Name(s)

Aneesh Bhardwaj; Abhinav Mukkamala

Project Number

J1301

Project Title

Defend Your Household Electronic Devices from Disruptive Electromagnetic Frequencies

Abstract

Objectives

When we have a natural disaster such as solar flares or hurricanes, any electronics can be destroyed and power grids can also completely shut down. The objective of our experiment was to test the shielding effectiveness of the Faraday Cage using household electronic devices. We target to experiment this objective with different thermal conductors.

Methods

Identify the frequencies of all devices without any variables using the radiation detector app to obtain the baseline.
First, take an aluminum paint can with a lid. Seal off all of the cracks with aluminum tape. (Bottom, and lid)
Turn both walkie talkies on the same channel
Place the 1st walkie talkie inside the can
Close the lid
Put aluminum foil on top of the whole can, to seal any gaps (This is the Faraday cage.)
Take the 2nd walkie talkie and go 100 meters away from the cage
Speak into the 2nd walkie talkie sending the signal
Listen to see if there is sound coming from the 1st walkie talkie placed inside the Faraday cage
Follow the same steps for placing other devices such as a Bluetooth speaker and a phone.
Repeat the steps with the other conductors (copper jug with a lid, metal container.)
To extend the experiment we used two laptops and tried to connect them wirelessly. We were able to see that one of the laptops was able to copy the files of the other laptop. We tested the same process keeping one laptop inside the Faraday cage. Inside the Faraday cage to check if the laptops stay connected.

Results

We observed that compared to steel container and copper jug, the homemade aluminum cage proved to be the best Faraday cage since it effectively shielded the electromagnetic frequency between devices inside and outside the cage.

Conclusions

After repeated experiments, we concluded that Aluminum was the best thermal conductor that reduced the electromagnetic frequencies. We also observed that regardless of how high the electromagnetic frequency is, the Faraday cage is still effective to shield the electronic devices.

Summary Statement

We concluded that Faraday cages made out of aluminum have the best shielding effectiveness to protect our household electronic devices.

Help Received

We received tips on materials to build the Faraday cage from Mr. Ken Kojima - Agency Information Security Officer, Department of Corrections and Rehabilitations

Name(s)

Thomas Chase

Project Number

J1302

Project Title

How Does the Density of Wood Affect the Frequency of Vibrations?

Abstract

Objectives

I wanted to test how much or if different densities of wood affected vibrations when a piece of wood is vibrated. This experiment would help instrument makers because it could indicate which woods have higher pitches and lower pitches. It also helps furniture makers because as the information could help technicians know which woods are lighter but sturdier and which ones are heavy or brittle.

Methods

Tested the frequency of vibrations (hz) of 6 different wood types (pine, redwood, cedar, oak, poplar, ipe). Cut to 1m long 2cm wide 8mm thick. Clamped to table, traced for control parameters, then pulled down and released. Measured with SpectrumView app on phone. Completed 5 tests for each wood type.

Results

The higher the density the lower the vibrations, with the exception of Oak which had an exceptionally high average frequency. A different independent variable could be affecting the frequency.

Conclusions

These results conclude that woods with higher densities emit lower frequencies and woods with low densities emit higher frequencies. This was true with the exception of oak, which is dense and had high frequency vibrations. As experienced in the case of oak, one factor that could affect the frequency could be the structure or grain of the wood. For example straight grain would bend easier while criss cross grain would be harder to bend which would affect the frequency greatly.

Summary Statement

I tested 6 equal sized pieces of different species of wood, measured their vibrations, and determined that the both the structure and the density of wood effects their vibrations.

Help Received

I took advice from a general contractor, David Chase, who helped me find a variety of woods with different densities. He also helped me safely cut the wood using a table saw. I conducted and measured the experiment with the minor help of a friend, Joey Rook.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Uday Chaudhary; Kinjal Govil

Project Number

J1303

Project Title

What Is the Effect of Using Compound Wood Boards on the Overall Flammability, Durability and Strength of the Wood Board?

Abstract

Objectives

The objective of our project is to create strong wood boards made of entire trees, twigs and sapwood deemed unusable as well as heartwood, the center part of the tree, that, after being glued together with different glues, would be relatively strong and durable compared to commercial boards and will be relative fireproof.

Methods

Redwood heartwood, oak twigs, dumbells, mold, wood glue, epoxy glue, stopwatch. Layered different woods into the mold with different glues and dried at different pressures. Put weight on the boards on until they snapped and measured the board's burn time.

Results

Wood glue tended to bond better with all types of wood while epoxy only bonded with smooth flat pieces of wood. High pressure tended to damage wood and was worse than low pressure even if it did remove gaps. A mix of both kinds of wood had the best results because it maximized the benefits of both types of woods.

Conclusions

This shows that the type of wood, glue and the amount of pressure in making compound wood boards does change their strengths. More studies on different types of woods, glues, and pressures could eventually lead to a compound wood board comparable to commercial wood boards.

Summary Statement

We found that different woods, glues, and pressures change the strength of compound wood boards meaning there could be a combination that comparable to commercial wood boards.

Help Received

Our parents and our science fair counselor reviewed our testing methodology.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Landon Fernald

Project Number

J1304

Project Title

Is It Possible to Build a Fireproof House?

Abstract

Objectives

Is it possible to build a fireproof house? By using various fireproof materials I have chosen to make a fireproof house. My project is about materials used and how to build a fireproof house

Methods

I built two 1:32 scaled houses out of wood. One was left as is (wood) the other was surrounded by non-flammable materials (fireproof rapper sheet shields, fire-resistant fiber cement boards and fireproof shingles) and was able to test them both by lighting them on fire to see which house caught on fire and which house didn't.

My independent variable is changing the structure and the dependent variable was measuring how many inches of flames. Testing controls included are temperature and lighter fuel.

Results

After building both houses to experiment on- The result was a good one as I was able to successfully gather and find materials that were fireproof and that particular house that I surrounded those non-flammable (fireproof) materials with did NOT burn. Yay!

Testing controls included are temperature and lighter fuel.
Wood = 3,6,8,inches
Fireproof Raptor Heat Shields = 0 inches
Fire Resistant Fiber Cement Shields = 0 inches

This costing a homeowner: $64,970 per 2,600 sq. ft. house
$38,970 to cover with Fireproof Raptor Heat Shield Sheets
$20,000 to cover with Fire Resistant Fiber Cement Boards
About $6,000 for the Fireproof Shingles

Conclusions

I was able to successfully build a fireproof house through my experiment and test and just the right materials. I think that this would be a VERY successful idea for contractors and developers for sure houses and communities based on how many houses catch on fire a year (374,000 a year in the U.S.) to be precise and 2,600 lives are lost from house fires a year.

Summary Statement

I was able to build a fireproof house which can possibly save lives

Help Received

I was able to Build a Fireproof House!

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Qianshu Gong

Project Number

J1305

Project Title

Hydroxide-ion Batteries: The Concept and Materials Engineering for High Capacity

Abstract

Objectives

The objective of this project is to describe a proof-of-concept energy-storage device that consists of oxidized carbon and nickel oxide as the electrode materials

Methods

The anode and cathode materials were prepared by a controlled firing and precipitation reaction, respectively. Afterwards, ink coating of as prepared materials was used to prepare membrane electrodes. After charging, the battery was tested by electronics like the multimeter.

Results

The results showed that the battery is able to exert a voltage of up to 0.525 volts. Results showed that performance can be boosted by engineering carbon materials to control the amount of oxygen in carbon black. Results showed that the amount of oxygen in the materials greatly affects the overall performance of the battery.

Conclusions

A proof-of-concept battery is demonstrated that comprises of inexpensive materials, that is oxidized carbon and nickel hydroxide. The performance depends on the surface oxidization state of carbon and the particle size and shape of nickel hydroxide. This battery can be used in portable devices.

Summary Statement

The hydroxide-ion battery provides an alternative solution to harvest energy in inexpensive materials.

Help Received

During my literature survey, I encountered many scientific terms that I did not understand, and so I asked my science teacher to explain them to me. However, I designed and created a prototype of the battery by myself.

Name(s)

Romy Greenwald

Project Number

J1306

Project Title

Testing the Decomposition of Alternatives to Plastic Drinking Straws Under Simulated Environments.

Abstract

Objectives

My objective was to identify eco-friendly straws that decompose efficiently in natural environments. I hypothesized that straws with a lower mass and higher cellulose content would biodegrade most efficiently.

Methods

I tested paper, hay, bamboo, polylactic acid, (PLA) and sugar cane husk straws in water, ocean water, hydrochloric acid, compost and a control in an empty test tube. The straws were immersed for 30 days then removed and set out to dry for 48 hours. Each straw was weighed before and after the experiment to determine how much it had decomposed.

Results

On average, the hay straws decomposed more than any other straw in three out of four of the simulated environments. Their mass decreased by 61% in compost, 25% in tap water, 18% in hydrochloric acid and 14% in ocean water. The majority of the straws decomposed more efficiently in compost. PLA straws decomposed the least in all cases.

Conclusions

The results show that lighter organic materials decompose more efficiently than heavier straws and polymer based straws. This likely because they are fragile and more easily broken down and consumed by decomposers. The data showed that cellulose content affected the rate of decomposition but was not the only factor accounting for rate of decomposition.

Summary Statement

I tested the decomposition of alternatives to plastic drinking straws under simulated natural environments.

Help Received

I consulted with James Radich, a technical director at Respirtek in Arkansas. Respirtek conducts biodegradability testing. I requested and received sample straws from numerous companies that I used in my experiment.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Jared Henderson

Project Number

J1307

Project Title

The Effect of Different Materials on Particle Decay from a Radioactive Source

Abstract

Objectives

My project is about the effect of different materials on particle decay from a radioactive source. My question is How do different materials affect particle decay from a radioactive source? My hypothesis is If aluminum foil is the best shield against radioactivity, and I wrap a radioactive source in a variety of different materials, then the source wrapped in aluminum foil will show the least amount of radioactivity.

Methods

To prepare this experiment I used, disposable gloves, an ionizing smoke detector (which contains my radioactive source, Americium-241), pliers, glass container, hot glue, black pan, black felt, warm bowl of water, heavy block of metal, cardboard box, tape measure, tweezers, dark room, insulating gloves, safety glasses, dry ice, 40 ml Isopropyl alcohol 99%, eye dropper, and a bright flashlight. I will put blocks of dry ice in the cardboard box. I will hot glue black felt to the bottom of the glass container. Using pliers, I will remove the radioactive source from the ionizing smoke detector. Using tweezers, I will set the radioactive source on top of the black pan. I will soak black felt with alcohol using an eye dropper. I will set the glass container on top of the black pan so the radioactive source is in the center. I will put the black pan on top of the dry ice. I will take a cardboard box and black pan with the glass container to a dark room. I will set the sealed bowl of warm water on top of the glass container, then set metal the block on top of that. I will darken the room. I will shine the light at a 45º angle, and look at the container in the same direction. I will observe the container and take notes on the number of radioactive tracks. I will wrap the radioactive source in different materials (aluminum foil, mylar, latex, wax paper) and repeat the above two steps for each material.

Results

My data did not support my hypothesis. I thought that aluminum foil would be the best shield against radioactivity, but my data showed that wax paper was the best shield against my radioactive source. My tests showed aluminum foil with an average of 58 radioactive tracks, while wax paper had an average of 38 radioactive tracks. My results also showed mylar wrapping had an average of 90 tracks.

Conclusions

I can make a variety of conclusions from my results. First, wax paper is a better shield against alpha particle radiation than aluminum foil. Second, mylar can make a great shield if it is sealed. Otherwise, the radiation may reflect, amplify, and escape. Finally, latex is a very weak shield as it had almost no effect because it was only 8.5 tracks below the control test (bare source).

Summary Statement

How different materials affect alpha particle radiation

Help Received

I received help from my parents, my teacher Michael Matthews, along with help from online resources such as IEEE, Educational research, ANS and Wikipedia.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Hannah Hsiao

Project Number

J1308

Project Title

Investigating Different Fabrics on Water Absorption, Drying Time, and Drying Cost

Abstract

Objectives

Sometimes when I pull the clothes out of the dryer, some are dry, while others are still a little wet. I became curious as to why this could be. Moreover, as globing warming is becoming a bigger problem, it has become important to find new ways to slow down the process to help decrease pollution and greenhouse gas emission. In line with these ideas, the goal of this project was to investigate ways to save energy during laundry by exploring how different fabrics affected the water absorption, drying time, and drying cost.

Methods

The materials included washing machine, dryer, infrared gun, big bowl, weighing scale, twelve different fabrics of pants, baskets, timers, pen and paper. The independent variable was the fabrics with different percentages of cotton, polyester, acrylic, rayon, elastane, and spandex. There were three dependent variables: (1) water absorption-measured by water gain (the weight of actual amount of water pick-up compared to the original weight) and water absorption rate (calculated by dividing the water gained by the original weight); (2) drying time-measured by the time spent from wet to the original weight of dry fabric; and (3) drying cost-measured by the dollar amount for the energy used to dry each piece of fabric.

Results

This study supported the hypotheses that (1) hydrophilic fabric would absorb the most water and (2) hydrophobic fabric would dry the fastest and thus save the most money. The more cotton was in the fabric, the greater the water absorption percentage and longer drying time. By comparing to nearly 100% cotton, 49% polyester with 49% acrylic and 2% spandex absorbed the least water, used less than 1/3 of energy and drying time and cut down 70% of the drying cost. This research suggested that the addition of acrylic to polyester resulted in lower water absorption and reduced dry time/energy/cost. It would help reduce the carbon footprint.

Conclusions

This study suggested that fabrics with higher water absorption would take more time to dry and cost more energy and money. Cotton is a hydrophilic fiber. The increase in the amount of fiber content in cotton can lead to higher water uptake and take more time to dry. On the other hand, both acrylic and polyester are hydrophobic and tend to repel water, creating droplets. Both acrylic and polyester do not absorb as much water as hydrophilic fabrics like cotton.

Summary Statement

This study examined that (1) hydrophilic fabric would absorb the most water and (2) hydrophobic fabric would dry the fastest and thus save the most money.

Help Received

I conducted this whole experiment by myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Nuha Iftekhar

Project Number

J1309

Project Title

The Effect of Different Light Sources on the Intensity of Phosphorescence

Abstract

Objectives

The purpose of this project is to observe the effect of different light sources on phosphorescence. The question asked is Do different types of light sources affect the excitation of phosphorescent materials? My hypothesis is that light types with shorter wavelengths will cause a higher state of excitation in phosphorescent materials. The procedure consisted of shining light from three different types of light sources over samples of phosphorescent powder and observing the brightness of the samples after absorbing a specific type of light. The results showed that the sample of phosphorescent powder emitted the brightest light when exposed to an ultraviolet light source. My hypothesis was supported, as the ultraviolet light source emitted light with a shorter wavelength as compared to the other light sources.

Methods

A light isolation chamber was created from cardboard and black paper. A commercially available phosphorescent powder was used to thinly coat one side of a circular adhesive sticker and laminated with tape to create identical samples. Three different light sources comprising UV, LED and Incandescent flashlights, were used to initiate the excitation of phosphorescence in the samples with a controlled duration of exposure. The light intensity from the samples was captured with a photo taken by a smartphone camera held at a fixed distance from the samples and holding camera settings constant for exposure. Readings were taken at equal intervals up to 5 minutes, starting from the same time after light exposure. A scientific image analysis software (ImageJ) was used to calculate average intensity in greyscale values across each sample and at each time point. The decay in light intensity for each light source over the period of observation as charted and compared.

Results

The experiment showed that the sample exposed to the ultraviolet light was the brightest and retained the most intensity by the end of the observed five minutes. After a ten-second period of UV exposure, the sample had a brightness of 195.2 grayscale value (255 is brightest). Using the initial UV brightness level as 100% and normalizing the other readings to this allowed for easier comparison. At the end of the five minutes, the UV sample had a brightness of 21% of the initial level. The LED sample showed an initial brightness of 66% of the initial UV level, decaying to 20% of this level. The incandescent sample had an initial brightness of 33% of the initial UV level, decaying to 11% of the initial UV level. This showed that the LED light produced 2/3rd the intensity of phosphorescence as the UV light, and the incandescent light produced only 1/3rd of this intensity, although all samples decayed to very similar levels at the end of 5

Summary Statement

My project establishes the superior effect of UV light to excite a phosphorescent material compared to LED and Incandescent light, using an inexpensive but reliable method to measure light intensity

Help Received

My science teacher, Mrs. Noor Zaweti, helped with the visual representation of my data. I developed the measurement method for light intensity alongside my father.

Name(s)

Diya Kadadi

Project Number

J1310

Project Title

Bioplastics from Biowaste: Using Plant Cellulose and Starch to Create Affordable and Durable Plastic Solutions

Abstract

Objectives

Petroleum based plastics, the ones most commonly used today, pose a huge threat to the environment, filling up nearly all of the world's landfills. This form of pollution can endanger wild species and cannot be decomposed. The materials that we throw away every day, biowaste, can be used to create plastics. Potato peels, banana peels, and corn husks contain natural polymers including starch and cellulose which can help create affordable and durable solutions to end the plastic crisis. The objective of this experiment was to test the tensile strength, water resistance, and biodegradability of bioplastics using biowaste. It was hypothesized that if the type of biowaste used is potato peels, then the plastic will have the greatest tensility. All plastics will be water resistant and biodegradable.

Methods

To make the bioplastic, the extracted starch and cellulose from each biowaste was combined with glycerin, water, and vinegar over a heat source. The plastic was then baked to stabilize the polymers. The different types of biowaste were the independent variables and the dependent variables were the plastics' effectiveness measured in tensility, water resistance, and biodegradability. A spring scale was used to test the tensile strength, and water was poured in increments on the bioplastic to test for water resistance. The bioplastics were then composted to be broken down by decomposers. Petroleum based plastics were used as the control group.

Results

The results showed that banana peels created the bioplastic with the greatest tensile strength of 3.706 Newtons per cm^2 because of its combined starch, cellulose, and fibers. Corn husks came in second with a tensile strength of 1.806 Newtons per cm^2 and potato peels came in last with an average tensile strength of 1.396 Newtons per cm^2. All bioplastics were water-resistant and biodegradable.

Conclusions

The hypotheses were partially supported, as all the plastics were water resistant and biodegradable but banana peels proved to have the greatest tensile strength. This was most likely because potato skins contain much starch but not as much cellulose as banana, which has about 65% cellulose. The results of this experiment suggest that bioplastics made from banana peels to form brittle plastics can be very effective and can replace petroleum based plastics. The world can be spared from the negative consequences of plastic pollution through the use and production of feasible, environmentally-friendly, and effective bioplastics made from biowaste.

Summary Statement

I created affordable bioplastics using potato peels, banana peels, and corn husks and tested their tensile strength, water resistance, and biodegradability.

Help Received

My science teacher guided me and provided feedback throughout the project.

Name(s)

Keghon Kasparian; Vahan Kordian

Project Number

J1311

Project Title

Eggshells to Save Lives: Lowering Rate of Combustion with Calcium Carbonate

Abstract

Objectives

The objective of this project is to determine the rate of combustion of wood by using various types of paint mixtures that contain different concentrations of egg shell powder. We will measure the time it takes for the wood to ignite. After researching, we hypothesize that the higher the concentration of the egg shell in the mixture of paint, the more time it will take for the wood to ignite.

Methods

Approximately 50 dozen of egg shells were collected from a local restaurant. After washing and drying the eggshells it was turned to powder with a blender. Into 50mL paint samples (Interior Latex Paint, Water based paint, Low Luster Paint, and Oil Based paint) various concentrations (5g, 10g, 15g, 20g, 25g, 30g, 35g, 40g, 45g, 50g) of egg shell powder was added and mixed. 132 pieces of wood (11cm x 7cm x 2cm) was cut and painted. After drying the wood for 2 days, each piece of wood was tested by igniting with a torch. The time it took for the first flame was recorded and analyzed.

Results

Based on our data we can conclude that the water based paint took the longest time to ignite. Our trials ranged from zero concentration (no egg shell) to 50g of egg shell concentration. The interior latex paint ranged from 60.33 sec 132 sec on average. The water base paint ranged from 90 sec to 180 sec. The low luster pain ranged from 62.33 sec to 159 sec. The oil base paint ranged from 44.33 sec to 110.67 sec. The water base paint with the highest concentration of eggshells (50g) took the longest time to ignite, averaging 180 sec, respectively. As we stated in our research, people have approximately 2 minutes to escape a fire. With our findings, we could possibly lengthen this time to 3 minutes, which could help save many lives.

Conclusions

The results observed from our study supports the hypothesis that the higher the concentration of the egg shells in the mixture of paint the more time it took for the wood to ignite.

Summary Statement

We will determine the rate of combustion of wood by using various types of paint mixtures that contain different concentrations of egg shell powder.

Help Received

We researched and planned the experiement ourselves. Consulted with our science teacher for scientific inquires. Recieved support from our parents in purchasing the materials needed.

Name(s)

Jemimah Khan

Project Number

J1312

Project Title

Comparing Bamboo and Plastic in Criss-Cross Patterns to Create Reinforced Concrete

Abstract

Objectives

The objective of this experiment was to find out whether bamboo or plastic would reinforce concrete better for constructing earthquake resistant buildings. The hypothesis was that concrete blocks reinforced with bamboo will have a higher tensile strength compared to those with plastic. The materials used were quick mix concrete mix, water, plastic food containers, weights, bamboo sticks, plastic bottles, and two tables. One half of concrete mix was poured into the plastic containers with either bamboo or plastic placed in the middle in a Criss cross pattern and covered with the other half. Once fully dry, the blocks were tested to compare the tensile strength. The blocks were placed between the 2 tables and weights were hung with a metal hook. That did not break the block, so it was placed under a piston attached to a car jack that produced 4 tons of pressure. It did not crack the blocks therefore, they were made again into longer and thinner blocks (17.78 cm). The tensile strength of the blocks was tested by placing the block in between two tables (15.24 cm) apart. The average amount of weight to break the block with bamboo was 47.05kg, whereas for plastic it was 36.88 kg, and control (no reinforcement) was 1.47kg. The hypothesis was correct. An error could be that the Criss cross pattern was not uniform when the top layer was poured. In the future, this project will be done with more concrete blocks made of different recyclable materials.

Methods

First, take the concrete mix and combine it with the required amount of water. Next, pour the concrete mix into a mold and measure half the stick by 8.89cm. Place the bamboo stick of 7.62cm in a criss-cross pattern. Then, pour the other half of concrete mix to cover the criss-cross pattern completely. Repeat the same procedure with the recycled plastic strips of 3inch by 1inch. Once fully dry, test the tensile strength. Place the block in between 2 tables 15.24cm apart. Place weights onto the brick with a metal hanging rod. Once full tested, document the results. The materials used were concrete mix, containers, tables, weights, and bamboo and plastic.

Results

The results were that concrete reinforced with bamboo gave most tensile strength to the concrete block. The second averaged tensile strength result was concrete reinforced with plastic. The block that withstood the least amount of pressure was the control or concrete not reinforced.

Conclusions

The importance of this project is that it helps in the construction industry. Construction workers or engineers can look to a recyclable and biodegradable way to reinforce structures. Using bamboo and plastic as

Summary Statement

This project is about comparing the tensile strength that concrete reinforced with bamboo and concrete reinforced with plastic will provide.

Help Received

Zeeshan Khan, Kavitha Satya

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Charlotte MacAvoy

Project Number

J1313

Project Title

Exploring New Alloys for Low Cost Thermoelectric Generation

Abstract

Objectives

The purpose of my project was to create sintered alloys and test their efficiency in converting heat into electricity to build a thermoelectric generator that would be cheaper than a commercial Peltier device.

Methods

25 different sintered alloys and pure cakes were synthesized and tested for the electrical output (in mV) in three trials at a known temperature difference of 74K. Sintering was used to combine the materials (Cu,Bi, Fe,Fe(2)O(3),Zn,ZnO,Sn,Al,Ni,Graphite)as an alternative to a high heat oven. The sintered cakes were tested for electrical output (in mV) on a custom testing apparatus built with a 74K temperature difference. In the application module, four cakes of Cu+Bi+ZnO+Fe were used to build a low cost thermoelectric generator (TEG).

Results

Combining materials to create alloys resulted in a higher electrical output compared to pure materials when subjected to a temperature difference. When testing the pure materials, copper had the highest average electrical output of 59 mV. The alloy with the highest electrical output was the 7:3 Cu:Bi alloy averaging 176 mV for 74K delta T. When testing over time, the electrical output of the Peltier module dropped to 58 mV while the electrical output of the Cu+Bi+ZnO+Fe stayed consistent at 438 mV for a 74K delta T.

Conclusions

The sintered alloys performed better than pure substances because of the ability to combine low thermal conductive materials and high electrical conductive materials. Combining materials with different atomic masses--therefore creating an alloy with a disturbed vibrational state--lowered the thermal conductivity of the alloy. Materials with lower melting points and larger particle size sintered more effectively together and contributed to larger electrical output. The Cu+Bi+ZnO+Fe TEG module had a lower thermal conductivity than the Peltier module contributing to its longer lasting electrical output.

Summary Statement

Different sintered alloys were synthesized and tested to transform heat into electricity and then a TEG was built with the best performing alloys that could effectively covert heat energy into electricity.

Help Received

My parents paid for the supplies and made sure I used safety equipment properly. I designed, built, and performed the experiment myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Noah Macknicki

Project Number

J1314

Project Title

Corrosion Rates of Differentiated Metals in Hyper Saline Environments

Abstract

Objectives

This project determined the corrosion rates of iron, steel, stainless steel, tungsten, copper, aluminum, zinc, graphite, and lead in a 5% saline environment.

Methods

Using sterilized jars, I measured out 100 mL of bottled water and added it to 36 jars. I used a triple beam balance to measure 0.5 grams of sea salt and added the salt to a jar of pre-measured water. I repeated this for 27 jars before confirming the salinity concentrations of each jar using a refractometer. I left 9 jars untreated for the controls. I measured and weighed each piece of metal before adding it to the jars to create three test trials and one control for each metal type. I then weighed and observed the metal and tested the salinity of the jars daily for two weeks and recorded observations, weights, and salinity in a journal. During the second week, I also tested the pH daily and recorded the results.

Results

Iron, copper, steel, zinc, aluminum, lead, and stainless steel changed in color as did their environments. Tungsten, steel, copper and lead increased in weight in all trials. Tungsten was the most corrosion resistant of the metals with only a slight weight change and color change. Copper and iron were the least corrosion resistant with significant color changes occurring rapidly, and they expelled the most debris into the water.

Conclusions

Tungsten, which is commonly used in construction of oil rigs and ships, was the least corrosive metal of the nine metals tested. Iron added the most debris to its environment through rust, and aluminum and zinc added a white debris to the environment, while copper turned the environment blue. The changes in the metal and the effects on the environment are important to note when industries create structures that must survive in the ocean from an environmental standpoint and from a fiscal standpoint. Industries should use the most resistant metals in order to create a product that will remain intact for years while also maintaining a sustainably low impact on the environment.

Summary Statement

Nine metals were observed and weighed in 5% salinity for two weeks supporting that the least corrosive, tungsten and lead, may be better for building ships and oil rigs than the most corrosive metals: iron, aluminum, copper and zinc.

Help Received

Greta Turney helped to acquire the materials for this project. Perrin Turney helped me to understand some chemistry behind corrosion and helped me design and modify my graphs. Jill Macknicki helped me create my backboard.

Name(s)

Aziza Mohammed

Project Number

J1315

Project Title

Investigating Kombucha Biofilm as an Alternative for Other Flexible Materials

Abstract

Objectives

The goal of my experiment was to determine if Kombucha Biofilm can replace other commonly used flexible materials.

Materials created by microbes have the potential to be used in manufacturing goods. Such materials require less energy to produce and provide higher biodegradability than traditional plastics. In the future, such materials can be bio-engineered to be stronger than non-renewable materials thereby reducing the carbon-footprint of manufactured materials.

Kombucha Biofilm is a flexible material created by microbes that can be produced from renewable waste sugar sources without requiring additional energy.

Can Kombucha Biofilm replace other flexible materials in common applications?

Methods

Kombucha Biofilm was cultured using sugar water, black tea, and a starter Kombucha culture containing bacteria and yeasts at room temperature. The resulting Kombucha Biofilm sheets were dried. Tests such as tensile strength, iodine permeability and oxygen permeability were performed to compare the usability of Kombucha Biofilm as a potential replacement for other flexible materials.

Results

Kombucha Biofilm had a higher tensile strength and ability to prevent oxidation than commonly used shopping-bag plastic, but not cloth or leather. In addition, it did not let iodine reach the starch in the iodine permeability test, as did the leather and plastic. However, cloth immediately let the iodine reach the starch. Kombucha biofilm absorbed the most water, which could be a disadvantage for use in common applications.

Conclusions

Under dry conditions, Kombucha Biofilm is an effective flexible material that can replace other flexible materials. However, under wet conditions, Kombucha Biofilm absorbs moisture from air and its texture changes. Due to moisture absorption, Kombucha Biofilm cannot be used as replacement for commonly used materials. It has potential for use in specialized applications such as medical bandages.

Summary Statement

Kombucha Biofilm shows partial viability for use in common applications with potential for use in specialized applications.

Help Received

None, I conducted the experiments myself.

Name(s)

Gael Neighbors

Project Number

J1316

Project Title

Which Type of Starch Makes a Stronger Bioplastic?

Abstract

Objectives

Strong bioplastics that are biodegradable might provide a solution to plastic pollution. My project investigated bioplastics made from different types of starch to compare how strong they were. I tested the hypothesis that starches with a finer texture will form stronger bioplastics because their molecules are more tightly packed.

Methods

Six bioplastics were prepared to the same size and shape with an identical method but using different starches: tapioca starch, cornstarch, arrowroot starch, rice flour, potato flour or potato starch. The bioplastics were then extended from the edge of a table and the distance until breaking or reaching a test limit of 5.5cm recorded. The average result from four replicate tests was calculated for each bioplastic as a measure of strength.

Results

The bioplastic made from arrowroot starch could be extended further than the other bioplastics before reaching the test limit. The six bioplastics ranked from strongest to weakest as follows: arrowroot starch, tapioca starch, cornstarch, potato starch, rice flour and potato flour. In addition, arrowroot starch was the only bioplastic which could be bent to the test limit without breaking.

Conclusions

My conclusion is that arrowroot starch made the strongest and most flexible bioplastic. In addition, I noticed the bioplastics that were starch-based, rather than flour-based, were stronger and they were all made from finer grained powder consistent with my hypothesis that finer textured starches can form stronger bioplastics because their molecules are more tightly packed.

I also observed that flexibility was an important component of strength for the arrowroot bioplastic. Further research is suggested to determine if a flexible bioplastic made from arrowroot could replace the plastics currently being used for some clothing, e.g. waterproof ponchos. To address this, it would be important to test how well the arrowroot bioplastic could withstand water. This could have important consequences for our environment because any bioplastic that was able to replace the plastic we use today in making clothing would help solve some of the plastic pollution issues that are harming our world.

Summary Statement

After making bioplastics from six different starches, I found that arrowroot was the strongest with a flexibility that may be suitable to replace some of the plastics currently used in today's clothing to help reduce plastic pollution.

Help Received

I made and tested the bioplastics myself with parental supervision for working on the hot stove and handling the hot bioplastic mixtures.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Elysiah Nguyen

Project Number

J1317

Project Title

How Does Chemical Lightening Affect the Structure of Human Hair?

Abstract

Objectives

This study examines the damages of chemical lightening on the structure of human hair by testing hair's elasticity.

Methods

Human hair, styrofoam boards, pins, chemical lightening solution (3% hydrogen peroxide). Hair was lightened for different periods of time and used the hair to make hygrometers. Measured the length of the hair from the hygrometers after being placed in a humid area.

Results

After placing the hygrometers in a humid area, the length of the chemically lightened hair from the hygrometer increased. The hair that was lightened for the longest period of time increased its length the most.

Conclusions

The longer the time of chemical lightening on hair, the more the growth of the hair. This means that the hydrogen peroxide solution caused more damage on the structure of human hair because there was more growth taking place for the lightened hair.

Summary Statement

I showed the damage of chemical lightening on the structure of human hair through its elasticity.

Help Received

None. I did all the parts of my project/experiment by myself.

Name(s)

Allison Quan

Project Number

J1318

Project Title

Reducing Plastic Pollution Brick by Brick: A Sustainable Brick to Combat Plastic Waste in the Water and Environment

Abstract

Objectives

More than 91% of the world s plastic is not recycled. To solve this, the scientist wanted to test if it was possible to transform plastic waste into functional and sustainable bricks. The scientist hypothesized that the plastic bricks would outperform conventional bricks (burnt clay, concrete, mix of fly ash/clay/sand lime) when testing for strength, insulation, and low-water absorption.

Methods

The scientist constructed plastic bricks (consisting of 70% polyethylene, 25% polypropylene, 5% polystyrene) by shredding plastic, melting it at 201?C, and forming the melted plastic into 20.32 x 10.16 x 6.03cm bricks. The scientist then performed various tests comparing the plastic bricks to commercially available bricks. The scientist constructed an insulation chamber to test insulation. Strength of the bricks was tested through compression and drop tests. A water absorption test was also performed.

Results

The plastic bricks performed most effectively overall, proving the hypothesis correct. After both the compression tests and drop tests, the plastic bricks exhibited no signs of compression, breakage, or changes in weight. The plastic bricks also proved to be the best insulators, having the highest temperatures on the side with the heat source, and lowest temperatures on the side opposing the heat source. In the water absorption tests, the plastic bricks absorbed the second least amount of water, with concrete absorbing the least.

Conclusions

The plastic bricks consistently performed most effectively overall, compared to the other bricks. This research is significant because it proved a way to turn plastic waste into a sustainable building material. This benefits society by reducing plastic pollution that might end up in the water and environment, and transforming it into a cost-effective and versatile building resource.

Summary Statement

I turned plastic waste that would have normally ended up in the landfills, waters, and environment, and re-purposed it into a sustainable and functional brick/building resource.

Help Received

None. I designed, built, and performed the experiments myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Harsha Rohan Rajkumar

Project Number

J1319

Project Title

Naturogenic Cloud

Abstract

Objectives

The objective of this study is to measure the raise in temperature in Sand, Ice & Water under heat by varying the water vapor cloud in the seam.

Methods

Vacuum Chamber, Red Heat Lamp, Measuring tools, Vapor producer, Polyphenol extract etc.
Measured the melting rate of ice, raise in temperature in sand and water under different concentrates of water vapor and poly phenols in a glass vacuum chamber.

Results

The rate of heat absorption of Sand, Ice & Water were directly proportional to the amount of the poly phenol in the water vapor.

Conclusions

The heat absorption and the raise in temperature was dependent only on the amount of polyphenol in the water vapor cloud. For higher concentrates of the polyphenol the heat absorption by the object under study significantly reduced. This clearly states that the effect of poly phenol in the water vapor cloud contributes to reduce the heat absorption and maintain a sustainable temperature.

Summary Statement

I observed that the poly phenolic cloud can help control the temperature raise for objects beneath it

Help Received

I designed and built the cloud system by myself. I got help in understanding the molecular science of the polyphenols from my science teachers Mrs.Kanchan & Mrs.Shama

Name(s)

Julian Schultz

Project Number

J1320

Project Title

Can Your Sweatshirt Save You? Is Clothing an Effective Particulate Filter against Air Pollution?

Abstract

Objectives

During the wildfires Fall 2018, I observed many students at my school attempting to protect their lungs from air pollution by covering their mouths with clothing. The purpose of this experiment was to determine the effectiveness of seven common fabrics and two commercial masks in filtering out fine particulate matter.

Methods

A small room was polluted using a match, and the particulate concentration was measured with a Temtop AQ Monitor. A small, airtight box with an opening covered by the testing material and an attached pump was then inserted into the room. The pump sucked polluted air through the fabric sample. The particulate concentration inside the box was measured and recorded at ten second intervals. Each fabric, as well as one control without any filter, was tested three times. Fabrics were subsequently examined by microscope to measure pore sizes.

Results

The effectiveness of the filters was quantified as the percent reduction of average particulate concentrations before and after the air was filtered. Across three trials, the control with no fabric filter ranged between -16% and 6% reduction. All dry fabrics ranged between -18.3% and 7.7% average reduction. The commercial masks were substantially more effective, with the particulate respirator reducing pollution by 92% to 95% and the surgical mask reducing by 45% to 54%. Microscopic observations showed that the pores of the fabrics were an order of magnitude larger than the size of the fine particulates.

Conclusions

This experiment shows that articles of clothing are not effective as particulate filters. As expected, the particulate mask filters out most particulates. Surprisingly, the surgical mask appeared rather effective; however, it does not create an airtight seal and would undoubtedly be less effective in actual use. Thus, when experiencing air pollution, covering your mouth with clothing will not reduce the quantity of particles inhaled; other measures must be taken to protect your lungs.

Summary Statement

Clothing is not effective at filtering out fine particulate matter and will not protect you from air pollution created by wildfires.

Help Received

I borrowed the air quality sensor from and was instructed in its use by my neighbor Jay Chesavage. I borrowed microscopes from the PA Junior Museum and Zoo for examining the fabrics. My parents assisted with data collection and safety procedures.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Griffin Short

Project Number

J1321

Project Title

Densities of Fluids in Shock Absorbers

Abstract

Objectives

The purpose of the project is to determine if whether or not, a fluid's density will contribute to the amount of force needed to move that fluid.

Methods

Water, Vegetable oil, Fox custom oil, Table salt, 10 mL graduated cylinder, 100 mL graduated cylinder, Dynamometer machine, Shock, nitrogen

Ran the shock on the dynamometer at different velocities and the "dyno" measured the force it took to compress the shock.

Results

Force outputs did not directly vary to the density of each fluid like I thought. At times, fluids with higher densities took less force to move than a fluid with a lower density.

Conclusions

The data did not support my hypothesis. Viscosity is the main factor in this situation and my data does prove that. Water and salt-water produced almost identical results to the Fox oil meaning you could fill a shock with them, but chemical and physical reactions would be detrimental to the shock over time.

Summary Statement

I used different fluids in shock absorbers to see if it took more force to move a denser liquid.

Help Received

I used lab equipment at Fox Racing Shox under the supervision of my brother, Robert Heinevetter.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Peter Sullivan

Project Number

J1322

Project Title

Temperature Effects on the Resistivity of Metals

Abstract

Objectives

My objective is to see which metal type brass, bronze, copper or titanium will have the lowest electrical resistivity independent of temperature.

Methods

I first built a functional test loop to test my metals on. The test loop was made of a 6 volt battery, 16 gage wires and alligator clips to connect my battery to my metal test sample with ease, then it consisted of a bulb from a flash light and a volt meter. I then cut the metal types into 3 sample and I tested them at 20F, 70F, and 300F. This will be repeated 3 times and I will catalog my data.

Results

In was observed copper's resistivity was the lowest and had the lowest variance throughout the temperature ranges at 20F, 70F, and 300F. Brass second lowest resistivity behind copper and it performed well at all the temperature ranges. Bronze had high resistivity and through each temperature range it got worse with dramatic changes in resistivity. Titanium performed worse than bronze, even though it is a pure metal. titanium had high resistivity throughout ever temperature range.

Conclusions

In conclusion my hypothesis was correct. copper had the most electrical conductivity/ lowest resistivity independent of temperature. Copper performed within 1 standard deviation of the mean showing it had low variance. Brass, bronze, and titanium were 3 standard deviations out side of the mean. That means they are untrustworthy conductors and had lot of variance in their performance.

Summary Statement

I tested how temperature affects the resisitivity of brass, bronze, copper, and titanium.

Help Received

My mom and dad helped me.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Lilia Tomoff

Project Number

J1323

Project Title

Squeaky Green: Environmentally Friendly Exfoliating Soap

Abstract

Objectives

This project addresses the need for an exfoliating soap that does not pollute ocean ecosystems with harmful plastic microbeads.

Methods

The designed product was a rectangular bar soap in translucent green which uses locally-sourced sand as an exfoliant, as well as tangerine essential oil. The engineer also considered adding either turbinado sugar or sea salt as additional exfoliant, eventually deciding on turbinado sugar due to its many benefits to skin. The prototype was tested using consumer surveys addressing the scent, abrasiveness, dissolving, cleansing, and overall desirability of the product; as well as simulated testing addressing the abrasiveness, dissolving, and cleansing properties of the soap as compared to a generic bar soap.

Results

The prototype was tested through consumer testing and simulated conditions. The consumer test collected user opinions of the scent, abrasiveness, dissolving, cleansing, and overall desirability of the product. The simulated testing collected data addressing the abrasiveness, dissolving, and cleansing properties of the soap as compared to a generic bar soap.

The simulated testing revealed that the exfoliation provided by the soap was extremely effective, and that its dissolving and cleansing properties were comparable to the generic bar soap. The results of the consumer testing showed that the majority of users found the soap very desirable.

Conclusions

This project demonstrated that it is feasible to create an exfoliating soap using locally sourced sand. Adoption of this product instead of commercially available exfoliating soap using plastic microbeads would have two main benefits. First, ocean ecosystems would benefit when local sand instead of plastic microbeads is deposited into the ocean. Second, consumers would benefit from the use of tangerine essential oil instead of potentially harmful acids as the secondary exfoliant in the soap.

Summary Statement

I created an appealing and ecologically responsible exfoliating soap using locally sourced sand and tangerine essential oil.

Help Received

My science teacher provided guidelines and a production timeline for creating a successful engineering project. My mother supervised the soap-making process for safety purposes.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Jasmine VanRenselaar

Project Number

J1324

Project Title

A Heating Pad that Stays Warm

Abstract

Objectives

My objective is to determine which combination of materials creates a heating pad that stays warm for a long time.

Methods

4 types of fabrics for outside, 3 types of grains for inside, infrared thermometer. Made 12 heating pads of identical size and volume of fillings, each of a different fabric and filling, heated up the bags for 2 min, and then took the temperature of the bags every 10 minutes until under 28 degrees Celsius.

Results

All of the bags made of flannel cooled off quite fast while the fleece bags stayed the warmest. Overall jasmine rice stayed warm for the longest amount of time while the rolled oats were often the fastest to cool down.

Conclusions

The rolled oats got hot very fast then dropped rapidly and finished decreasing slowly in all the fabrics, the jasmine rice and fleece stayed warm the longest by about 3.4 minutes.

Summary Statement

By making heating pads of various materials I found that a heating pad made of fleece and filled with jasmine rice stays warm the longest.

Help Received

I designed and conducted this experiment on my own.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Annli Zhu; Sabrina Zhu

Project Number

J1325

Project Title

The Effect of Water on the Strength of Retted Fiber

Abstract

Objectives

Our goal was to find the optimal retting conditions for the outer layer of flax to break with the least force in order to accelerate production. We hypothesized that if increased moisture has an effect on retting speed, then the outer shell soaked in the highest amount of water should be weakest.

Methods

Equal amounts of flax were cut and distributed among bins with different volumes of water: 150mL, 400mL, and 650mL, and a control without water. A mixture of distilled water, kelp fertilizer, and Bacillus subtilis was used to simulate retting in lake waters. Fibers retted for one week and then were bleached to remove excess bacteria before drying. The strength of each fiber sample was tested by hooking it onto a Vernier force sensor and pulling until it broke while recording the force exerted.

Results

Samples that received no moisture were significantly harder to break than those placed in shallow water, and fibers that were completely soaked also required less force than those in little water. The control required an average force of 64.14 N to break, the 150mL needed 48.99 N, 400mL required 34.59 N; and the 600mL fibers needed 32.23 N. The contrast between samples at 400 mL and 650 mL was an insubstantial 6.8%. These conditions allowed for submersion of the samples and the data suggests that as long as fibers are totally wet, adding additional water is not necessary.

Conclusions

Our hypothesis was correct. Water retting, where fibers are completely soaked, is more efficient than dew retting, when only limited moisture is present, with a 29.4% decrease in force needed. Therefore, the benefits of water retting outweigh its potentially higher costs. Additionally, water retting does not have to be done in excess: as long as fibers are completely submerged, using higher quantities of water is unnecessary. Hence, flax farmers should switch to water retting, even if large bodies of water are not available.

Summary Statement

We found the optimal amount of retting water for flax fibers in an effort to lower the cost and time of producing linen; our results showed that water retting is most efficient, but excess water after the submersion of fibers is unecessary.

Help Received

Our project advisor prepared our bacteria culture and purchased all of our required materials. My partner and I came up with and performed the experiment ourselves.