditional numerical solvers, while also estimating uncertainty. Open-source packages such as SunPy, SRAG, and CACTus, alongside other data sources, were used to develop the model. Additionally, key MHD equations, including the continuity equation, were incorporated to provide three-dimensional propagation analysis. The model also utilized uncertainty quantification to provide a crucial risk assessment for the model. The model was validated through accuracy tests and statistical analysis. Results demonstrate strong predictive performance, with an r^2 of 0.9958 and a 100% halo classification rate. The inclusion of uncertainty quantification further enhances its utility in risk assessment. Overall, this study produces a more accurate and efficient forecasting model, offering significant potential to protect critical infrastructure and satellite operations that are essential to daily life.

Physics and Astronomy

9 PH 1015

Ayers Caballero, Anabelle

Washington-Liberty High School

Effect of Different Insulation Materials on Decibel Level of Sound

The purpose of the experiment was to determine the effects of different insulation materials on the decibel levels of sound/music. The research question that was investigated was "What is the effect of different soundproofing materials on the decibel levels of music?" The research hypothesis was that if the insulation material in each box is changed, then the decibel levels of the music will decrease because the materials will block the music by adding mass to the box to a point that the sound energy will be reflected or converted into heat by the mass of the insulation material. The independent variables were the control group, the box insulated with cotton towels, the box insulated with yarn, and the box insulated with acoustic foam. The experimental design was a speaker that played music from inside a box, and the music was measured by a decibel meter app on an iPhone placed three inches away from the box. There were five trials conducted where the music would be played for ten seconds, and the decibel level of the music was measured during those ten seconds. In this experiment, the research hypothesis was supported by the data. The statistical tests done indicate that the results were statistically significant. In this experiment, the calculated p-value was 2.8×10^{-10}, which is less than the critical value of 0.05, meaning that the null hypothesis can be rejected.

Physics and Astronomy

9 PH 1016

Grutza, Alissa

Alexandria City High School - Minnie Howard

What Shoe Makes Me Run Faster?

The purpose of this experiment was to see if wearing track spikes actually makes a runner faster than wearing regular sneakers. My hypothesis was that track spikes would improve running times because they provide better grip on the track surface. To test this, I ran several 100-meter sprints, 3 times wearing spikes, 3 times wearing trainers, 3 times while wearing sambas, 3 times while wearing Birkenstock and 3 times wearing just my socks. The results showed that my times were consistently faster when wearing the spikes, with an average improvement of about 1 second. This happened because the metal spikes dug into the track, giving me more traction and power during my start and throughout the sprint. In conclusion, my hypothesis was correct. Using track spikes is a very beneficial way for runners to improve their speed and reach their performance goals.

Physics and Astronomy

9 PH 1017

Johnson, Catherine

Washington-Liberty High School

The Effect of Environmental Variables on Wireless WiFi Frequencies.

This experiment was done to test the effect of environmental variables on the strength of radio frequencies (rf) and what specific variables caused the signal to become weaker. The test was performed to determine whether there was any combination that was stronger or weaker, or if there was statistical significance between specific groups or interferences. The research hypothesis is, if the distance for each interference is changed, then the signal strength will degrade because of electromagnetic interference and the inverse square law. The inverse square law describes the relationship between signal strength and distance; specifically that due to waves becoming more spread out, they become weaker, and electromagnetic interference describes how interference affects signal strength.

There were 3 trials done at every distance per interference - at distances of 0 m, 1m, 2m, 3m, 4m, and 5m. Control groups were used to simulate interference; specifically aluminum foil, a cardboard box, and a combination of both. The experiment consisted of a 2-Factor ANOVA test to determine statistical significance for the combined means of the groups. The calculated p-values were 5.21 x 10-19, 6.40 x 10-24, and 0.03. Two T-Tests to determine statistical significance were done between the control group and the cardboard box group at the distances of 1 meter and 5 meters. Both the p-values were greater than 0.05, meaning there was no statistical significance between these two groups. When looking at the whole experiment, an overall significance was achieved.

Physics and Astronomy

9 PH 1018

Williams, John

Yorktown High School

The Effect of Wind Turbine Blade Shape on Wind Turbine Energy Output

This experiment was conducted to find what blade shape caused a wind turbine to generate the most electricity in 10 seconds. The independent variable levels were: oval, square, pentagon, and triangle. I measured the energy produced using the current in amps and the electric potential in volts over ten seconds that the wind turbine produced depending on the blade shape it had. I then multiplied the amperes by volts by the time in seconds to get the joules (energy) produced. Based on the data averages, Tukey HSD test, and ANOVA test, blade shape did affect wind turbine energy production. The oval blade shape was shown to generate the most energy, and the pentagon was found to generate the least energy. Based on the results, the null hypothesis and my hypothesis were rejected. The oval blade shape generated the most electricity because of its curved edge; which, allowed the wind to stay along the surface of the blade for a long time, slowing it. Based on Bernoulli's Law this allows more pressure to be exerted on the blade and generates more electricity and the oval blade shape has a high aspect ratio, causing a smaller amount of drag while maintaining high thrust. The pentagon performed the worst. The pentagon had a low aspect ratio meaning it had significant drag. The pentagon had edges that broke up airflow, thus speeding up airflow. Bernoulli's Law states that this decreases the pressure the air has on the blade; which decreases energy generation.

Physics and Astronomy

10 PH 1019

Bhatnagar, Radhika

Washington-Liberty High School

The Effect of Salt Concentration on the Refraction of a Laser Beam

The purpose of this experiment was to determine whether different salt concentrations could affect the angle of refraction of a laser beam. The hypothesis of this experiment was that if the salt concentration in the water is 20%, then the angle of refraction will be smaller because the solution is more dense, which will cause the angle of refraction to decrease. The laser beam shined through water that was treated with five independent variables: 0% salt concentration which posed as the control group, 5% salt concentration, 10% salt concentration, 15% salt concentration, and 20% salt concentration. Each saline solution would be used to determine whether or not an increase in salt concentration, and therefore an increase in refractive index would decrease the angle of refraction. After conducting ten trials for each saline solution, it was determined that the refraction of the laser beam decreased as a result of an increase in salt concentration. Each 5% increment resulted in a small decrease in the angle. The statistical analysis, using both ANOVA and T-tests, confirmed that the results were statistically significant and supported the hypothesis. These findings prove Snell's Law of Refraction, and that the denser the solution, the smaller the difference between the angle of refraction and the angle of incidence.

Physics and Astronomy

10 PH 1020

Fenster, Esther

Yorktown High School

The Effect of Materials on Wi-Fi Speed

The purpose of this experiment, testing how different materials affect Wi-Fi speed, is that Wi-Fi and routers are used throughout society for a variety of purposes related to communication, education, and entertainment. Various materials commonly used in homes or other buildings can disrupt the radio waves coming off the router, so this project helps to find the most efficient materials. It then helps people know where to have their router located in order to receive the fastest and most reliable signal. The hypothesis for this project was if the type of material is plexiglass, then the Wi-Fi speed will be greatest because glass generally has little effect on the travel of radio waves. To do the experimentation, the router was surrounded with one material (aluminum, basswood, plastic, and plexiglass) at a time. Six sheets held together by packing tape were used for each material, three in front, one on each side, and one on top. To test the Wi-Fi speed, the AirPort application was used on a cell phone ten meters in front of the router. The app measures the speed in decibel-milliwats (dBm). The hypothesis was then proven wrong as basswood was the material with the highest speed, not plexiglass. The materials all had relatively similar means, but still a clear difference between each one.

Physics and Astronomy

10 PH 1021

Tkabladze, Luka

Yorktown High School

The Effect of Applied Force on the Voltage Measured Across a Beam of Ice

In 2025, a group of scientists made a groundbreaking discovery, revealing that ordinary ice has extraordinary powers. It is flexoelectric. This means that ice generates an electric charge when subjected to uneven mechanical stress, such as bending, twisting, or stretching. Inspired by the new discovery, this project explores a fundamental question: How does the amount of force applied to ice affect the strength of the voltage it produces? The experiment tests the effect of varying applied forces on the voltage produced from bent ice beams. The procedure includes applying a three-point bending force by hanging different weights from the middle of the ice beams, and analyzing the resulting voltage readings over time. The results show that voltage generally increases as more weight is applied, suggesting a positive correlation between flexoelectricity and force because greater force creates larger strain gradient, which in turn generates a stronger electrical response. The consistent voltage variations observed over time, regardless of the weight applied, further supports that bending-induced deformation drives the electrical behavior of ice. Because ice covers approximately 10% of Earth's surface, uncovering how the application of mechanical forces leads to electric potential in ice opens unparalleled possibilities, from understanding climate science and atmospheric physics, such as lightning, to developing new technologies for harvesting low-cost, waste-free energy in cold and remote regions. This experiment lays a foundation for further research, including tests involving saline ice or different temperatures, and contributes to the emerging field of science sparked by one of the most intriguing discoveries.

Physics and Astronomy

10 PH 1022

Malseed, Alexander; Brennan, Rory

Alexandria City High School - Minnie Howard

Do More Expensive Golf Balls Really Perform Better?

Scientific literature has virtually ignored the price-performance relationship of golf balls, though several golf industry studies have examined the question in experiments with swing robots. These studies found that mid-range balls are competitive with premium balls in raw distance, but provide significantly better spin rate on short-iron shots, and overall greater consistency.

This experiment explores the practical question of whether a premium golf ball is worth the added price in the performance advantage it can bring. Since golf balls are costly and easily lost, it is hoped that the findings will help golfers make economical choices of which balls to use.

Physics and Astronomy

11 PH 1023

Keane, Taogh

H-B Woodlawn Secondary Program

Antineutrino Detection As a Means to Monitor Nuclear Reactor Activity

The aim of this experiment would be to create and test a small, practical antineutrino detector that can be used to monitor nuclear activity in reactors as a way to increase safety which could help boost opinion of nuclear energy, allowing growth in the nuclear industry to help as a transition from fossil fuels to renewable sources. This detector will use the Ultima Gold LLT scintillation cocktail. This was chosen over the other available scintillator NaI(Tl) because, while less efficient, a larger detector can be built, increasing detection probability. This scintillator will be paired with photomultiplier tubes and a multichannel analyzer to process the data and feed it to a computer. This data can then be used to calculate activity.

The nuclear activity will be calculated by taking the output from the multichannel analyzer (voltage spikes that correspond to detections) to determine detections per time The macroscopic cross section, Σt, will be calculated using the formula $\Sigma t = \sigma \cdot N$ with the known values of the microscopic cross section of antineutrinos and the atomic number density. The rate and macroscopic cross section will be used to calculate antineutrino flux using the formula $RR = \phi \cdot \Sigma t$. The rate of antineutrino production in the training reactor will then be estimated by applying the inverse square law: $\phi = (\nu s^{-1})/4\pi(r^2)$. Finally, the rate of fission can be estimated by dividing the rate of antineutrino production by 6 since fission events produce 6 antineutrinos on average.

Physics and Astronomy

11 PH 1024

Maloney, Evie

Washington-Liberty High School

The Effect of Cup Material on Heat Loss

This experiment explored the process of heat loss and the barrier that different cup materials create to slow that process. The purpose of this experiment was to see if the type of cup material used would have an impact on how much heat is retained over time. It was hypothesized that if hot water is placed in a foam cup, then it will retain heat the longest because the foam cup provides the greatest barrier to heat loss.

Four different cup materials were tested: paper, foam, plastic, and metal. Hot water was poured into each cup, and the temperature was measured after every 3 minutes for 30 minutes. A timer was used to ensure that the time was consistent for each trial. This process was repeated ten times for each cup material. Data was collected, and after concluding all trials, statistical tests were performed. The calculated p-values for both the ANOVA test and the t-test were less than the critical value of 0.05; therefore, the null hypothesis can be rejected. This experiment demonstrates how different materials affect heat retention and can be applied to real world situations involving insulation and heat transfer.

Physics and Astronomy

7 PS 1100

Lahr, Elizabeth

George Washington Middle School

Race to Ripen!

The purpose of this lab is to investigate the effect of storage methods on the speed bananas ripen. To conduct this experiment the following procedures were used: First, I placed one green banana on the test surface. Then, I placed another green banana in a plastic Ziploc bag. Next, I put a green banana in a brown paper bag. After that, I wrapped the last banana in saran wrap. Next, I placed all of the bananas in the same location to control temperature and exposure to light. I observed the ripeness of the bananas for seven days and measured them on a scale of 1-5 for ripeness levels and recorded results daily. I repeated the experiment three times with the same materials and variables. The data did not support my hypothesis because the banana in saran wrap ripened fastest, which was not the most or least porous storage method. The data led to further research that proved that oxygen is essential to the ripening process. However, in previous research, I learned that bananas ripen quickest when in less oxygenated areas. This experiment showed that both things can be true; bananas do not ripen without oxygen, but ripen fastest when in containment that reduces oxygen.

Plant and Animal Sciences

7 PS 1101

Mullen, Miles

Williamsburg Middle School

The Effect of the Type of Water on the Growth of Sugar Snap Peas

My independent science project was: The effect of the type of water on the growth of sugar snap peas. The independent variable for this experiment was the type of water, and the dependent variable was the growth of peas. The question for this experiment was simply: "What is the effect of the type of water on the growth of sugar snap peas"? I created this project for a couple of reasons but most prominent was because if you lived in an area where regular water was scarce, you might be able to use a different type of water based on the results of this experiment. With help from sources like Britannica, I came up with my hypothesis: "If the water type is sparkling, then the plants will grow the tallest, because the water will penetrate the soil the fastest before evaporating, thus giving the plants more water". My hypothesis was rejected because the regular water plants had the highest average height at 11cm. This was somewhat unexpected, but the plants with sparkling water did indeed have the second best average height, at 7.8cm. The other levels of independent variables were not as successful, with sugar water having an average height of 3cm, and saltwater having an average height of 0cm. Although there were a few errors in this experiment, including the fact that disease could have spread between the plants, and the dependent variable could have been edited, I believe this experiment consisted of very productive and representative work.

Plant and Animal Sciences

7 PS 1102

Pleva, Piper

Swanson Middle School

The Effect of Number of Wolves on Amount of Deer Culled

I recently learned that Arlington County will begin culling deer this year in a park near my house. My project examined the problem of overpopulation of deer and the different ways this problem could be solved. I learned about different methods that could be used to reduce the population of deer, such as sterilization or culling (professional sharpshooting). Both options are expensive and hard to implement in the real world so my project experimented with a different method: introducing a natural predator of deer, wolves. I coded an online model, using Scratch, to look at the effect of the number of wolves on the amount of deer culled. My model focused on does (female deer) and implemented culling whenever the number of deer was higher than the carrying capacity. In each of my tests I increased the number of wolves and tested if it would drop the amount of deer culled in a 10 "year" span. My results showed that when there were three wolves in the model the least amount of deer were culled. Overall I learned a lot about ecosystems and how different amounts of species can greatly change the way the ecosystem works. I learned about how modeling can be a powerful tool to look at the effects of environmental changes. In the real world I could never release wolves in Arlington, Virginia, modeling adds a way to test different ideas that we may someday be able to do.

Plant and Animal Sciences

7 PS 1103

Witschorik, Janie

Williamsburg Middle School

The Effect of the Type of Solvent on the Height of the Wheatgrass

Does Wheatgrass benefit from a specific solvent? The purpose of this experiment is to determine what type of solvent will make the Wheatgrass grow the tallest. This is important because we can figure out how to get our plants growing strong and healthy. Every day I gave each Wheatgrass plant 30 mL of their solvent. The hypothesis said that the Rice water solvent would have the best results of the Wheatgrass growing the tallest because it has so many nutrients like phosphorus and potassium. The results of this experiment did not support the hypothesis because the results show that the Rice water solvent actually made the Wheatgrass grow the least, with an average height of 15.7. While the other Wheatgrass plants had an average of 16.9-18.2. This data can be very beneficial to anyone out there who wants to help their plants grow healthy and strong.

Plant and Animal Sciences

7 PS 1104

Woldu, Amanuel; Getahun, Maedot; Lasker, Rafan

Gunston Middle School

How Do Aquatic Plants Effect the Eutrophication of a Body of Water?

Have you ever had a plant die due to lack of nutrients? If so, that is usually an "example of other plants disrupting the eutrophication, or amount of nutrients, of soil or water." We wanted to test if this really was the case, so we will conduct an experiment. To conduct this experiment, we would first buy three one gallon sized tanks, soil, nitrogen and Ph testing kits, duckweed, guppy grass, and amazon frogbit seeds. Then, add 10 grams of soil to the bottom of the tanks, and add one gallon of water. Then, add the seeds into the soil and wait. Over the span of three weeks, test the water with the testing strips and look for sediment using a microscope. Then, after each observrnent, record the data. After the experiment is over, graph the data to see if there is any correlation between species of plant and eutrophication of the water. To dispose of the experiment, freeze the plants, and evaporate the water, and put everything else in the compost bin. We believe this data would be useful to the world, as to see which plants would take the most nutrients, and would leave no other nutrients for other plants. Many people could benif

Plant and Animal Sciences

8 PS 1105

Bourque, Michael

Thomas Jefferson Middle School

Algae Growth

The purpose of this project is to raise awareness about the impacts of plant fertilizers on algae growth. I was drawn to this topic out of a desire to understand more about algae and the factors influencing its growth. My hypothesis was that increased levels of plant fertilizer would lead to more substantial algae growth. To test this, I collected pond water and applied different levels of plant fertilizer to each jar. After several weeks, the results confirmed my hypothesis: the jar with the highest fertilizer concentration exhibited the most algae growth, while jars with medium and low fertilizer levels still showed some algae growth. Therefore, the experiment demonstrated that when the amount of fertilizer increases, so does the amount of algae.

Plant and Animal Sciences

8 PS 1106

Cole, Somers

Dorothy Hamm Middle School

What is the Effect of Soil pH on Plant Growth?

This research is scientifically important because soil pH affects plant health, food production, and environmental balance. In this experiment, 4 soils with different pH levels were used to grow 48 sunflower plants. The soils were separated into 4 tins then pH tested. Each had 12 sunflower seeds. For 15 days the seedlings received 75mL of water per tin, and their height was measured then recorded. In the end of the experiment, it showed that soil pH had a major effect on the growth of the sunflowers. The optimal pH for a sunflower seed to be grown in is 6.5. In soil A, there was a pH of 6.6, and the sunflowers grew an average of 10.19cm, which was the highest amount of growth. In soil B, there was a pH of 7.3, and the sunflowers grew an average of 6.76cm. In soil C, there was a pH of 5.4, and the sunflowers grew an average of 2.15cm, which was the least amount of growth. In soil D, there was a pH of 6.9, and the sunflowers grew an average of 6.90cm. Farmers and gardeners rely on soil chemistry to grow crops effectively. By understanding how to test and adjust soil pH, people can produce healthier plants with fewer chemical fertilizers.

Plant and Animal Sciences

8 PS 1107

Ferrill, Olivia

Dorothy Hamm Middle School

Fighting Squirrels With Spice

For as long as people have put up birdfeeders outside their homes, there have been squirrels there to disrupt the peaceful feeders and mercilessly devour all of the seed. My project tests the efficiency of adding a chemical called capsaicin, naturally found in spicy peppers, to the seed, which the birds do not have enough taste buds to notice but greatly affects squirrels. One way to do this is by using a product called Cole's Spicy Squirrel Seed Sauce, which contains capsaicin. My project shows whether or not the recommended amount of seed sauce (9.46 mL per feeder) is actually necessary to deter squirrels, or if the same results can be found with a lower concentration. To do this experiment, I set up two feeders, one with plain birdseed and the other with birdseed containing a varying concentration of seed sauce. With the use of cameras, I then recorded every visitor to both feeders. As it turns out, on average, merely one-quarter of the recommended amount, only 2.73 mL per feeder, is enough to keep most squirrels away. Spicy seed sauce is not cheap, so this allows you to use the product for four times as long! The only drawback is that the amount of birds does decrease when the seed sauce is added, but not by very much. I believe that I have met my objectives for this project, having found the most efficient amount of seed sauce to use in bird seed to effectively deter squirrels. For as

Plant and Animal Sciences

8 PS 1108

Hearding, Ridley

George Washington Middle School

The Effect of Salinity on Zostera marina

This experiment helps to understand how changing salinity affects the growth of submerged aquatic vegetation. There have been salinity changes worldwide as ocean levels rise due to global warming melting the ice caps. By studying the effects of salinity changes it can help determine future changes that may appear as sea levels continue to rise. In this experiment there were 5 different salinity levels 10 ppt, 16 ppt, 22 ppt, 28 ppt, and 34 ppt. The higher the ppt, the saltier the water is. Every other week each plant was measured for its height and the amount of leaves it had. Results showed that the healthiest plants were in the brackish salinity which would be closest to 22 ppt and is also the control salinity. It is not surprising seeing as Zostera Marina is a brackish water plant and often used for restoration purposes, meaning it is meant to survive in medium salinity, not as salty as the ocean though which averages 35 ppt. However, if sea level rises in the ocean, it will also rise in bays and estuaries pushing more salty water into the ecosystem. An example of this is the Chesapeake Bay which is the largest estuary in North America, which is slowly rising in salinity levels. The loss of Zostera vegetation could affect the whole ecosystem. This includes all the plant species in and around the bay, fish species, crabs, oysters, otters, sea birds, and so many more.

Plant and Animal Sciences

8 PS 1109

Ribble, Rowan

Swanson Middle School

The Effect of Different Types of Light Wavelengths on Germination Rate

This experiment tested the effect of different types of light wavelength on a plant's germination rate. The goal of this experiment was to learn more about different kinds of light and plant growth. Over 10 days, 30 radish seeds were observed everyday. The seeds were divided into 3 sections (UV light, Infrared light, and White light—the control). Seeds received their specific light 6 hours a day. When the lights weren't on, the station was covered with a dark table cloth to prevent outside light impacting the experiment. After the 10 day period, the infrared light seeds had the slowest germination rate with an average of 3.625 days. White light seeds (control) had an average rate of 3.6 days. The UV trials had the fastest germination rate with an average of 3.1 days. Results indicated that using UV light when germinating seeds will have the fastest overall germination rate. This information could be used by botanists to assess seed health, while farmers can use this information to grow cash crops quicker.

Plant and Animal Sciences

8 PS 1110

Willis, Calliope; Creed, Maddie; Rahman, Ridwana

Thomas Jefferson Middle School

How Does Salinity Affect Plant Growth?

We conducted this experiment to find out how salinity affects plant growth. The reason we decided to do this experiment is that as the sea gets higher and higher because of global warming, the water that plants use to grow will become more saturated with salt. The idea of this experiment is to see how plants are affected by the salinity content in the water. Going into the experiment our hypothesis was: If the plants have different amounts of salinity in their water, then the plant with the least amount of salt (control group) in it's water will have the highest growth, because osmosis causes salt to accumulate near the roots of the plant so the salt will suck up the water instead of the roots. To test our hypothesis, we ran trials with a control group with no salt, a group with ½ teaspoon of salt per 300ml of water, a group with 1 teaspoon of salt per 300ml of water, and a group with 1 ½ teaspoons of salt per 300ml of water. On Mondays we water the plants with these groups and accumulate height data for our tables. You can see from the results section that plants with ½ teaspoon of salt per 300ml had the highest growth therefore our hypothesis was rejected. This is because the control group was closest to the space heater therefore this dried them out. We were correct, however, about the lower growth of the plants with a full teaspoon or more.

Plant and Animal Sciences

9 PS 1111

Admassu, Zoe

Washington-Liberty High School

Effect of Chemical and Natural Fertilizer on Plant Growth

This experiment was conducted to test whether fertilizer type affects short-term plant growth when nitrogen is equal. The hypothesis was that plants treated with chemical fertilizer at a standard nitrogen rate would show the fastest early growth because chemical nutrients are immediately available, which accelerates cell division and elongation compared to the slower release from natural fertilizers.

The tested groups: no fertilizer (control), chemical fertilizer at a low nitrogen rate, chemical fertilizer at a standard nitrogen rate, and natural fertilizer (compost/worm castings) matched to the standard nitrogen rate. Chemical fertilizer at the standard nitrogen rate has been shown to increase early growth the most. Eight plants per group were tested over six weeks by growing identical seedlings under the same light, water, soil, pot size, temperature, and measuring plant height, leaf color, and number on a schedule. Qualitative observations (leaf color and vigor) were also recorded. An ANOVA test showed statistically significant differences among groups. T-tests indicated that the chemical standard-nitrogen group outperformed the control, the natural fertilizer, and the chemical low-nitrogen group. Observational data indicated greener leaves and sturdier stems in the chemical standard group.

The experiment data support the hypothesis that chemical fertilizer at a standard nitrogen rate yields the most rapid short-term growth under equal nitrogen supply. The chemical standard group had the highest mean height, the natural fertilizer group showed moderate improvement over the control, and the chemical low-nitrogen group showed smaller gains. The experiment is important for understanding how fertilizer type influences early growth.

Plant and Animal Sciences

9 PS 1112

Plafcan, Aoife

Washington-Liberty High School

The Effect of Different MP Polymer Types on Raphanus sativus Height

The hypothesis for this experiment is that raphanus sativus grown in soil with microcrystalline cellulose (MCC) glitter will grow the tallest because cellulose is a natural substance in plants, made for the strength of the cell wall. The glitter cores tested were MCC, PET, and PU. Twenty raphanus sativus were grown per group, and 2 oz of soil was mixed with 0.35 oz of glitter. Contrary to the hypothesis, the data demonstrated that MCC glitter inhibited the growth of raphanus sativus the most, with the average plant growing to 75 mm, compared to the control's 102. Later investigation revealed that the apparent PU core glitter may have been another polymer, supported by the minimal difference between the 'PU' and PET glitters backed by a p-value of 0.472. The only statistically significant difference in the data (ANOVA tests) was between the control and MCC glitter. Acrylates copolymer was used to create a film around the MCC, and it is probable that this outermost layer caused environmental hazards to the raphanus sativus. The amount of acrylates copolymer coating found in the plant environment was more than enough to hinder plant growth, due to its superabsorbent polymer (SAP) tendencies which disrupt exchangeable cations within the plant. Understanding microplastics (MPs) and their effects on soil ecosystems remains a vital next step in preventing the further degradation of agricultural health. To enhance this experiment further, and to investigate the predictions regarding SAPs, the root length would also have to be measured and recorded.

Plant and Animal Sciences

9 PS 1113

Stern, Charlotte; Salerno, Ella

Alexandria City High School - Minnie Howard

What Type of Natural Fertilizer Elicits the Most Plant Growth for Red Russian Kale Plants?

Environmentalists and plant lovers are always stressing the need for the use of environmentally friendly and natural fertilizers, so this brings the question: is using a natural fertilizer truly effective? This project looks at what types of natural fertilizers work the best on red Russian kale plants. For our project we tested 4 natural fertilizers along with a control group of soil. The fertilizers tested were coffee grounds, banana peels, earthworm castings and compost. As stated prior these fertilization methods were tested on red Russian kales plants over the course of 5 weeks with 5 trials per method. The change of fertilization method is the independent variable within this experiment and the amount of growth the plant elicited is the dependent variable. To determine the dependent variable in our experiment we looked at two forms of qualitative data: the leaf appearance and stem structure and two pieces of quantitative data: the end height and end weight. Our hypothesis was: If red Russian kale plants are grown with the natural fertilizer of compost then it will elicit the most growth because of the high growth vitamin boosting contents in compost like potassium. The experiment results supported our hypothesis by showing that, overall, the plants grown using composts had the highest and healthiest results for our quantitative and qualitative data tests that were stated above. In conclusion, our hypothesis of compost being the most effective was proven correct using the data that we gathered throughout the duration of our experiment.

Plant and Animal Sciences

10 PS 1114

Hass, Reed

Washington-Liberty High School

The Effect of Different Levels of Water Intake on Grass Growth and Health

The purpose of this experiment was to find the effect of water on grass growth and health, whether that be over or underwatering the grass samples. The hypothesis for this experiment was if an area of soil and the grass growing upon it has a lower water intake, then the grass health and growth will be significantly worse because water is needed for the chemical reaction photosynthesis to occur, which gives the grass Glucose and allows for growth. However, on the other hand, the null hypothesis was that if an area of soil and the grass growing upon it has a lower water intake, there will be no significant difference in grass growth and health. Overall, the data collected confirms with the hypothesis as the results were overall statistically significant. Both the Anova Test conducted between all groups, which resulted in a p-value of 4.93×10^{-20}, and the t-Test between the 15 mL and 30 mL groups, which resulted in a p-value of .000265, were statistically significant. Although the t-Test between the 30 mL and 45 mL did not turn out to be statistically significant with a p-value of 0.644, the data collected was overall significant. To conclude, the hypothesis is supported by the data and the experiment is successful. Additionally, of the groups: 0 mL, 15 mL, 30 mL, 45 mL, and 75 mL, the 15 mL group had the largest mean growth and the 75 mL group had the least growth.

Plant and Animal Sciences

10 PS 1115

Karlton, James

Arlington Tech and Career Center

The Effect of Decomposer on Plant Growth

The Purpose of this experiment is to be used as research to show which decomposers are most beneficial to plant growth. It is hoped that this experiment can provide simple, yet important data, that could help farmers, gardeners, and all other manner of botanical enthusiasts alike. Sixty Zeya Mays Indentata (Dent Corn) were planted in 3 separate containers and split into three groups of twenty. Group A was given no decomposer in its soil each week, group B was given worms in its soil, & group C was given mycorrhizal inoculant. Of the three groups, the plants in group C grew the highest. This proved my hypothesis that if the plants are grown with mycorrhizal inoculant, then they will grow bigger than plants grown with worms, because fungi do a better job at promoting root health (Bonfante et.al, 2009). I used ANOVA to analyze my data. What I found was that there was no statistical, significant difference between the data in the different groups. It would be interesting to retry this experiment with different plants over a longer period of time.

Plant and Animal Sciences

10 PS 1116

Larsen, Harry

Washington-Liberty High School

The Effect of Gibberellic Acid (GA) Concentration on the Growth of Bean Plants

The purpose of this experiment was to determine if increasing concentrations of GA would result in faster germination and increased growth in bean plants. It was hypothesized that higher GA concentrations would accelerate germination and promote greater plant height in the Dragon Tongue bean plant compared to untreated plants. The four treatment groups were no GA (control), 5 ppm (Group 1), 10 ppm (Group 2), and 20 ppm (Group 3). Each group (20 seeds) was treated with different GA concentrations while the control was treated with distilled water. Germination time was recorded and plant height was measured weekly for three weeks.   GA-treated plants germinated faster than the control group. An ANOVA test showed statistically significant differences in germination rate (p= 0.027). T-tests showed that the 10 ppm and 20 ppm germinated faster than the control, but the 5 ppm was not significantly different to the control. ANOVA tests showed no statistically significant differences in height Week 1; differences were seen in Weeks 2 and 3 (p = 9.16×10^{-7} and p = 2.19×10^{-10}). By Week 3, Group 3 showed the greatest mean plant height (p < 0.05). GA-treated plants were taller and exhibited increased elongation, specifically for Group 3 (Week 3). Overall, the results support the hypothesis that gibberellic acid promotes germination and increased height in Dragon Tongue bean plants. These findings show the benefits of optimizing plant hormones and further study could include additional GA levels, longer duration time, and other plant species.

Plant and Animal Sciences

11 PS 1117

Dalton, Arthur

Alexandria City High School - Minnie Howard

Tiny Titans: An Urban Agriculture and Nutrient Powerhouse

Americans are lacking, both in reliable urban agriculture and nutrient consumption. 60% of U.S. high school students are missing critical nutrients with Alexandria City High School (ACHS) school lunches often lacking in vitamins A,C, K and D. Urban Agriculture is also lacking with a lack of reliable onsite horticulture for ACHS students. This project seeks to fix both of these problems by growing microgreens in the school greenhouse. By using these results of this experiment the microgreens can be grown as efficiently as possible by using the correct type of microgreen. The hypothesis in the experiment is- If Daikon Radish is the microgreen tested then the growth will be greater than the other tested varieties.

The experiment was run using three varieties of microgreens- Daikon Radish, Red Radish, and Broccoli. The seeds were measured and soaked for three days. The seeds were planted in wetted soil flats, placed under pink lights and put in a greenhouse. The three Daikon flats were all over 100g of growth. The red radish had one flat with over 100g and one with the lowest growth. The broccoli were all under 100g. The data supported the hypothesis as the three flats of Daikon radish had the most growth out of any flats tested. This data is currently used to ensure proper microgreen growth for ACHS cafeterias. This data is used to back up the choice of Daikon microgreens in the school cafeteria. And the expansion of the experiment to Brooks Elementary School.

Plant and Animal Sciences

11 PS 1118

Yu, Zimeng Jessie; Bai, Yuxi; Zhang, Kele

Veritas Collegiate Academy

Solving Invasive Species Problem Based on Neural Networks and LightGBM Algorithm

Invasive Alien Plants (IAPs) severely threaten global biodiversity and ecosystem stability, but existing models lack mechanistic integration of climatic heterogeneity and objective impact quantification for herbaceous species. This study develops an end-to-end framework: a seed dispersal-mechanized climate-weighted Backpropagation (BP) neural network for short-term spread prediction, and a Random Forest-LightGBM hybrid model for impact factor quantification. Trained on authoritative climate and species distribution data from Arkansas, the BP neural network reliably predicts dandelion (referring to Taraxacum mongolicum Hand.-Mazz. in this study) population dynamics over 1–12 months across temperate, arid or tropical climates. The hybrid model screens 5 non-redundant impact factors (including population density, reproduction rate, transmission ability, environmental pollution rate, and biodiversity destruction rate) and quantifies invasion severity, with validation on tumbleweed and iron broom identifying severely invaded U.S. regions. This work advances herbaceous IAP management with mechanistic, high-precision tools.

Plant and Animal Sciences

12 PS 1119

Lee, Julia

Washington-Liberty High School

Seasonality and Salinity Shape Parasite Prevalence in an Estuarine Crab Host

Parasite-host dynamics in marine ecosystems are strongly influenced by spatial and temporal conditions. We aimed to investigate how spatiotemporal factors such as salinity and seasonality influenced the prevalence of macroparasites - the entoniscid Cryptocancrion brevibrachium, the rhizocephalan Loxothylacus panopaei, and digenean trematode cysts - in the estuarine crab host, Rhithropanopeus harrisii. Crabs (N=912) were collected from the Chesapeake Bay across a salinity gradient of 10.5ppt-20ppt from August 2024-May 2025. Crabs were dissected, and crab and parasite species were recorded. Linear modeling showed that salinity significantly influenced L. panopaei prevalence but had no effect on C. brevibrachium, cysts, or coinfection prevalence. Trematode cyst prevalence was scarce throughout the year, but prevalence of L. panopaei, C. brevibrachium, and coinfections was higher during warmer months (e.g., summer through early fall). The high prevalence of C. brevibrachium (13%), L. panopaei (40%), and coinfections (12%) found in warmer months is likely associated with high parasite reproduction during this time. Understanding the role that salinity and seasonality play in determining the prevalence of these parasites within this host is important because R. harrisii is an invasive species around the globe and can be used as a vector for these parasites to spread.

Plant and Animal Sciences