CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Charles Bamford; Michael Fraser

Project Number
J1501

Project Title
Vibration Sensation

Abstract

Objectives/Goals
The purpose of this project is to explore what happens to air molecules when a trumpet is played. The researchers wanted to see if the effects of invisible air molecule movement could be made visible. The researchers also desired to find out why different notes or pitches sound differently. They predicted that higher sounding notes vibrate air molecules more quickly than lower sounding notes.

Methods/Materials
Evidence of the movement of air molecules was explored by observing and measuring the effect of different trumpet notes on a laser beam reflected off a mirror that was glued to the center of a plastic membrane placed tightly over a large mixing bowl. Lower trumpet notes expanded the plastic membrane more and could be "seen" as longer marks of laser light. The lengths of light that resulted from the different notes were recorded, averaged, and compared.

Conclusions/Discussion
At first the student researchers concluded that the length of the laser light on the wall probably equaled the measurement or actual length of the sound waves that are created when a trumpet note is played. This seemed to make sense because in trials the lower notes caused a longer laser light reflection. However, retesting by moving the laser further from the wall, and thereby changing the angle of reflection, resulted in the notes having different measurements for the lengths of the reflected laser beam than had been recorded previously. It was observed that if the same note was played, and if the angle of the reflected laser beam changed, then the measurement of the laser light on the poster board changed as well. (However, higher notes continued to consistently produce lengths much shorter than lower notes.) Thus, it was concluded that the measurement and length of the laser light on the poster board is a visible indication of the relative lengths of sounds waves produced by different notes (not the actual lengths of the sound waves). Higher notes really do vibrate air molecules more quickly than lower notes. The differences of the invisible waves of vibrating air molecules were made visible!

Summary Statement
The researchers wanted to see (1) if the effects of invisible air molecule movement caused by the playing of notes on a trumpet could be made visible, and (2) how different movements of air molecules can cause notes to have different pitche

Help Received

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Kaitlyn K. Carter

Project Number
J1502

Project Title
Crazy Calorimetry, Calories Consumed by You

Abstract

Objectives/Goals
Through this project I can demonstrate how food is being burned and stored in my body. I used a calorimeter in this demonstration to calculate the food I burned and the heat it gave off. I constructed this calorimeter by using a simple aluminum can, an insulator/holder, water, a thermometer, and basic chopped foods. I placed a fixed amount of water in the can, placed the insulator over it and stuck the thermometer through, and read the temperature. I burned an exact amount of chopped food, with the calorimeter over it, and read the temperature. Then by knowing the two temperatures, subtract them to find the difference in temp. I calculated the amount of Calories per gram I burned and then compared my results to the labeled calories in the product.

Conclusions/Discussion
In this project I realized that there were some sources of error. For example, while burning the food, some of the food remained unburned. This could have been the reason of the difference between the two data. Another example of why the results differed may have been due to the loss of heat when the sample was removed to be relit. The construction of the calorimeter was made with inexpensive items so that this project could be easily reproduced. This made the results some what inaccurate but to try and solve this problem of inaccuracy a thick insulation was put on the calorimeter. Foods that were high carbohydrates such as the cereal, were demonstrated in this experiment, to have less calories per gram than foods with more fats and oils such as peanuts and sunflower seeds.

Summary Statement
Through burnig the chosen foods, I made a calorimeter to measure the calories in those foods and compared them to their labels.

Help Received
used lab equipment at Genetic Identification Services

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Aaron G. Chen

Project Number
J1503

Project Title
How Does Temperature Affect the Pitch of a Violin's Strings?

Abstract

Objectives/Goals
This experiment specifically tested how temperature affects a violin's pitch.

Methods/Materials
In the experiment, a perfectly tuned violin was put into a 30 cubic meter room which was heated to the temperatures of 20, 22.5, 25, and 30 degrees Celsius. For each trial, the violin's pitch was measured in cents using a Seiko tuner after an hour.

Results
In this experiment, as temperature increased, the pitch increased.

Conclusions/Discussion
From the experiment, temperature is directly related to a violin's pitch.

Summary Statement
My project is about how temperature can affect a violin's pitch.

Help Received
My teacher reviewed and graded all of my written work.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Samuel A. De La O

Project Number
J1504

Project Title
What Materials Will Best Shield Radiation?

Abstract

Objectives/Goals
The objective of this investigation was to determine what materials best shield gamma radiation. I hypothesized that if I placed different materials between the radiation source and the radiation detector, the radiation would be blocked at different levels.

Methods/Materials
This experiment was conducted by placing different shielding materials between an ion chamber that I built (I will call it a radiation detector) and a low level gamma radiation source (uranium ore). The materials used for shielding were plastic, cardboard, and a super dense sheet of lead. I recorded the amount of radiation detected after 30 seconds of exposure. This process was repeated three times, and then the average results of each material were calculated and graphed. During the experiment, the uranium ore was safely handled as per instructions from the supplier, and it is currently being stored in a safe place.

Results
The plastic blocked an average of 3% of the radiation. The cardboard blocked an average of 87% of the radiation. The lead sheet blocked 100% of the radiation.

Conclusions/Discussion
The data shows that the radiation detected decreased as denser objects were used for shielding. There were only two problems I encountered while testing my experiment. During the first trial, I forgot to place the radiation source an inch away from the radiation detector, so when I altered it during trials 2 and 3, the readings were different. I also messed up while building the radiation detector#s amplifier circuit, so I had to rebuild it several times. For my next experiment, I would try to determine if lead would be a good shield if the radiation level were higher. I hypothesize that the thickness of the lead shield would have to increase to block 100% of the radiation if the radiation level were higher.

In conclusion, I discovered that lead is good for shielding radiation and plastic is not. That is why lead is used as a protective blanket when X-Rays are taken.

Summary Statement
My project tests which materials (plastic, cardboard or lead) will best shield radiation.

Help Received
Dad helped purchase materials and solder and wire circuit board. Mom bought uranium ore on-line. Charles Wenzel gave advice through email on fixing problems I encountered while building the radiation detector.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Thomas P. de Lyon

Project Number
J1505

Project Title
Polarimetry: Measuring the Optical Activity of Sugars

Abstract

Objectives/Goals
I wish to measure the optical activity of various sugars and artificial sweeteners, both in their pure form and in food products. I would like to find out the similarities and differences between the optical activity of these sugars and artificial sweeteners.

Methods/Materials
I built a simple polarimeter using a light bulb, color filters, polarizing filters, and a sample cell. I prepared 100 - 200mm long columns of water solutions of sugars (sucrose, fructose, dextrose, and lactose), artificial sweeteners (aspartame, sucralose, and saccharin), or food products (sodas, syrup, wines, and jello). I measured the optical rotation of the sugars in solution by rotating the analyzer in the polarimeter until no light was transmitted.

Results
I found that the optical activity of sugars and artificial sweeteners can be measured and that the wavelength of the light, the solution concentration, and the liquid column height all change the amount of optical rotation. I also found that artificial sweeteners had much stronger optical activity than sugars. Finally, I discovered that sugars in gelatins behave like sugars in water and that the optical activity of dextrose can change with time.

Conclusions/Discussion
All the common sugars and artificial sweeteners are optically active, while the artificial sweeteners had much stronger optical activity than sugars. These results mean that polarimetry is a useful way of measuring the content of sugars or artificial sweeteners in beverages and food products.

Summary Statement
My project is about using polarimetry to measure the optical activity of sugars and artificial sweeteners.

Help Received
My father helped me with getting the supplies, constructing the polarimeter and mixing some of the solutions.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Salvador Eligio; Elio Gonzalez; Lily Leighton

Project Number
J1506

Project Title
Let It Roll

Abstract

Objectives/Goals
Our objective was to find out if the diameter of a PVC pipe would effect the speed of a small metal ball travelling a pre-set length of 6'. We were exploring the relationship of friction and gravity inside the pipe.

Methods/Materials
We constructed a testing board made of plywood and three 6' lengths of PVC pipe of the following diameters: 1/2", 1", and 2". We attached the pipes to the board with metal straps making sure they were parallel. We propped up one end of the board to create a slope. We ran a series of tests simultaneously releasing one ball into each pipe and recording the time it took the ball to come out at the other end. We did this ten times and then averaged the times for each diameter pipe.

Results
We found out that the ball rolled fastest in the 2" pipe, second fastest in the 1" pipe and slowest in the 1/2" pipe.

Conclusions/Discussion
We concluded that this happened because in the 2" pipe the ball had less contact with the pipe wall which caused less friction than in the other smaller diameter pipes. In the smaller diameter pipes there was more contact between the ball and the pipe causing more friction which slowed the ball.

Summary Statement
Our project is about gravity and friction working against each other.

Help Received
Salvador Garcia was part of our original team. Our teacher helped us with editing the conclusion and our classmate, Lucero Jimenez, help us decorate the board.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Tyler D. Fair

Project Number
J1507

Project Title
How Lenses Work: Testing the Lensmaker's Formula

Abstract

Objectives/Goals

Problem: When does a lens bring an image into focus; that is, what is the relationship between lens-to-object distance (o) and the lens-to-image distance (i)? Hypothesis: Every lens has a characteristic focal length (f). The relationship between o, i, and f is

1/o + 1/i = 1/f

This formula is known as #The Lensmakers Formula# or #The Thin Lens Formula.# The formula is used in making eyeglasses, microscopes and telescopes.

Methods/Materials

Setup: Actual focal lengths for five lenses of different nominal focal lengths and diameters were measured using the sun an "infinitely far away" light source. The sunlight was focused to as small a dot as possible on cardboard, and the distance from lens to cardboard measured with a tape measure. It was hard to get an accurate measure, and the measured focal lengths could be as much a 25% off from what was nominally claimed.

Procedure: Initially an attempt was made to test the Lensmakers Formula by trying to find the position where the lens best focused an "X" written on cardboard. However, data was not repeatable. Different observers got substantially different results! The second approach was to simply replicate the setup as shown in the picture above with a candle. Results were much easier to replicate. See photo for illustration of measurement setup.

The distance from candle to lens was varied. Then, a cardboard screen was moved until the inverted image of a candle was sharply in focus. The lens-to-object distance (o) and the lens-to-image distance (i) were measured to collect about half a dozen data points for each of the five lenses.

Results

Results: Results from the measurements are shown in the tables below. All data is captured in inches. The values for (1/o + 1/i) are generally consistent with each other within a few percent. The measurements that differed the most from the average values tended to be the ones when it was most difficult to tell if the object was in the best focus. The calculated values can differ significantly from both nominal and measured inverse focal lengths.

Conclusions/Discussion

Within the bounds of the precision of the experiment setup, the Lensmaker Formula was confirmed.

Summary Statement

Showing that experiment confirms the Lensmakers Formula, 1/o + 1/i = 1/f

Help Received

Dad helped with the setup and data analysis. Mom helped with the report and display board.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Ellen R. Feldman

Project Number
J1508

Project Title
The Science of Music

Abstract

Objectives/Goals
The goal of my project was to determine why the same notes sound different when played on different instruments, and how these differences can be mathematically characterized.

Methods/Materials
The same notes were played on a piano, violin, viola, cello, flute, and voice, recorded, and then analyzed using Matlab and Goldwave software. For each of these six instruments, the envelope and the harmonic characteristics were examined from qualitative and quantitative points of view. This project involved learning methods of harmonic analysis (mathematics, signal processing, and Matlab Software).

Results
The envelope characteristics allow one to distinguish between (a) piano (percussion), (b) voice and string instruments, and (c) flute (woodwind).The harmonic analysis allows one to differentiate between all of the instruments except for the flute and piano.
Specifically, in the experiments, the attack time on the piano was consistently shorter than that of the voice and strings, while the attack time on the flute was consistently the longest. The flute was the only instrument whose envelope showed a periodic structure (vibrato). The harmonic characteristics of a piano and a flute were indistinguishable, and were the closest to a pure synthesized tone. All string instruments had many spectral frequencies present, because of the sympathetic vibration of the strings. In all tests, the cello was the only one with significant subharmonics, and, among these instruments, the viola was unique in having more power in its second harmonic than in the fundamental (first harmonic). The voice had the least power in its fundamental.

Conclusions/Discussion
The envelope and harmonic characteristics of the sound waves enable us to differentiate between the sounds produced by different instruments. This research suggests that an electronic device can be built that would train a beginning string instrument player to position his or her bow and fingers correctly on the instrument to produce notes correctly. Although this is not necessarily a great contribution to humanity, it could help to save young musicians and their parents from much frustration.

Summary Statement
I recorded the same pitches played on six different instruments, and analyzed them using a computer to discover why different instruments sound different.

Help Received
Dad acted as a mentor--wrote computer programs and showed me how to use Matlab and Goldwave software; musicians from the Music and Arts Conservatory of Santa Barbara played notes for me to record; parents edited report; Dr. Kuchera-Morin of UCSB gave an interview about computer music and

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Kiera L. Fuller

Project Number
J1509

Project Title
Double-Slit Interference Patterns

Abstract

Objectives/Goals
This project was conducted to find out whether the distance between double-slits in a slide would affect the resulting interference fringes the same way with a piece of glass placed in front of one slit. The hypothesis was that, with the glass and without, the smaller the distance between the slits, the more spread out the fringes would be.

Methods/Materials
The setup of the experiment was a version of Young#s double-slit experiment in which a laser was shined through ten different slit spacings ranging up to 1 mm in width. The slits were made in a glass slide that was sprayed with black spray paint. This arrangement was then directed at a wall where the distance between the resulting interference fringes could be easily recorded. The ten slits were each tested once with glass in front of one slit and once without for a total of twenty trials.

Results
The results gathered from the experiment showed that, for each slit spacing, with and without glass, the fringes became more spread out as the spacings were decreased.

Conclusions/Discussion
The results strongly supported the hypothesis. The only significant change the glass caused was that the laser light refracted and the entire pattern shifted over, but the correlation remained the same as did the interference pattern. This was because the actual interference that caused the resulting patterns was not changed, it was only directed differently. This data also shows that light is not only a particle, but also has wave properties causing it to diffract, refract, and interfere.

Summary Statement
This project was conducted to observe the effects different levels of diffraction and refraction would have on the interference patterns in a double-slit interference experiment.

Help Received
Mother bought supplies; Brother took pictures; Dad held setup in place; Sister recommended paint type

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Leah C. Grams-Johnson

Project Number
J1510

Project Title
Looking at Sound

Abstract

Objectives/Goals
The objective is to determine which musical instrument has the purest tone through visual image analysis of the digitized sound waves.

Methods/Materials
I recorded ten different instrument's singular "A" note in an isolated environment using a Sony mini-disc sound recorder and dynamic microphone. Each instrument that I was able to tune was precisely tuned using a Korg Chromatic Tuner. To ensure the tonal value of each instrument's note, I played and recorded the "A" note at least three times. After this step I connected the recorder and computer through a stereo mini plug cable, and used the software Sound Forge to capture and digitize each instrument's sound wave. Selecting a waveform for each instrument based on quality, accuracy, and consistency, I was able to determine and classify the purity of each instruments tone through my extensive research on sound.

Results
Through visual representations of digital sound waves, I discovered variation in tonal purity and harmonics. Of the musical instruments I tested, only the piano and song flute/recorder had periodic (pure) wave forms. The other eight remaining instruments, including a violin, mandolin, saxophone, banjo, guitar, harmonica, organ, and human voice, all had complex periodic tones. Due to a slight variation in the visual wave train of the song flute/recorder, the piano proved to have the most consistent, simple, and continuous waveform. Thus, the purest tone was from a piano.

Conclusions/Discussion
In conclusion, my hypothesis that the piano has the purest tone, was correct. I initially thought the piano would have the purest tone because a piano doesn't have variations in playing a simple note. Other instruments have bow contact, mouth shape, and finger control which can all affect the note being played.

Summary Statement
My project is an intricate comparison of digitized soundwaves to determine the purity of tones from different musical instruments.

Help Received
My Dad helped set up the recorder and capture the sounds into the computer as well as teaching me about the Sound Forge software.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Samantha M. Guhan

Project Number
J1511

Project Title
Float Me If You Can

Abstract

Objectives/Goals
A picture of a woman floating in the Dead Sea and reading a newspaper, inspired me to investigate whether salt water allows heavier objects to float than tap water and whether liquid density plays any role. My hypothesis was that salt water can float heavier objects than tap water because of its higher density. In order to prove my hypothesis, I performed several sets of experiments.

Methods/Materials
In the first experiment, a piece of carrot was dropped in a bowl filled with tap water. After the carrot sank, salt was dissolved in measured amounts to see if the increased salt content helped the carrot float.
The next experiment called the flotation experiment, addressed the role of liquid density in floating objects. Liquids with a wide range of densities (0.86g/l-1.28g/l) were chosen (with tap water as control) and tested repeatedly for the maximum mass they could float. The object, a plastic container into which glass pebbles and chickpeas were added until it sank, was chosen to ensure that the observed differences in the maximum mass floated could be attributed solely to the effect of liquid density. The averaged value of the maximum mass floated by each liquid was then compared to the value predicted by the Archimedes Principle.

Results
In the carrot experiment, it was observed that the carrot floated at a salt concentration greater than 30g/l. The data from the flotation experiment clearly demonstrated that the higher the density of the liquid, the greater the mass of the object it could float. The observed maximum masses floated were in very good agreement with their corresponding values predicted by the Archimedes Principle.

Conclusions/Discussion
The results from my experiments prove that my hypothesis that salt water floats objects better than tap water due to its higher density is true, and that Archimedes Principle clearly applies to my experiment.
It turns out that the Dead Sea has a salt concentration that is ten times more than that found in other oceans (330 g/l); the resulting higher liquid density makes it easy for objects to float in it.
In future, it would be interesting to study the properties of the object which affect its ability to float.

Summary Statement
This project highlights the role of liquid density in floating objects through suitably designed experiments whose data agree with theoretical predictions obtained using the Archimedes Principle.

Help Received
Mother served as general advisor for project and helped me understand the Archimedes Principle.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

A. Si-Si Hensley

Project Number

J1512

Project Title

Marco Polo Dolphin Style: How Accurately Can Direction Be Determined by Animals using Echo Location?

Abstract

Objectives/Goals

The objective of my project is to determine how accurately can animals that use echolocation determine the direction to an object and how is the accuracy affected by frequency, separation of the ears and background noise?

I hypothesized that angle estimates using sound waves with a lower frequency will not be as accurate as waves with a higher frequency, that the closer the ears of the animal are together, the less accurate their ability to determine direction and that the more noise the less accurate the direction estimate.

Methods/Materials

Materials used in my project included: Meter stick, protractor, T-square, 2 microphones, 1 Apple I-Pod earphones (used as a speaker), PC and sound card in PC, digital thermometer, Goldwave Software, homemade anechoic chamber made from foam board, thick packaging foam, glue and duct tape.

I conducted my experiment using two different frequencies (7500 Hz and 11000 Hz), two separations of the ears (6 and 10 cm), a number of different angles from -15° to 15° , and three different noise levels (no noise, 1/3 noise amplitude compared to the signal, and equal amplitude of noise and signal). A sound card emitted a sound signal with a wave of a specified frequency plus noise at a specified level. Two microphones were placed the opposite ened of the anechoic chamber (built at home) separated 6 or 10 cm. Using a computer and the sound card I recorded the received signal at the two microphones.

Results

Using the recorded sound signals, I observed the time shift in the received signals that varied with angle. I calculated the estimated angle based on the ratio of the amplitudes of the sum signal (addition of the two signals) and difference signal (subtraction of the signals), the separation distance of the microphones and the wavelength. Six estimates were made for each angle and the mean was my estimated angle and the standard deviation the error estimate.

Conclusions/Discussion

The conclusions of my experiment were: There is maximal angle for making good angle estimates that depends on the wavelength, w, and separation distance between the ears, L, given by (w/2L). The greater the frequency or separation between the ears the more accurate the angle estimate. As the noise increases the angle estimate is under estimated. Dolphins and bats may be able to estimate direction to better than 0.2° for an angle range of about ±4° and ±6° for dolphins and bats respectively.

Summary Statement

This project determined the accuracy for which animals using echolocation can determine direction as a function of separation distance between the ears, sound frequency and noise level using a PC sound card and a homemade anechoic chamber.

Help Received

My dad helped me learn the math needed (basic trigonometry) and the mathematical description of waves. My mother helped me to learn how to use the Goldwave software (for the sound card). My dad helped get the sound card data into Excel. My parents also helped me build the anechoic chamber.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Sara N. Hubl

Project Number
J1513

Project Title
Are the Many Losses of Vessels in the Bermuda Triangle Caused by Extraterrestrial Sources or a Simpler Scientific Answer

Abstract

Objectives/Goals
The objective of my project was to determine if the injection of a large amount of tiny gas bubbles in to a tank of water would cause a weighted cylinder to sink. I believe that in the Bermuda Triangle, massive amounts of tiny gas bubbles are emitted from the ocean floor. As a result of this emission, the water becomes less dense therefore resulting in the vessel having a greater density than the water and potentially losing its buoyancy.

Methods/Materials
In my study, a weighted cylinder with a controllable floatation point was placed into a tank of water. Varying amounts of tiny gas bubbles were then introduced into the observation tank via the diffuser plate (a small rectangular chamber containing approximately eight-hundred eighty-eight small holes). Although this injection of gas caused some turbulence in the water there was also an undeniable change in the flotation level of the cylinder. This process was repeated several times each time with a specific volume of compressed air.

Results
Four out of five times with varying specific volumes of compressed air released into the observation tank resulted in the full submersion of the cylinder.

Conclusions/Discussion
After reviewing my study, I can conclude that the experimental results did support my hypothesis. The higher volumes of air did result in a more accurate and visible submersion. If there were further investigation into this project in the future, a cylinder with slits cut into the sides might pose for a more realistic vessel design. With the slits, if the cylinder was fully submersed it may continue to fully submerse until it reached the floor of the observation tank.

Summary Statement
This project was performed to determine if tiny gas bubbles being released through the ocean floor, beneath the Bermuda Triangle, are the cause of many sunken vessels.

Help Received
Father supervised project and assembling equipment; Grandfather assisted in diffuser plate assembly

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Hanna E. Hurr

Project Number
J1514

Project Title
Cost Efficiency: Alternative Fuels and Their Financial Counterparts

Abstract

Objectives/Goals
The question to be answered is which common gasoline alternative fuel is the most efficient in cost and caloric content including wood, vegetable oil, animal fats, and natural gas.

Methods/Materials
Calorimeter-homemade apparatus
20 cm cubed balsa wood, 20 cm cubed redwood chips, 20 ml cane sugar, 20 ml lard oil, 20 ml soybean oil, 20 ml canola oil, 20 ml paraffin, thermometer, 9-volt, batteries, snap connectors, rubber insulated wire
Procedure:
Place fuel in central chamber of calorimeter
Place water in external chamber of calorimeter
Be sure that the central chamber is selaed off
Make sure that the battery coil is hot
Wait ten minutes for each fuel to burn
Record change in temperature
Repeat twice with each fuel

Results
Fuels Starting Temperature(Celsius) Caloric Content 1 degree/ml water Cost Amount
Canola Oil 20 degrees 88 degrees .68 $0.11 20 ml Soybean Oil 20 degrees 75 degrees .55 $0.12 20 ml Lard Oil 20 degrees 68 degrees .48 $0.06 20 ml Sugar 20 degrees 48 degrees .28 $0.16 20 grams Paraffin 20 degrees 84 degrees .64 $0.18 20 ml Balsa wood 20 degrees 31 degrees .11 $0.08 20 cm cubed Redwood Chips 20 degrees 42 degrees .22 $0.13 20 cm cubed

Conclusions/Discussion
This experiment proved that animal fats and plant oils could very potentially replace gasolin and other fossil fuels as the powerhouse energy sources of the centruy. The most efficient oils were canola oil and sorbean oil being the most efficient. This experiment showed that there are many alternative fuels that can be more enviromentally friendly, safe, and much more cost efficient, while being renewable as well as plentiful. This experiment also showed that these new and used oils can be used to blend biodiesels, various mixtures of small amounts of petroleum and the plant oils to create a new fuel, burnable in car and truck engines.

Summary Statement
Testing fuels as alternatives for gas and biodiesel development

Help Received
Mother drove me to store to buy materials

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Victoria N. Hutchins

Project Number
J1515

Project Title
Navigating the Sky with My Telescope: Do the Planets Revolve Around the Earth or the Sun?

Abstract

Objectives/Goals
The object of this experiment was to observe the phases of the Moon and Venus and to determine if the planets revolve around the Earth or the Sun.

Methods/Materials
I observed Venus for three months every other week and the Moon twice a week for one month.
I sketched my observations of the Moon and Venus to scale.
I also modeled the geocentric and heliocentric system with a Styrofoam ball and light bulb to compare with my observation of the Moon and Venus.
I built a telescope to use as a tool for my experiments. For the telescope I used a cardboard mailing tube, a coffee can, a plastic vacuum tube, a cardboard spool, objective and eyepiece lenses, duct tape, black spray paint and a camera tripod.

Results
The apparent diameter of Venus increased approximately three times in three months with decreasing percentage illumination.
The apparent diameter of the Moon was almost constant over one cycle.
Both the Moon and Venus go through a complete cycle of phases.
The Magnification of my telescope is 38.5x.

Conclusions/Discussion
I determined that the full cycle of phases of Venus doesn't exist in Ptolemy's geocentric system and has only new and crescent phases. My observations didn't support Ptolemy system.
I determined that in Aristotle's geocentric system, Venus would have complete phases, but the apparent size would not change much.
My observations of Venus matched Copernicus' heliocentric system because the apparent diameter increases as the percentage illumination decreases.
My observations of the Moon matched the geocentric system because the apparent diameter remains the same over one cycle.
I determine that the planets revolve around the Sun not Earth because my observations of Venus matched better with the heliocentric model than the geocentric model.

Summary Statement
Through my experiments and observations, I proved that the planets revolve around the Sun.

Help Received
Dr. Pimol Moth provided support with my research and experiments. Hartnell College provided reflecting telescope for my observations of the Moon and Venus. Mr. Ed Allen donated objective and eyepiece lenses for my telescope. My parents provided transportation.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Amanda C. Imfeld

Project Number
J1516

Project Title
The Effects of Different Glazing Types on Energy Consumption

Abstract

Objectives/Goals
My project was to determine what type of glass would hold out radiant heat and cold air. The Types of glass I used were single pane, double pane , and Low E. I believed the Low E would hold out the most radiant heat and cold air

Methods/Materials
A box made of insulated wood, would hold each type of glass. For example.. I would place the Low E glass in the slot, then place six inches away from a heat lamp. For 5 minutes, checking the temperature every minute. I would do this for each glazing type. For the cold conditions I would put the galss in the slot and then put it in a large walk in freezer for five minutes checking the temperature every minute. Each glazing type will be tested 10 times in each condition.

Results
Of the three different type of galzing the Low E did the best at holding out radiant heat and cold air. The Double Pane did the second best and the Single Pane the worst of the three.

Conclusions/Discussion
People who would like to buy new windows for their home should pay more attention to the type coating on the glass and not number of panes. I would suggest buying Low E because it would insulate your home the best.

Summary Statement
My project was about trying to figure out what type of glass would hold out radiant heat and cold air the best.

Help Received
My mom helped me type report. Dad aquired materials. Also helped make the insulated wood box

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Michael A. Iorga

Project Number
J1517

Project Title
Diffractive Bending of Laser Beams Around Objects

Abstract

Objectives/Goals
My science project studies the phenomenon of light bending around objects. When traveling close to an object, the direction of a light beam slightly bends towards that object. Light bending was first predicted by Einstein, and later proved by astronomical observations. Previous research resulted in three independent theories: one based on Einstein relativity, one on classical Newtonian particle interaction, and one based on electromagnetic wave diffraction. My objective is to expand the existing theories coverage by developing a new theory that describes the light bending dependence on the geometrical shape of the object.

Methods/Materials
The method consists in measuring the deviation of a laser beam spot on a screen when a test object is brought very close to the beam. I have built an experimental fixture consisting of a laser pointer mounted on a solid stand and having an adjustable sliding table for the test objects. Since the deviation is very small and hard to be seen with the eye, I used a microscope to amplify this deviation.

Materials: Laser pointer; Sliding mechanism from a telescope; Intel #Play# Microscope; Mechanical clamps; Screws, Nuts and Nails; Light sensor and Voltage Meter; Pieces of wood; Cylindrical rubber objects; Laptop computer; Software: Microsoft Excel, Microsoft Word, and Intel-Play image capture program.

Results
The results showed that the light bending angle depends on the test object radius, in the way that it increases as the radius decreases. Based on the measurement results, I have created a mathematical model that can be used to calculate the bending angle for a given radius. This model consists of three equations, first a second order polynomial type, second a power function type, and third a linear type.

Conclusions/Discussion
My study has proved that the diffractive bending of light beams around objects depends on the partial curvature radius of the object#s surface closest to the beam. The experimental fixture I have built was able to be used to measure the bending angle of a light beam generated by a laser pointer, and using this fixture I have measured the bending angles for different radius test objects. The results showed that the bending angle increases with the decreasing of the test object radius. From the measured data I have built a mathematical model that describe the variation of the bending angle function of the object#s radius.

Summary Statement
My project studies how laser beams bend when traveling near an object and how the bending angle depends on the object#s geometry.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Abhishek Jairam

Project Number
J1518

Project Title
Detecting a Red Light Runner the Easy Way

Abstract

Objectives/Goals
My objective was to see if I could use the simple principle of sound as a function of car speed to detect red-light-runners and prevent potential collisions. I believe that if there is a green light, and the car is moving at a constant speed then the noise level will be high. I believe that if there is a red light, and a vehicle is decelerating then the sound level will be low.

Methods/Materials
The materials that I used to complete my experiment were a clipboard, two pencils, my sound meter (with a maximum DB hold function), and my data sheets. First, I did my control experiment by measuring a single vehicle moving at a constant speed through four points (simulating a green light). In addition, I conducted a real time traffic experiment. I went to different intersections and measured the overall noise level from vehicles that reacted to either red or green lights. I recorded up to three readings at each intersection for each condition.

Results
Out of all the eighteen intersections that I went to, the noise readings for the green lights were always much higher than those for the red lights. . In a single car control experiment, I found that a slowing car always results in lower sound levels. Using this principle, it implies that a vehicle that ceases to slow down during a red light will trigger a noise level that would be similar to that observed during a green light.

Conclusions/Discussion
In conclusion, my hypothesis turned out to be correct. For every intersection that I went to, the green light sound (db) readings were always higher than the red light db readings. Additionally, the control experiment with a single car always shows that DB level reduces as a car slows down near the intersection. This basically means one could use multiple sound sensors in the path of travel to detect constant or decreasing sound levels. Decrease in sound levels would denote a decelerating car. I also obtained an expert's point of view about my project. I talked to the Senior Deputy of Ventura County, Sheriff R.J. Godfrey. His exact words were, #This is a unique idea. It is a benchmark in our society. People have tried to come up with ideas for this red-light-running problem but no one has thought of using sound!# Most importantly, my project can save lives.

Summary Statement
My project is about how I can use sound measurements to detect a red-light-runner and prevent potential collisions.

Help Received
My dad helped me get the sound meter and drove me to various intersections.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Arun K. Jandaur

Project Number
J1519

Project Title
How Do Metals Compare in Conducting Heat?

Abstract

Objectives/Goals
My experiment is to study how metals will compare in conducting heat. By knowing how metals compare in conducting heat will help in designs, where it is required for metals to conduct more or less heat. Based on my research, I predicted that among the metals (Copper, Aluminum, Brass, Lead, and Stainless Steel) that are being studied in this experiment, Copper would conduct heat the best, Aluminum the 2nd, Brass the 3rd, Lead the 4th, and Stainless Steel the worst.

Methods/Materials
I conducted two experiments to verify my hypothesis. In expt.# 1, one end of each metal was heated and a wax blob was mounted on the other end. The time was recorded when the wax blob fell off from the end of the metal. The materials used in this experiment were: Metals (Aluminum, Brass, Copper, Lead and Stainless Steel), candles, wax blobs, a Stopwatch and a Clamp stand. In expt.# 2, one end of each metal rod was put in boiling water and the thermocouple was mounted on the other end. Time vs. Temp. was recorded using a stopwatch and a Multimeter. The materials used were Metals (Aluminum, Brass, Copper, Lead and Stainless Steel), Temp. probe, Multimeter, Beaker of water, Clamp stand, and a stove.

Results
The results of expt.# 1 state that in case of Copper, the wax blob melted the 1st(time 3:30minutes). The wax on Aluminum melted 2nd(time 4:41minutes), Brass the 3rd(time 5:21minutes), Lead the 4th(time 6:05minutes), and Stainless Steel the last (time 8:15minutes). This data suggests that Copper had conducted heat the best and Stainless Steel the worst. The results of expt# 2 state that Copper attained the highest temperature in a short period of time (180sec. 93C), Aluminum the 2nd highest (180sec. 81C), Brass (180sec. 76C) the 3rd highest, Lead (180sec. 74C) the 4th highest, and Stainless Steel is the lowest (180sec. 73C). The data suggests that Copper is the best conductor of heat and Stainless Steel the worst.

Conclusions/Discussion
Based on the data I collected from my experiments, Copper was the best conductor, Aluminum the 2nd, Brass the 3rd, Lead the 4th and Stainless Steel the worst. The best conductivity in case of Copper may be because Copper is a univalent metal with a pure atom structure and probably has very few defects. However, Stainless Steel is a poor conductor because it has an alloy structure. Further experiment could be studying how impurities in different metals affect the conductivity.

Summary Statement
My project is about knowing which metals (Copper, Aluminum, Brass, Lead, and Stainless Steel) would conduct heat the best.

Help Received
My parents took me to library for research, ordered the metals, supervise during experimentation and helped typing. My uncle helped cut the metals. Michelle C. and Viviane N. helped assemble the poster board. Mrs. Flora and my Dad helped in answering technical questions.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Matthew R. Johnson

Project Number
J1520

Project Title
Flow Synchronization in Two Coupled Salt Oscillators

Abstract

Objectives/Goals
The objective of my project was to determine the effect of hole size in coupled salt oscillators on the period and relative phase to which the oscillators stabilized after achieving synchronization.

Methods/Materials
Each salt oscillator consisted of a cup of salt water with a small hole in the bottom which is partially submerged in a common, larger container of distilled water. Given certain hole sizes and salt water densities, the two systems will start to oscillate. I ran a series of trials with different combinations of two hole sizes, 0.9 mm and 1.4 mm, and measured the oscillation periods of the two oscillators. A salt water density of 1.05 g/mL was the same for both oscillators and all trials. I used a stopwatch to measure the oscillation periods, a micrometer to measure the size of the hole, scales, measuring spoons, measuring cups and a digital camera.

Results
I found that the coupled salt oscillators with the same hole sizes (resulting in similar individual periods) stabilized at oscillations with equal periods and a constant relative phase. The salt oscillators with different hole sizes (resulting in different individual periods) stabilized at two different frequencies, with a frequency ratio of about 1:4, and constant relative phases. The oscillations of the salt oscillators consisted of periodic jets of salt water down flow and distilled water up flow. The time elapsed before flow synchronization was observed to vary from 5 minutes to 10 hours.

Conclusions/Discussion
The coupled salt oscillators did become synchronized with constant frequency ratios and relative phases. However, the time taken for synchronization was very sensitive to the hole size combinations, with 10 hours observed for the two different hole size combination.

Summary Statement
The periods of two coupled salt oscillators were measured to see if the flows became synchronized.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Lauren E. Kelly

Project Number
J1521

Project Title
Coastin' the Curves: Is the Shortest Path Always the Fastest Path between Two Points?

Abstract

Objectives/Goals
The objective is to determine if the path with the shortest distance between two horizontal planes is necessarily the path which will take the least amount of time to travel and will this path create the fastest rate of travel, i.e., speed.

Methods/Materials
Four geometric curves were graphed, (a cycloid, parabola, circle, and straight line) projected onto poster board and traced, cut out and then traced onto plywood. These were then cut out using a saber saw and sanded to smooth the curve. A channel was cut down the middle of each curve and the curves were mounted to a plywood base. Finally, I used adhesive caulking to attach plastic tubing along each side of the channel on each curve. The tubing created an elevated track along which the steel ball would run down the curve. A light gate was placed at each end of the curve and set to measure the time it took the steel ball to travel between the two points. This was recorded and repeated ten times for each ramp. Each data set of ten recorded times was averaged. The length of each curve was found by laying a piece of string along the path the steel ball traveled when it went from the first light gate to the second one. The string was then measured along a meter stick. The measured distance for each curve and its respective average time were used to determine the average speed of the steel ball along each curve.

Results
The circle curve had the longest distance. Its average time was the shortest of all four curves with an average of 0.00885 seconds. This resulted in the circle creating the fastest average speed for the steel ball, 86.4407 m/sec. The straight line, on the other hand, had the shortest distance to travel yet its average time was the longest. This resulted in the straight line creating the slowest average speed for the steel ball, 52.6394 m/sec.

Conclusions/Discussion
I can conclude that the shortest distance between two points does not guarantee the fastest time. Whether in designing roads, creating roller coasters, or designing ski jumps and skateboarding ramps, you need to check the math!

Summary Statement
Is the shortest path always the fastest path between two points?

Help Received
Father cut the plywood and helped me build the curved ramps; used light gates from Reedley College Physics Dept, courtesy of Lauren Novatne (instructor)

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Misha Y. Khan

Project Number
J1522

Project Title
Viscosity's Effect on Liquid Droplets

Abstract

Objectives/Goals
This project was done in order to determine whether the property of fluids, viscosity, has an effect on the shape of a liquid#s droplet. The hypothesis was viscosity affects the shape of a liquid#s droplets. It also stated that liquids with higher viscosities have longer droplets and longer necks, because they take more time to separate and stretch out before dropping.

Methods/Materials
1. A stopwatch
2. A digital camera with multi-burst function
3. Straws cut into 5cm pieces
4. Graph paper
5. Water
6. Oil
7. Maple syrup
8. Chocolate Syrup
9. milk
10. Isopropyl
11. A ruler

The viscosity was determined by passing the liquid through a five centimeter straw and timing how long it takes to cover the distance. This gave a general idea of the viscosity of each liquid, because the longer a fluid takes to flow through the straw, the higher its resistance to flowing. Thus, its viscosity is higher. A sheet of graph paper was taped to the wall with the ruler taped to it. Eachliquid was squeezed into a dropper and dripped constantly. While the drops were dripping, pictures were taken from a digital camera that was set on multi-burst function.

Results
The results of this project proved that the viscosity of a liquid does not affect the size or shape of its droplet so that the liquid with a higher viscosity has a longer neck.

Conclusions/Discussion
My project could have been affected by human error, timming miscalculations, space provided, air pressure, and inaccurate calculations.

Summary Statement
My project experiments to find out whether the viscosity of a liquid has an affect on the shape of its droplet.

Help Received
Sister helped time, father helped take pictures

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

Maureen Kim; Leon Wang

Project Number

J1523

Project Title

Spectral Lines Emitted by Noble Gases

Abstract

Objectives/Goals

Our project was to determine the spectra line colors that were produced by noble gases. In addition, it was to determine what wavelengths each spectrum tube created. We believe the spectral lines would mostly be red, yellow, and green in each gas and that wavelength will change. Most importantly we wanted to explore the realm of light and see what it creates. On the other hand we had the noble gases to research.

Methods/Materials

Four spectrum tubes containing compressed gases were excited with the Electro-Technic Model SP-2000 Tube Power Supply. Diffraction gratings were used to see the spectrum colors and a vague count of how many there are.

Results

All different spectra line colors add up and create the assorted lights emitted by gases that we were experimenting on. Wavelengths were discovered -measured in nanometers- for each gas. We have discovered many properties of light. For instance the diffraction grating splits light up into what it reflects - different colors of the rainbow. As for the gases we have identified the properties of each and their own uses.

Conclusions/Discussion

Our conclusion is that the spectrum tubes show mostly red, green, and yellow spectral lines when viewed through diffraction gratings, all of which the wavelength of each spectral line vary from 4000 to 7400 nanometers. Also, there are various properties of light of which the gases emitted.For example, after using the diffraction gratings, the light that was reflected added up to the original color seen by the naked eye.

Summary Statement

Our project is about spectral lines emitted by noble gases.

Help Received

Our teachers gave us knowledge; Parents helped us get together and give us rides ; School provided us with equipment; Each other for trying our best and helping each other out.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Nicole Kowtko

Project Number
J1524

Project Title
Can You Hear Me Now? Part 2: Determining the Relationship between Density and Sound

Abstract

Objectives/Goals
I chose to expand upon my project from last year (determining the relationship between air pressure and sound). My curiosity first led me to test various material densities and their affect on sound. As I learned more, I decided to also test what happens when there is a change of distance and frequency. I will attempt to calculate if the data will follow Newton's Inverse Square Law. Since this project is multi-layered, my hypotheses are as follows: I believe that as the density increases, the decibels will decrease. Also, I believe that as the distance increases, the decibels will decrease. I further believe that different frequencies will not affect the density and distance hypotheses.

Methods/Materials
A Density Measurement was first used to calculate the density of seven test mediums (polyethylene, sponge rubber, plywood, sheet rock, fiber board, aluminum and steel). Next, a Decibel Test was conducted to measure the sound level passing through each material. The test was repeated using two different frequencies (3800Hz and 400 Hz), and it was repeated for seven distances (4, 8, 12, 16, 20, 24 and 256 inches). The test rig was created using various lengths of 2 inch ABS open drainage pipe, buzzers attached to two different end caps, a sound meter, and ½ inch thick test materials.

Results
The Density Measurement resulted in three groupings of density measurements. The least dense were polyethylene and sponge rubber. Plywood, sheet rock, and fiber board were very similar in density, while aluminum and steel were the densest. For each test material, the Decibel Test data was analyzed for the linear distances (4, 8, 12, 16, 20 and 24 inches) and then separately analyzed for the exponential distances (4, 16 and 256 inches). For the higher frequency of 3800 Hz, there was a fairly constant decrease of decibels as the distance increased. The results were more varied for the lower frequency of 400 Hz, but it still had a general decreasing decibel trend.

Conclusions/Discussion
The data shows there is an inverse relationship between the increasing density and the decreasing decibels. There is also an inverse relationship between the increasing distance and the decreasing decibels for each test material. The different frequencies did not significantly affect the results, so my multi-layered hypotheses were correct. Due to the nature of the data, I was unfortunately unable to apply the inverse square law.

Summary Statement
This project examines the relationship between density and sound, plus it tests how linear and exponential distances and high/low frequencies affect sound passing thru various test materials.

Help Received
Several neighbors helped provide some of the test materials and equipment. My science teacher assisted me by reviewing my ideas and answering my questions. My mother was my test assistant, helped me with Excel and reviewed my work.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Denise Lum; Michelle Tan

Project Number
J1525

Project Title
Conductivity with Density

Abstract

Objectives/Goals
We investigated if the density of wood affects the conductivity of the wood.

Methods/Materials
We used 30 Cedar Wood blocks (2in x 2in x 2in), 30 Oak Wood blocks (2in x 2in x 2in), 30 Pine Wood blocks (2in x 2in x 2in), a Saw, 30 Thermocouple wires, a Thermocouple meter, a Drill, Epoxy, an Oven, a Stopwatch, and a Triple beam balance. We drilled a hole in the center of each of the cubes that we cut. We massed each of the blocks to determine their densities. We then placed the thermocouple wire into each hole and poured the epoxy into the hole to make it permanent. We preheated the oven for 15 minutes at 200oF. We measured the temperature of the wood outside the oven, and then every minute for thirty minutes within the oven. This was repeated for each type of block with ten trials each.

Results
Cedar was the least conductive, next was pine, with oak being the most conductive. In the beginning oak, pine, and cedar#s temperatures went up very fast at 5-10 degrees per minute. In the end though, they slowed down and only went up about 2-4 degrees each minute or sometimes didn#t change at all. Also cedar always had the lowest density, then pine, and then oak.

Conclusions/Discussion
Our hypothesis was that materials with lower densities would have lower conductivity. Our hypothesis was found to be correct because cedar had the lowest conductivity and the lowest density, followed by pine, and then last of all oak. So if we were to remodel our oak cabinets in the kitchen, we should use cedar instead of the oak.

Summary Statement
In this project we investigated if the density of wood affected its conductivity and found out that lower density materials have lower conductivity.

Help Received
Mother bought materials, Advisor helped us get started on project

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Janise E. Marvin

Project Number
J1526

Project Title
What Is the Effect of Various Window Coverings on the Temperature of the Enclosed Area?

Abstract

Objectives/Goals
The purpose of my project is to discover which of the most commonly used window coverings keeps heat out of a house the best. I believe that a reflective window covering will suceed in keeping out the heat.

Methods/Materials
I used a dual pane window fitted in a frame of plywood. I then insulated the frame with fiberglass insulation and dry walled the inside. I also covered the outside with T111 wood covering. I tested each of the different coverings: mini blinds, window shade, aluminum foil, reflective and non-reflective window films, and tested with no covering for a control. I used two 250-watt heat lamps mounted on a stand to stimulate the sun. I tested each covering three times.

Results
I found out that the aluminum foil did the best at keeping the heat out, although reflective window film consistently was second best at keeping the interior cooler.

Conclusions/Discussion
I concluded that if you can just reflect the light away from your house, the interior of your home would stay cooler.

Summary Statement
The object of my project was to figure out which window covering would keep the most heat out of a house.

Help Received
My father helped my build the house.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Lindsay H. McHugh

Project Number
J1527

Project Title
It's Getting Hot in Here! A Study on the Greenhouse Effect

Abstract

Objectives/Goals
The purpose of this experiment is to determine if different amounts of carbon dioxide in the air affect the amount of heat retained in the air. I infer that the can containing the most carbon dioxide, 8g, will retain the most heat and cool down the slowest.

Methods/Materials
The greenhouse effect will be recreated inside of a coffee can. Carbon dioxide will be made by mixing 140ml of vinegar with various amounts of baking soda. The experiment will include five different coffee cans: one with 140ml. vinegar with no baking soda, one with 140ml. vinegar and 2g baking soda, one with 140ml. vinegar and 4g baking soda, one with 140ml. vinegar and 6g baking soda, and one with 140ml. vinegar and 8g baking soda. Carbon dioxide will be poured into the coffee can and the can will be sealed closed. There will be a special sun lamp positioned above each coffee can to simulate the heat and light of the sun. A thermometer will be taped at the top, middle and bottom of the can to read the temperatures at different heights of the can. The temperature on the thermometers will be recorded every 10 minutes with the light on until the temperatures stopped rising. Then the lights will be turned off and the temperatures at each height of the can will be taken every 10 minutes until they reach room temperature. The readings of the temperatures inside the cans will be compared with those of another thermometer that measures the room temperature at the same time intervals.

Results
I feel my hypothesis is partially correct because the air within the cans that have the highest amounts of carbon dioxide cooled down more slowly and retained a higher temperature at the end of the test period while the can with air and vinegar cooled to the original starting temperature the quickest and had the lowest temperature in each section of the cans at the end of the test period. However, the can with 6g of baking soda, the second highest amount of baking soda, retained the most heat in all levels of the can and cooled at the slowest rate, not the can with 8g of baking soda as I hypothesized.

Conclusions/Discussion
My conclusion is that more carbon dioxide in the air caused the air to retain more heat and take longer to cool down. This experiment may show that as the amount of carbon dioxide in Earth's atmosphere increases, the atmosphere will hold more heat, causing the temperature to rise in the future.

Summary Statement
The purpose of this experiment is to determine if different amounts of carbon dioxide in the air affect the amount of heat retained in the air.

Help Received
My father helped by purchasing the supplies that I needed. He also helped with some typing when my hands got tired. My mother helped by giving advice for the design of the board. Both of my siblings informed me when the timer was buzzing so that I could take temperatures and recordings.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Anderson R. Mills

Project Number
J1528

Project Title
Can Fiber Optic Wire Light a Home?

Abstract

Objectives/Goals
My project was to determine if a home could be lit by single light source transmitted by fiber optics wire. I hypothesized that a small home, about 1225 square feet, could be lit by fiber optic wire, with a considerable savings on the electricity used.

Methods/Materials
I designed a model home lit using two different lighting systems, traditional and fiber optic to visually compare both. Calculations were used to compare energy consumption of the two lighting systems.

Results
Calculations proved that a fiber optic lighting system used significantly less energy than a traditional lighting system without sacrificing light output. Through research, calculations used, and observations of light output from model, the fiber optic lighting system was proven to be a viable lighting system for possible use in the future.

Conclusions/Discussion
I concluded that a small home, about 1225 square feet, could be lit by fibers carrying light to different rooms.

Summary Statement
My project is about lighting a home with a single light source using fiber optic wire.

Help Received
Mother and father helped in construction of model; Glass Illuminations supplied free fiber optic wire and gave helpful advice on how to prime the wire for transferring light

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Kate Lee Newcomb

Project Number
J1529

Project Title
At What Angle Does Refracted Light Create a Mirage?

Abstract

Objectives/Goals
The objective of the project is to determine the angle at which light refracts to create an inferior mirage. The second goal of the project is to get a better understanding of the physics of light.

Methods/Materials
The purpose of the procedure was to create an artificial mirage to refract a laser beam and measure the angle of refraction. Set up apparatus (laser, stove, metal plate, and target), record the variables to be changed (distances of laser and heated plate to target, and temperature of heated plate) and record the zero point of the laser beam on the target for the particular trail. Run an experiment(heat the plate to create the mirage) and record the variables that need to be recorded for that trial (maximum and average distances laser beam moves from zero point). Repeat until data is collected for several sets of setup conditions (variables to be changed) are recorded. Then take the recorded data and calculate angle of refracted light using trigonometry from zero point and refracted laser beam positions and the distance from the heated plate to the target.

Results
The data collected is from the nine different experimental trails. The distances of the heated plate and the laser were increased to produce a more measurable effect. The overall angle of refracted light was calculated after performing the experiment. The experimenter observed that the mirage is only visible when the line of vision is almost parallel to the surface. The results were that none of the angles of refracted light were less than 179 degrees, referring to the experimenter's hypothesis.

Conclusions/Discussion
The angle of refracted light discussed in the hypothesis is the angle between the projected beam and the resulting refracted beam (obtuse angle). Several trails were conducted to verify the accuracy of the data recorded. The resulting refraction angles (acute) ranged from 0.13 to 0.51 degrees. Therefore, the angle of refraction (obtuse) was over 179 degrees, which confirms the hypothesis of this experiment. Several other conclusions were made by the experimenter based on observations of this experiment. However, prior to conducting this experiment, the experimenter did not fully realize the limited conditions required to create the mirage effect, particularly with regard to the condition that a mirage will only refract light that is nearly parallel to the surface of the mirage.

Summary Statement
To discover the angle of refracted light needed to create an inferior mirage.

Help Received
High school teachers assisted with designing the experimental apparatus and my Dad helped with conducting the experiment and the mathematical equations.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Heather R. O'Connor

Project Number
J1530

Project Title
What Effect Does a Solution's Temperature Have on the Duration of a Bubble Film?

Abstract

Objectives/Goals
The purpose of this experiment was to find the optimum temperature range for bubble solution to produce the longest lasting bubble film. I became interested in this topic when I began my research I learned that bubble science has many useful applications in fire suppression, agriculture, and pure research. My question is, #What Effect Does a Solution's Temperature Have on the Duration of a Bubble Film?# My hypothesis is that the greater the temperature of the solution the shorter the duration of the film.

Methods/Materials
My experiment began with the design and building of a bubble film device. I then prepared the bubble solution using 250 mL Original Dawn dishwashing soap,65 drops of glycerin and 4 liters of tap water. The solution was either refrigerated to 3° C,kept at 18º-20ºC or heated to 33°C and 45°C. on a hot plate. The solution was poured into the bubble device and allowed to soak into the wooded dowel for 10 minutes. 40 trials for each temperature range were completed and duration time was recorded. A 20 second soak time was maintained between each trial as a control.

Results
My raw data for the 5-7° C range produced a bubble film with an average duration of 45.97 seconds. The 18-20° C range produced an average of 42.62 seconds. The 33-35° C range produced an average of 31.63 seconds. The shortest duration was found in the temperature range of 45-51° C range producing a bubble average of 23.19 seconds.

Conclusions/Discussion
In conclusion, I found that my hypothesis was partially supported. The 5-7° C group had the most outliers and was skewing the data especially when calculating the average for each temperature range. The possible reasons for the outliers were that it was difficult to keep the solution cool enough or the concentration of the detergent or the glycerin on the bar may have been greater or lesser during some trials. Then when I got rid of the outliers in the 5°- 7° C range I found that the averages and the median for that temperature range became more accurate. The solution at room temperature was the temperature range that produced the bubble film with the longest duration. The coldest temperature had too many outliers to accurately calculate its data. I think that at room temperature the surface tension of the water is lowest and the rate of evaporation or decent of water towards the bottom is slower. This may be due to the bonding attraction of the water molecules.

Summary Statement
The project is exploring the effect of a solution's temperature on the duration of a bubble film.

Help Received
My father helped me with the statistics by explaining how to find the standard deviation and my mother helped me time my trials,

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Thomas A. Parque

Project Number
J1531

Project Title
Just Cool It!

Abstract

Objectives/Goals
The objective was to determine how quickly a carbonated soft drink at room temperature could be cooled to an optimum drinking temperature without diluting the liquid with ice.

Methods/Materials
Two trials were conducted with the same brand of carbonated soft drink. A can of soft drink was placed in four different prepartions, cubed ice, crushed ice, crushed ice with water, and crushed ice with water and salt. The time it took for each can of soft drink to reach the optimum temperature of 7 degrees Celsius was timed and recorded.

Results
In both trials, the soft drink can placed in the crushed ice with water and salt cool significatly faster than the other three preparations.

Conclusions/Discussion
If a person does not like ice in their soft drink, they can quickly cool a single can of soft drink to an optimum temperature in 2.5 minutes using crushed ice, tap water, and table salt. The liquid in the can is not diluted but the temperature is lowered by process of conduction.

Summary Statement
How to quickly cool a single can of soft drink without diluting it with ice.

Help Received
Mother helped me type the report and taught me how to make charts and graphs. Ms. Patricia Krupa, science teacher at Herlong High School, allow me to borrow the necessary lab equipment.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Rodrigo J. Plaza

Project Number
J1532

Project Title
Sink or Swim: The Effects of Temperature on Liquid Density and Buoyancy

Abstract

Objectives/Goals
To determine the effects of liquid temperature on the density of the liquid and the buoyancy of an object in the liquid.

Methods/Materials
Four different liquids: tap water, vinegar, canola oil and sugar-water, were each examined at three different temperatures: 5, 25 and 75 degrees Celsius. The mass and volume of each liquid at each temperature were determined using a digital balance and a graduated cylinder, and the densities of each calculated. Then, buoyancy was measured for each liquid at each temperature using a hydrometer. Each data point was repeated three times and an average taken for each. Averages were graphed and trends were examined.

Results
As temperature increased, liquid density decreased for all liquids. This decrease in liquid density resulted in a decrease in the buoyancy of the hydrometer in the liquid (the hydrometer rested lower in the liquid at higher temperatures). The most extreme differences in temperature effects on buoyancy were seen with the sugar-water (the most dense liquid) and the canola oil (the least dense liquid), while the vinegar and tap water had smaller effects.

Conclusions/Discussion
As liquid temperature increased, liquid density decreased, making objects floating in the liquid less buoyant, as I had hypothesized. Although differences seen were not very large, the trends were followed for all liquids. The larger changes in buoyancy for sugar-water and canola oil may have been due to their greater viscosity than the other two liquids. The effects of temperature on buoyancy are important to take into account when designing a buoyant object such as a boat, floating bridge, or life vest.

Summary Statement
This project demonstrates the relationships between liquid temperature, liquid density and the buoyancy of objects in liquid by determining the differences in the density of, and hydrometer buoyancy in, liquids at different temperatures.

Help Received
Mother helped type report and used lab equipment borrowed from Cabrillo Community College under mother's supervision (a chemistry teacher); general project guidance by 8th grade science teacher, Ms. Kilkenny.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Kristen Reynier; Spencer Shoemaker

Project Number
J1533

Project Title
What's Hot? What's Not?

Abstract

Objectives/Goals
The objective is to determine which material will insulate heat best out of wood, polystyrene or aluminum foil. We believe that polystyrene will be the best heat insulator.

Methods/Materials
Our experiment had three identical boxes, three identical jelly jars, three identical thermometers. The insulators that we used were common wood chips, aluminum foil, and polystyrene packaging. 200 degree water was poured into each of the jelly jars surrounded by each of the insulators and the temperature was recorded in equal time increments up to 90 minutes.

Results
It was found that of the three insulators polystyrene was shown to be the best insulator under these conditions.

Conclusions/Discussion
We concluded that our hypothesis was correct. The polystyrene insulated hot water better than aluminum foil or wood. This is due to the fact that polystyrene is a closed cell material that resists moisture and other things that may cause the temperature of the water to decrease.

Summary Statement
Which material insulated heat best, polystyrene, wood, or aluminum foil?

Help Received
Our parents, Kevin and Pam Reynier and Steve and Teresa Shoemaker, Jim Kapin, and Jerry Reinen

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Ricardo C. Robledo

Project Number
J1534

Project Title
The Loudness of Different Sized Stringed Instruments

Abstract

Objectives/Goals
The objective for this project was to figure out which stringed instrument had the greater loudness. Then the problem established was, "What is the effect of different sized stringed instruments on loudness?" The hypothesis that was thought was, "If the size of the stringed instrument (a violin, viola, cello, and double bass) is bigger, then the instrument will be louder."

Methods/Materials
In the experiment, the independent variables were the different instruments played. The controlled variables were the sound meter, distance between both items, same note ("A"), the same person playing, same room being played in, same tempo, and the same pressure applied to the instruments. The size of the instruments are in order from smallest to largest; violin, viola, cello, string bass. The way the results were gotten, were by playing an "A" note on the second string on every instrument. For the violin, a fourth finger: for the viola and cello, first finger: and for the string bass, an open string. The sound meter was put 30cm away from the instrument. The sound meter was at the level 70 to 90 db. The instruments were played for 4 counts at 80 beats per minute. This step was done 40 times on each instrument. That would mean that each time counted as a trial, therefore making forty trials for each instrument, or 160 trials all together.

Results
The results came out to oppose the hypothesis. Results, at the average note, were as follows: violin, 85.9 db: viola, 79.5 db: cello, 76.52 db: double bass, 75.97 db.

Conclusions/Discussion
As a conclusion, it is not the biggest instrument having the greater loudness. The smallest, the violin, has the greatest loudness, and the string bass, the biggest, has the smallest loudness.

Summary Statement
Loudness was measured in decibels by playing different sized stringed instruments.

Help Received
SB Music teacher Mike Pretzer provided Viola & Double Bass. Dad helped Gluing & Pictures. Mom helped type report & record results.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Katharine J. Russell

Project Number
J1535

Project Title
Are Good Electrical Insulators Also Good Thermal Insulators? A Study of Thermal Conductivity

Abstract

Objectives/Goals
My experiment is to test which materials work best as thermal insulators. My hypothesis is that a good electrical conductor would be a bad thermal insulator. This hypothesis was based on my observation that copper is used in most electrical wires because it is a good electrical conductor; it is also placed on the bottom of pans because it conducts heat well. This leads me to believe that a material like an aerogel is a good thermal insulator because it is a bad electrical conductor.

Methods/Materials
I will test my hypothesis by taking different materials (electrical conductors and electrical insulators) and placing then next to a source of controlled heat and measuring, with a thermometer, how long it takes for the other side of the object to reach an equilibrium temperature. I will then use Fourier's equation to calculate the thermal conductivity.

Results
Using the temperature vs. time plot for each of the materials, I determined the equilibrium temperature and used Fourier's equation to calculate the thermal conductivity. The best thermal insulator is PVC, it had a thermal conductivity of 1.185(W/mK). In order of best thermal insulator to the best thermal conductor I then found polyethylene with a thermal conductivity of 2.11(W/mK), teflon 3.018(W/mK), steel wool 3.762(W/mK), oak 3.985(W/mK), silicon dioxide 4.006(W/mK), acrylic plexiglass 4.106(W/mK), poplar 4.606(W/mK), fiberglass 4.69(W/mK), polystyrene 4.994(W/mK), silica aerogel 8.755(W/mK), gypsum 10.18(W/mK), ceramic (Macor) 16.316(W/mK), marble 25.474(W/mK), silicon 106.692(W/mK), aluminum 114.502(W/mK), steel 122.388(W/mK), and finally copper with 185.5(W/mK).

Conclusions/Discussion
The material that was the best thermal insulator was PVC. I found, from my background research, that PVC is a very bad electrical conductor which is consistent with my hypothesis. Copper was the best thermal conductor. Copper is well known for its high thermal conductivity and is used in many things such as the bottom of cooking pans so that the pans heat up faster, and in electrical wires because it is also a good electrical conductor. My hypothesis said that I thought a good electrical insulator would be a good thermal insulator, which was shown to be correct.

Summary Statement
My experiment measures thermal conductivity to test which materials work best as thermal insulators.

Help Received
Science teacher Mr. Ozeni gave pointers to improve my experiment; English teacher Mrs. Williams taught me how to do my background research paper and abstract; my Dad got the materials and monitored my experiemnt to keep things safe.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Sona N. Shah

Project Number
J1536

Project Title
The Twists and Turns of Light

Abstract

Objectives/Goals
My goal was to learn whether the denstiy of a liquid medium would affect the way it refracts light. I thought that the density of a liquid medium would affect the way it refracts light because the closer the molecules are(denser), there will be more collisions. This means that light will have more molecules to bounce off of, causing light rays to bend.

Methods/Materials
First, make a small lighthouse with six slits out of construction paper and then, in the dark, one by one place each of the liquids (water, water with two teaspoons of salt, water with two teaspoons of glucose, club soda, syrup, Sprite, vinegar, Canola oil, and an empty cup) 3 inches away from the house, turn on the light, and record the distance between the focal point and cup.

Results
I did my experiment five times. Water had a distance of two inches between the focal point and the cup, water w/ salt-1.6in., water w/ glucose-1.7in., Club Soda-1.9in., syrup-.4in., Sprite-1.7in., vinegar-1.8in., every time. Except Canola oil had a .9 inch distance the second time, and a .8 inch distance the other four times.

Conclusions/Discussion
My hypothesis was correct. The density of a liquid medium would affect the way it reftacts light. In my experiment, I found that as I tested denser liquids, the refraction increased and the focal point came closer to the cup. So, as density increased, refration does, too. In this experiments, I learned that refraction is affected by the density of liquid medium. I also learned how the principal of refraction is used to correct human eyesight.

Summary Statement
My project is about whether the density of a liquid medium affects the way it refracts light.

Help Received
Mohter helped me collect my materials and my Dad helped me when I had any unanswered questions.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Lindsey K. Sweeney

Project Number
J1537

Project Title
The Mass Properties of Light

Abstract

Objectives/Goals
My project objective was to determine if photons in sunlight exhibit detectable mass properties when striking a mechanical detector. This exercise would be accomplished by building an extremely sensitive detector with the ability to control many influencing variables.

Methods/Materials
To conduct this experiment, the materials needed were gathered: 1 can of flat black spray paint, 1 fine human hair, 1 sheet of aluminum foil - 20cm x 20cm, 1 pair of scissors, Scotch tape, 3 hand-mirrors, 1-20cm by 20cm piece of opaque cardboard, 5-20cm x 20cm panes of glass (standard windowpane thickness), 2-22cm x 22cm panes of glass (standard windowpane thickness), 1 tube of clear silicone, 3-5cm x 12cm x 2mm steel plates, 4-3mm x 12cm bolts with 4 nuts each, 1 tube of cyannoacrylate glue, and 1 drill and 4mm bit. A test environment was created that controls friction, torque, infrared light, convection, and the refraction and reflection of light to a minimum so that the radiated photons would be the only significant element affecting rotation. Three mirrors reflecting the sun's light were shone on the detector five times for twelve seconds and off for twelve seconds in each series of tests, while checking for movement or rotation. Next, a series of different variations of the test were done by blocking one of the two different colored sides, or putting another pane of glass in front of the environment to demonstrate that heat and/or convection was not a significant source of energy.

Results
According to the data and observations, the results that were acquired did support the hypothesis that the inertial properties of photons in sunlight would exhibit detectable mass properties when striking a mechanical detector. The evolution of the test apparatus from the original, nearly friction free detector, to the final detector - many times more sensitive due to it's reduced mass, along with a continual refinement of test procedures, assured the outcome.

Conclusions/Discussion
The hypothesis that the mass properties of light would be detectable when striking a mechanical detector was supported, but the experiment was much more than that. It was the realization of how minute the forces of photons were and the evolution of the detector from the nearly frictionless beginning, to the final detector, many times more sensitive to be able to detect these forces.

Summary Statement
The goal of this project was to develop a detector capable of registering the photon's inertial properties in reflected natural sunlight.

Help Received
My dad helped me research information, drill holes in the metal used for the detector, and cut the glass of my environment for me. Mrs. White, my teacher, proofread my work for grammatical errors.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Mark A. Swerdlow

Project Number
J1538

Project Title
Can You Tell How Much Sugar Is in Your Drink by How Much It Bends Light?

Abstract

Objectives/Goals
My objective was to determine the effect of sugar concentration on the index of refraction (IOR) of sugar solutions. My hypothesis was that IOR increases enough with increasing concentrations of sugar to differentiate a diet soft drink from a regular (sugar) soft drink.

Methods/Materials
I placed a cylindrical tank with its axis parallel to the ground, filled it half way with liquid, and mounted a laser on a metal arm that rotated around its center. To vary the angle of incidence at the air-liquid boundary, I rotated metal arm. I photographed the path of the laser using a digital camera and loaded the photos into iPhoto. I used a digital protractor to measure the angles of incidence and refraction; I used Excel to plot sine of the angle of incidence on the Y axis and sine of the angle of refraction on the X axis. I calculated IOR as the slope of the best fit line through the origin. Experimental variables were the IORs of 10%, 20%, or 30% sugar solutions, Diet Sprite, or regular (10.7% sugar) Sprite. The control was the IOR of water. I assessed reproducibility by making 8 repeated measurements of 3 photos.

Results
Overall, 95 photos were suitable for analysis. The standard deviation was < 0.1° for the offset between the water and camera levels and 0.2° to 0.3° for the angles of incidence and refraction. There was a strong linear correlation between the sines of the angles of incidence and refraction ($R^2 > 0.98$). The IOR increased with increasing concentrations of sugar from 1.335 for water to 1.357, 1.372, and 1.397 for 10%, 20%, and 30% solutions, respectively ($F = 8.5$, $p < .0001$ by ANOVA). The IOR was less for Diet Sprite than for regular Sprite (1.329 vs. 1.363, $p = .03$).

Conclusions/Discussion
The IOR increases 1% to 2% for each 10% increase in sugar concentration up to 30%. The IORs of Diet regular Sprite are close to those of water and 10% sugar solutions, respectively. Using a series of measurements, this method is accurate enough to detect about a 10% change in concentration of sugar and to determine if a soft drink is diet.

Summary Statement
The index of refraction increases with increasing concentration of sugar in water; this property can be used to distinguish a diet soft drink from a regular (sugar) soft drink.

Help Received
Father showed me how to do statistical tests. Mother helped assemble display. Henry McGilton modified digital protractor program (Protractor) to store measured angles.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Brian VanDerhoff

Project Number
J1539

Project Title
Caloric Energy Output from Concentrating Solar Arrays

Abstract

Objectives/Goals
The project objective was to determine whether the average number of calories produced by each 1.25 inch mirror tile in a concentrating solar array would remain constant as the size of the array was changed. In my hypothesis, I state that the average calories produced by a single mirror would remain constant as the number of mirrors in the array is increased and/or decreased.

Methods/Materials
In order to test my hypothesis, I built a solar array with 225 1.25 inch adjustable mirror tiles which could all be focused on a single spot. I then filled a test tube with 30 milliliters of water and focused the mirrors so that they were all reflecting onto the test tube. I recorded the temperature and repeated the process after covering up 25 mirrors every ten minutes. I then used the formula: the quantity of heat = the mass times the specific heat times the change in temperature. This formula told me how many calories the array was emitting.

Results
The experiment showed a range of calories per mirror from 15.6 calories to 9.6 calories. There was an average of about 11.8 calories per mirror when all of the tests had been completed.

Conclusions/Discussion
The hypothesis of the experiment was not supported. There was an expectation of a constant proportion of calories per mirror; however, the tests showed no recognizable mode of the number of calories per mirror.

Summary Statement
I built a concentrating solar array of 225 adjustable mirrors and used it to determine whether the average caloric energy output per mirror tile remained constant as the number of tiles in the array was increased and/or decreased.

Help Received
Friend/science teacher supplied me with books and feedback; Dad taught me how to use tools and assisted me during testing; Mom helped type report; Advisors gave feedback and suggestions.

CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Constance Wu

Project Number
J1541

Project Title
How Does the Period of Motion of a Pendulum Depend on Its Mass, Amplitude, or Length?

Abstract

Objectives/Goals
The purpose of my project was to find out how a pendulum worked and what variables affected it, because there are many pendulums that exist in everyday life (in grandfather clocks, swings, and more). Finding out how a pendulum works and what affects it helps us understand how some everyday objects work, as well as build those objects.

Methods/Materials
I built a pendulum frame and constructed a pendulum that consisted of fishing wire, which I could change for length, and a plastic cup with weights I could change for mass. For amplitude, I adjusted the angle at which the pendulum was released using a protractor attached to the pendulum frame. Using a stopwatch, I would record the amount of time the pendulum took to complete one full period of motion. I controlled the environment the pendulum was in so that there were no outside effects acting on the pendulum.

Results
My results for my experiment showed that the period of motion did not change when the variables of mass and amplitude were changed, but increased when the length of the pendulum was increased. (However, the data was not exact enough to find the exact relationship between the length and the period of motion).

Conclusions/Discussion
The results for the experiment are important because they show that a pendulum's period of motion is only affected by length and not by mass or amplitude. Learning that the mass and amplitude do not affect a pendulum's period of motion is important because the explanation of it can be tied to physics and ideas like inertia. Knowing that the length of a pendulum affects its period of motion can impact us because we can better understand everyday pendulums in our lives and so could, for example, understand how to fix a grandfather clock if it were running too slow. Further experimentation could be done to find the exact relationship between the length of a pendulum and its period of motion so our understanding would increase.

Summary Statement
My project was finding out how the variables of length, mass, and amplitude affect the period of motion of a pendulum.

Help Received
My father helped me build the pendulum frame (but I ran the experimentation.)