CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)	Project Number
Dhruv Aggarwal	J1701

Project Title

Spotlight on Infrared Radiation: Luminous Flux or Radiant Flux?

Abstract

Objectives/Goals

My objective was to determine what makes performers feel hot on stage, and whether it is the light that falls on the body creating the heat, or whether the heat from the bulbs is travelling to the performer. I also wanted to understand how the heat traveled, because it is invisible.

Since the light sources generated both light, and heat, I had to either keep the light or the heat constant, or find a way to separate the light from the heat.

My hypothesis was that the temperature of the measured surface would increase due to the heat rather than the light.

Methods/Materials

My method was to keep the Luminous Flux (lumens) constant, so that the heating would be only due to the infrared radiation.

I created a setup using bulbs and an LED light, measured the baseline temperature calibrating across three different thermometers, and then exposed the skin pad and later human skin to the lighting for 20 minutes, measuring every 5 minutes.

Finally, I eliminated the effect of difference in lumens from the light sources by confirming the results with half the lumens for the bulbs.

Results

The temperature of the skin pad and human skin increased by 1.5 degrees every 5 minutes with the incandescent bulbs, and by 0.5 degrees every 5 minutes with the LED lights. (Incandescent bulb had 300% increase as compared to the LED). Even with half the lumens the incandescent bulb had a 200% increase and the halogen bulb had a 133% increase as compared to the LED. My data also confirmed the Inverse Square Law for radiation.

When testing on my skin, with the LED and Halogen bulbs, there was a decrease in temperature of 0.6 and 0.2 degrees, respectively, since my body regulated its temperature. With the incandescent bulb, the temperature increased by 0.1 degrees, since the bulb produced more heat than my body could dissipate.

Conclusions/Discussion

My hypothesis was substantiated. Luminous Flux was approximately the same, so the light sources had to be radiating infrared waves (Radiant Flux) that was travelling to the measured surface.

Recent advances in LED technology have improved their CRI, so that the light is comparable to that from Halogen bulbs, and I expect that it will be increasingly adopted on stages, improving the environment for performers.

Summary Statement

This project studies the visible light and infrared regions of the electromagnetic spectrum in an effort to reduce the heat experienced by performers on stage.

Help Received

My parents funded my project and helped me set up the electrical wiring.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Rahul Araza

Project Number

J1702

Project Title

How Does the Size of a Speaker Affect Its Frequency Response?

Abstract

Objectives/Goals

The objective of this project is to learn about speakers and how they work, understand the movement and characteristics of sound waves and how they affect the speaker, how frequency and loudness of sound waves are measured, and understand how to conduct and complete a valid, successful experiment. It will test how different sized speakers (drivers) produce different frequency responses.

Methods/Materials

The independent variables used in this experiment are the size of the speaker (driver) and audio frequency of the test tones used. The dependent variable is the frequency response of the speaker being tested. The readings are measured using a microphone and a computer-based audio spectrum analyzer. The constants (control variables) are the amplifier, the measurement microphone, physical location and layout of the different components of this test, including the distance from the microphone to the speaker. The different sized speakers, which are all required to be have the same electrical impedance and cone material, are connected to an amplifier in order for the test tone to be audible. This amplifier is connected to the computer which has the TrueRTA software to generate the test tones and record the data. There is a measurement microphone connected to the computer such that when the test tone is played, the microphone will send the response back to the computer to be analyzed.

Results

In this experiment, the speakers responded as predicted. The larger speaker produced lower frequencies louder than the smaller speaker, and the smaller speaker produced higher frequencies louder than the larger speakers. However, the higher frequencies all responded similarly, which was very surprising.

Conclusions/Discussion

Overall, the experiment was designed well and therefore the hypothesis was properly tested though there were some parts of the experiment that could have been conducted better. The way the experiment was performed was very efficient, and was necessary to retrieve accurate data. The only issue was controlling the various variables. Controlling background noise is very challenging, especially since the experiment was not done in an anechoic room. Also, more sophisticated software and measuring instruments would have produced more data points with higher accuracy.

Summary Statement

An experiment to determine how the size of a speaker may affect its ability to reproduce sound frequencies across the audible spectrum.

Help Received

Parent helped with the conducting of the experiment.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Chloe Brandon

Project Number

J1703

Project Title

What Is the Effect of Color on Solar Water Heating?

Abstract

Objectives/Goals

The main goal of my experiment was to answer the question: How can color affect solar water heating? A second goal was to develop a practical demonstration in the form of a solar shower. Color should influence water temperature by changing the amount of light energy that is absorbed versus reflected. Light striking the container is converted to thermal energy. My hypothesis is that there will be a difference in temperature between the varying colors of the bottles that contain the water. Once I determine the best color, I will use it to build a shower using solar water heating.

Methods/Materials

1. 10 500 mL polyethylene terephthalate plastic bottles coated with red, orange, yellow, green, blue, purple, black, silver, white acrylic paints 2. 5,000 mL of tap water 3. Glass thermometers 4. Electronic timer 5. Self-designed and assembled solar shower

Results

The data were plotted as water temperature vs. time. At a point where the air temperatures were stable, the order and temperatures of the bottle#s water was compiled. This was done for both of the two different days that data were collected. Results of the data analysis include: 1. All water temperatures inside the bottles were higher than the air temperature after 30 minutes. 2. The water in the black bottle stayed the hottest for the whole testing period. 3. Green and blue bottles became the 2nd and 3rd warmest after the black bottle. 4. The other colors were within 3-6 degrees Celsius of the control bottle. 5. The white bottle either stayed the same temperature or was slightly cooler than the control.

Conclusions/Discussion

The hypothesis was proven correct. Some of my conclusions are: 1. The darker the bottle, the warmer the water inside. 2. The black bottle became the hottest because it absorbs all of the colors of light. 3. The lighter colored bottles reflected more light and were less hot or were very similar to each other. 4. The best choice of color for the solar shower is black. A good second choice of color would be blue or green as they were very similar in temperature to black. 5. The solar shower using a black container lasted 6 minutes and was a very comfortable showering temperature.

Summary Statement

Color has a strong effect on the amount of solar water heating, which can be used to lower household energy use.

Help Received

Parents helped purchase suppplies, drill parts and use long arm cutter for poster

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Shona M. Brown

Project Number
J1704

Project Title
Shake It Up

Abstract

Objectives/Goals
The project is to find if a speaker's performance is dependent on its size.Two speakers were built and a decibel meter was used to measure the sound level of various tones.The hypothesis is, "reducing the speaker enclosure size will cause the sound level of some frequencies to be louder."The Chladni Plate experiment is replicated to visualize the patterns generated by the signals applied.

Methods/Materials
Speaker Materials: 10"and 4"speakers, plywood, Decibel meter, tone generator.

Procedures:A 10" speaker was built with enclosures ranging from 100-500mm. A decibel meter placed 1m in front of the speaker measured the magnitude of frequency tones from 500-15,000 Hz.This procedure was repeated for a 4" speaker with enclosures ranging from 40-200mm.A multi-output jack was used to apply the tones simultaneously to both speakers and the combined sound level recorded.

Chladni Plate Experiment Materials: Metal plate,black sand,tone modified speaker

Procedures: A metal plate was attached to a 10" speaker so that it would vibrate when tones were applied.The speaker was placed flat,and black sand was poured on the plate.Tones ranging from 10-573Hz were applied and the patterns recorded.

Results
This project partly supported the hypothesis.I found that reducing the speaker size does improve the response but once the enclosure reached a certain size the response got worse. I also found that each had a resonance frequency.The Chladni Plate experiment was replicated and patterns were clearly shown when signals were applied.

Conclusions/Discussion
The best enclosure is not the smallest or the largest.The best was 200mm for the 10", 80mm for the 4".Each also had a resonance frequency of 600Hz.The Chladni experiment showed that the patterns produced are more complex for higher frequencies.

Summary Statement
"Shake It Up" is an experiment to determine how the size of a speaker enclosure effects its loudness, and the Chladni Plate Experiment is to visualize patterns of complex sound waves.

Help Received
Mrs. Janet Herreweyers,my 8th grade Science teacher, and Mr. Stephen Brown, my father and an engineer at Qualcomm.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Isabella J. Catanzaro

Project Number
J1705

Project Title
Measuring the Spectral Reflectance of Food as It Cooks

Abstract

Objectives/Goals
We can all see that some foods change color when they cook. I wanted to understand what aspect of reflectivity changes in food as it cooks. The human eye has difficulty quantifying color because it sees in only blue, green, and red. A spectrometer is an instrument that quantifies light emission as a function of wavelength. My hypothesis is that a spectrometer can be used to detect changes in the spectrum of light reflected from food as it cooks.

Methods/Materials
I used a black and white camera combined with a diffraction grating, a slit, and three lenses to create a spectrometer to observe the spectral reflectance of various foods at different times during the cooking process. The diffraction grating split the monochromatic light into separate wavelengths and produced an image of the spectrum on the camera sensor. I was able to convert these images from the camera into graphs of relative reflectivity as a function of wavelength. I calibrated my spectrometer by using a fluorescent light source.

Results
Using the spectrometer I built, I measured the brightness of the reflected light of raw and cooked food. I normalized much of my data in order to compare the relevant portions of the spectrum. When the broccoli was boiled, most of the nutrients were destroyed in the heat and the boiled broccoli lost color at 500nm-650nm. The steamed broccoli reflected less 450nm-650nm than the raw broccoli. After it was cooked, the beef#s spectral reflectance increased at 500nm-600nm (green). The shrimp#s spectral reflectance changed at 600nm-700nm (red). But the blue (400nm-500nm) and green (500nm-600nm) stayed relatively the same.

Conclusions/Discussion
My hypothesis was correct. By using the signature of the spectrum of raw and cooked food, I was able to detect the change in reflectance of broccoli, beef, and shrimp at various points during the cooking process.

Summary Statement
I determined I could detect the change in raw and cooked food by measuring the spectral reflectance by using a spectrometer.

Help Received
I borrowed a camera and lenses from CFE Services

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Justin S. Delgado

Project Number

J1706

Project Title

Flying High: How Ambient Temperature Affects the Buoyancy of Helium Filled Latex Balloons

Abstract

Objectives/Goals

The objective of my project was to determine how different ambient temperatures would affect the buoyancy and rate of lift decay of helium-filled balloons.

Methods/Materials

The initial buoyancy of six helium-filled latex balloons was measured using a gram scale. Six balloons were placed in three different temperature zones, two balloons in each zone at 10 degrees Celsius, 24 degrees Celsius, and 38 degrees Celsius. The buoyancy of the balloons was measured every hour for nine hours and the rate of lift decay was logged on a chart.

Results

The balloons in the coldest temperature zone maintained the highest buoyancy for the longest period of time. The balloons in the hottest temperature zone lost buoyancy the quickest.

Conclusions/Discussion

Helium-filled latex balloons float because the helium inside the balloons is less dense and therefore lighter than the air around it. Since the weight of the displaced air is greater than the weight of the balloon (along with the helium inside it and the attached ribbon) the balloon floats upward. Latex balloons have a permeable membrane, which means that there are small holes in the surface that allow atoms of helium to escape. As more helium atoms escape, buoyancy decreases, resulting in lift decay. The balloons in the hottest temperature zone lost buoyancy quickest. It could be concluded that the higher temperature caused the helium atoms and particles in the latex to vibrate faster, putting pressure on and expanding the latex, and increasing the area of the holes in the permeable membrane, allowing more helium atoms to escape. This resulted in rapid lift decay. In the coldest temperature, the opposite was true; the particles vibrated at a slower rate, the area of the holes in the permeable membrane decreased, and buoyancy was maintained.

Summary Statement

My project tests the effects of ambient temperatures on the buoyancy and rate of lift decay of helium-filled latex balloons.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Sean F. Duarte

Project Number

J1707

Project Title

Refraction and the Speed of Light

Abstract

Objectives/Goals

The purpose of my project is to find out how fast light travels through different mediums.

Methods/Materials

Materials

5 Sheets of Paper; Pen; Ruler; Printer; Printable Radian Protractors; Scientific Calculator; Laser Pointer; 5 Square Plastic Containers; 200mL of Distilled Water ;200mL of Cooking Oil; 200mL of Dish Soap; 200mL of Surface Cleaner.

Procedure

1. Print out five radian protractors.
2. Fill the plastic container with 200mL of the test medium.
3. Fold a printed protractor in half.
4. Put a test medium on the center of the protractor.
5. Using the pen, make a dot about 4 centimeters from the fold on the paper of the protractor.
6. Put the laser down, and aim it at the dot. Aim the laser so it goes over the dot and enters the test medium at the fold on the protractor.
7. Using the pen, mark where the laser enters and exits the test medium.
8. Using the protractor, measure the angle of incidence and the angle of angle of refraction.
9. Use Snell's law to calculate the speed of light in the air and in the test material.
10. Repeat steps 2-8 with the different test mediums.

Results

Test Medium	Density (g/ml)	Speed of Light in Medium (m/s)	Weight in Grams	Angle of Refraction
Control	0	287,422,723	0	0.85
Surface Cleaner	0.8230	304,410,967	164.6	0.92
Distilled Water	0.8535	308,964,122	170.7	0.94
Cooking Oil	0.8775	302,076,996	175.5	0.91
Dishwashing Liquid	0.9170	306,706,675	183.4	0.93

Conclusions/Discussion

Summary Statement

My project is about finding out how light speed is affected as it travels through fluids with different densities.

Help Received

My parents bought materials for the project.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
William P. Edwards

Project Number
J1708

Project Title
Archimedes' Golden Crown Principle: Could It Have Worked?

Abstract

Objectives/Goals
I tested to see if Archimedes could have used his golden crown principle to determine if King Heiro's crown was all gold or if the smith had substituted some silver in place of the gold. I hypothesized that I would be able to see a difference in the volume of the crown as more and more gold was replaced with silver.

Methods/Materials
To test my hypothesis, I needed to find two surrogate metals with close to the same density ratio as gold and silver. I found titanium and aluminum has a similar density ratio. The largest known golden wreath crown in Archimedes' time was about 700 grams. This crown would have had a volume similar to a crown of 200 grams of titanium. Because of this, I made my baseline test crown with 200 grams of titanium. To test my hypothesis I decided to do test cases in five percent increments up to 50% of the titanium being replaced with aluminum. To create the five percent increments, I cut my titanium into ten, ten gram pieces and a single 100 gram piece and I cut my aluminum into ten, ten gram pieces. For my tests, I used an overflow vessel (a bucket with a single spout near the top) to measure volume of the crown. First I measured and recorded the volume of all of the titanium pieces (100% titanium case). Then I took out one ten gram titanium piece and replaced it with an aluminum piece. I continued to replace one titanium piece with one aluminum piece until I had all of my aluminum pieces and my 100 gram titanium piece in the overflow vessel. I repeated this until I had ten trials of each of my five percent increments.

Results
I took a median of my recorded volumes. Based off of this, I was able to see a difference in the volume of the crown with only 10% of titanium replaced with aluminum.

Conclusions/Discussion
My hypothesis was correct. As more aluminum was substituted for titanium there was a noticeable difference in the crown's volume.

Summary Statement
In my project, I tested to see if Archimedes could have used water displacement to determine if the king's golden crown had some gold replaced with silver.

Help Received
My dad helped me obtain and prepare my test samples. He also helped me layout my display board.

Name(s)

Zachary B. Follett

Project Number

J1709

Project Title

See the Light: A Study of Measuring Electromagnetic Wavelengths

Abstract

Objectives/Goals

The purpose of my project was to determine if common household supplies could be used in building an effective way to measure wavelengths of a spectrum.

Methods/Materials

For the first experiment a CD was attached to a wooden platform. The glasses were then filled with water, and 4 drops of food dye were dropped into each glass. The glasses were then aligned with an LED light and the CD, which showed a spectrum of colors and pictures were taken. For the second experiment a linear diffraction grating was used to separate the light shown through colored water contained in glass cuvettes. A software application analyzed all pictures.

Results

The results of my experiment supported my hypotheses that a spectrum could be accurately captured and measured using common household supplies.

Conclusions/Discussion

The information gained form this project can be used to show that science experiments can be done with common household objects and without spending a lot of money.

Summary Statement

To demonstrate that household materials can be used to perform effective scientific experiments.

Help Received

My dad helped buy supplies and set up software application.

Name(s)

Priya Goel; Ankita Vinod

Project Number

J1710

Project Title

Effect of Impurities on the Surface Tension of Water

Abstract

Objectives/Goals

This project examined the effect of nine different impurities on the Surface Tension of water. Based on our research, the hypothesis was that the surface tension of water would decrease when impurities are added.

Methods/Materials

A balance was constructed with a needle hanging on one end of the beam and a pan to hold weights on the other end. A small piece of modeling clay was put on the beam to balance the needle and the empty pan. Other materials used included plastic cups, thread and rice grains. Distilled white vinegar, salt, sugar, milk, buttermilk, lemon juice, olive oil, food coloring, and honey were used as impurities. One cup was filled with bottled water and the other cups were filled with half water and half impurity. For salt and sugar, a saturated solution was formed. The cup of liquid was placed under the needle, so that the needle rested horizontally just on the surface of the water. The weights (rice grains) were added on the pan at the other end of the balance. Rice grains were calibrated by weighing fifty numbers of rice grains on a postal scale. The experiment was repeated 3 times for each solution for accuracy. Surface tension was calculated using the equation F=2sd, where F is the force in newtons N that was used to detach the needle from the liquid surface, the factor 2 was used because the needle has 2 surfaces, s is the surface tension/unit length in Newtons/meter (N/m), and d is the length of the needle in units of meters (m) Force was calculated using equation f=mg, where m is total mass of rice grains used to detach the needle from the surface of the liquid, and g is the gravity constant whose value is 9.8 * 10^-3 N/gm. Formula f=2sd was rearranged to solve for s (s= 2d/f). Measured length of the needle in meters was 0.05m. Formula was solved to get the surface tension of that impurity in N/m. The calculated value of surface tension was multiplied by 1000 to convert into mN/m.

Results

Results showed that water with salt impurity had the highest surface tension 82 mN/m followed by water with sugar impurity. Bottled water ranked third at 69 mN/m. Water with olive oil impurity had the lowest surface tension at 32 mN/m.

Conclusions/Discussion

Conclusion was that our hypothesis was correct to a certain extent. In most cases, surface tension of water decreased when impurities were added, except for salt and sugar.

Summary Statement

Measure the changes in Surface Tension of Water on adding Impurities.

Help Received

Teacher and Parents

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Anshul Gupta

Project Number

J1711

Project Title

The Gauss Gun

Abstract

Objectives/Goals

A Gauss gun is a device that uses magnets to launch a ball from a stack of balls. My objective is to find if the material of the ball will affect its speed from the Gauss gun? I hypothesize that the more mass a ball had the faster it would go, but its ability to be magnetized would also affect the speed. I believed that the glass ball would go the fastest than metal, and plastic would go the slowest.

Methods/Materials

The experiment was set up with a grooved ramp slanted upward that finally would go straight up. At the bottom of the ramp, a Gauss gun was set up using magnets and balls. I found the initial velocity(v0) of the launched ball by measuring the height(h) it traveled, and using the equation, v0= sqrt(2gh), which comes from the equations of motion for the ball moving upward against gravity(g). I had three experiments, the first two being the ones that define the control variables for the third and final experiment. The first experiment was done to find out how many metal balls behind the magnet gives the highest speed. For the second experiment, I moved the plastic and glass balls in different positions. In the third experiment I launched metal, glass, and plastic balls from the last position to see which one went the fastest. In total I had 90 trials, 35 in the first, 40 in the second, and 15 in the third.

Results

From first experiment I learned that three balls behind the magnet delivered the highest speed. Hence, for remaining experiments I used three metal balls behind the magnet. In the second experiment, I discovered that if the plastic or glass ball is the farthest from the magnet, it gives the highest velocity. In the third and final experiment, the metal ball went at the slowest speed at 137.65 cm/s, then the plastic at 216.22 cm/s, and the glass, which was the fastest, at 225.62 cm/s.

Conclusions/Discussion

I conclude that the glass ball goes the fastest, followed by the plastic ball, then the metal ball as the slowest. This is partially true with my hypothesis, which said that the glass would go the fastest, followed by metal, and plastic as the slowest. This project helps to find appropriate materials for high speed projectiles, which could be used to launch things into space.

Summary Statement

Choice of projectile (ball) material from a Gauss gun (a magnetic accelerator) for the fastest speed.

Help Received

Parents helped in setup and organization.

Name(s)
Neil T. Hoffmann

Project Number
J1712

Project Title

The Tarzan Problem: What Is the Best Angle to Jump Off a Swinging Object to Maximize Distance?

Abstract

Objectives/Goals

The purpose of my experiment was to find a solution to the Tarzan problem: what is the best angle that Tarzan should jump off the vine to go the maximum distance.

Methods/Materials

I built a swing that uses an electromagnet to hold a metal ball at the end of a rod. The rod was pulled back to 97 degrees and released, breaking a breakwire which cut the power to the electromagnet so the ball went flying. I did 5 trials each for five different release angles: 0 degrees, 15 degrees, 30 degrees, 45 degrees, and 60 degrees. I put sand on a tarp so I could measure how far the ball went. To compare the experimental results to theoretical results, I figured out the equations for velocity, time in the air, and distance, and then plugged all the equations into Excel. With the equations, I varied swing length, height off ground, and pull back angle to see if the results changed.

Results

Based on my measured data for my swing, the best angle to release at is about 37 degrees, but the best calculated angle for my swing is 40-41 degrees. By plugging in different numbers into my equations in Excel I learned there was no one right answer. When you increase the pullback angle, it increases the best angle. When you increase the height off the ground, it decreases the best angle. When you increase the length of the swing, it increases the best angle.

Conclusions/Discussion

The best angle to jump off of a swinging object depends on how long it is, how high it is off the ground, and the angle you start at. The variable that changed the best angle the most was the pullback angle. The maximum best angle I calculated was 43 degrees.

This is a true STEM project: Science (potential and kinetic energy, equations of motion), Technology (electromagnets and circuits), Engineering (swing construction), and Mathematics (trigonometry and quadratic equation).

Summary Statement

What is the best angle to jump off a swinging object to maximize your distance.

Help Received

Dad supervised swing construction and mom answered questions during scientific research.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Kate E. Jackson

Project Number
J1713

Project Title
Demonstrating Doppler: Determining the Speed of an Object with Sound

Abstract

Objectives/Goals
I want to find out if the Doppler Effect can be used to measure the speed of a toy car with a buzzer mounted on top. I found in my research that Doppler's formula relates the change in pitch to speed. I expect that when the car is moving towards the microphone the pitch of the buzzer will sound higher. I also expect that the pitch of the buzzer will sound lower when the car is moving away from the microphone. My project is to show that I can use Doppler's formula to accurately measure the speed of the toy car.

Methods/Materials
I set up an experiment using a loud buzzer mounted on top of a toy car. I slid the car down a sloped track so the car could gain momentum and have speed. I used a microphone and oscilloscope to measure the wavelength and frequency of the buzzer sound emitted by the car standing still. I then repeated the sound measurement with the car moving at top speed past a trigger at the base of the hill. I used Doppler's formula to calculate the speed of the moving car from my still and moving frequency measurements. I needed some way to find the true speed of the car to compare with my Doppler measurements. I purchased a photogate sensor, which measures the time it takes the car to pass through a gate and converts that time to speed. I measured the car using Doppler and the photogate at three different speeds moving forward and backwards relative to the microphone. For each of these six tests, I repeated the measurement five times for a total of 30 measurements in all.

Results
My results showed a clear increase in pitch with the car moving towards the microphone and a decrease in pitch with it moving away. All of my Doppler results matched the photogate speed with less than ten percent error. The average error in the forward direction was 1.2%. The average error in the reverse direction was -1.6%.

Conclusions/Discussion
My hypothesis was that I could accurately measure speed using the Doppler Effect. "Accurate" is a broad word. I think that my results are not exact, but an average error of less than 2% and a peak error of ten percent seem reasonably accurate. I conclude that my hypothesis was correct.

Summary Statement
I constructed an experimental setup and accurately measured the speed of a toy car with a buzzer mounted on top using the Doppler Effect.

Help Received
My father loaned me an oscilloscope and taught me how to use it. My father supervised and assisted me with the use of power tools during the construction of my experimental setup.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Nikhil Kalita

Project Number

J1714

Project Title

Volumetric 3-D Display

Abstract

Objectives/Goals

The objective of the experiment was to use an inexpensive mirror with an anisotropic holographic diffuser, rotating at 5 times a second by being mounted on a 300RPM motor synchronized with the projecting tablet, to display a non-flickering 3D image, viewable from 4 different angles without correcting for parallax and other visual artifacts.

Methods/Materials

The experiment involves using a system that consists of a spinning mirror, a tablet display, and a synchronized stepper motor. The tablet is made to display 20 image frames per second with interleaved blank frames, showing the object from 4 different angles 5 times a second, forming 4 different viewing angles. The mirror is placed at a 45 degree angle on a motor which spins synchronized relative to the images displayed by the tablet. As the mirror rotates and displays at 5 times per second , persistence of vision creates the illusion of an almost non-flickering object at the center of the mirror.

Results

The challenge was to synchronize the two key components, the tablet display and the mirror motor. The display frame rate as detected by a photosensor closely matched the expected frame rate of the composed video i.e. 200us between the start of each frame sequence. It required several attempts to adjust the stepper motor micro-stepping delay to 230us in order to get the motor speed to approximately match the targeted 200ms interval. A final step required making small changes (400us) to the motor speed on-the-fly to track the display frames. The resultant spinning mirror system was able to display stable views to viewers on 4 sides.

Conclusions/Discussion

This experiment proved to be surprisingly effective in exploring new ways of displaying images specially, in three-dimension. It was accomplished by using a regular off-the-shelf tablet with a synchronized rotating mirror. This exercise has demonstrated that with readily available consumer tablets and simple electronic components one can implement a volumetric display at a very low cost. Mass production and fine tuning of such a low-cost device will bring in a new age of displays. Viewers would be able to inspect, observe, and interact with an image in live space from any angle. Clearly these technologies can be deployed widely and at a low cost today instead of remaining in the realm of science-fiction.

Summary Statement

A low-cost 3D volumetric display that can be seen from four different angles around the apparatus creating the impression of observing an object in real space.

Help Received

My Dad helped wire the apparatus, gave pointers for key concepts.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Ashwin Kumar

Project Number

J1715

Project Title

The Relationship between a Projectile's Kinetic Energy and the Crater's Diameter

Abstract

Objectives/Goals

The objective of this project is to use household materials to calculate a relationship between any crater and its projectile energy. It can be applied to save human lives.

Methods/Materials

The materials used in this project were tennis balls, a sand basin, measuring tools, a pegboard-prong contraption, and a balance. The pegboard-prong contraption was formed from a 5 foot pegboard attached with screws to a wall. Double hook prongs were attached to it and a PVC pipe was wedged in between. A ball was dropped from either different heights or different masses and the diameter was recorded.

Results

Overall, when all the points were plotted from the tests, all of the constants were found. The height testing proved to have much more accurate results than the mass testing. Since the margins for the mass testing were very low, the differences were also low and hard to measure. But using the data the equation of D = 0.0325 + 0.0489E0.2589 was formed.

Conclusions/Discussion

The equation relating crater diameter to projectile energy is D = 0.0325 + 0.0489E0.2589. The results of the validation to the Meteor Crater in Arizona came out a little bit less than expected, possibly because of the underestimation of the effect of mass. This information can also be applied to real-life issues. In 2013, the Chelyabinsk Meteor was a fraction of a degree from hitting Earth, and if it did, it would have destroyed an area equivalent to the size of Manhattan in New York. It can also be used to derive what caused different craters on the moon, and it shows that the Alphonsus Crater had to be caused by a projectile traveling at 20 meters per second with a mass of 600 billion kilograms. This information can be used to evacuate people until technology to stop asteroids is produced, expanding upon the knowledge about asteroids.

Summary Statement

This project is designed to relate the dimensions of a projectile to the size of the crater formed.

Help Received

Dad helped with building pegboard, format data

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Magnus A. Lauer; Riley I. Mann

Project Number

J1716

Project Title

When Ions Flow: The Effects of Magnetic Fields on Electric Propulsion

Abstract

Objectives/Goals

The purpose of this science fair project was to test how different magnetic fields affect the shape and direction of a flow of charged ions. We believe that different magnets will affect the shape and direction of the thrust. This information could be used to help control ion thrusters in space.

Methods/Materials

We first made multiple ion thruster designs and high voltage systems before we came upon the one that worked the best. Various magnets were placed in the ion thruster's chamber. We ran smoke through the thruster to make the flow of ions more visible and took note on the direction and shape of the thrust.

Results

The magnets that had the greatest effect were the long rectangular magnets, and the large neodymium magnets. The rectangular magnet split the thrust in two and the large magnetic fields slowed the ions down.

Conclusions/Discussion

Magnets did change the shape of the ion flow. A future study might involve moving the magnet up and down in the thruster to test different angles. Another test might be using a wider range of magnets. Using the information we have collected from the test, future thrusters can use electromagnets to simulate the same magnetic fields. An electromagnetic iris can be used to pulse and control the thrust. This information could be used to make spacecraft more efficient and controlled.

Summary Statement

How do magnetic fields affect the flow of ions in an electric propulsion thruster?

Help Received

Michael Patterson, NASA Sr. Technician, Glenn Research Center, provided information and advice; Val Sabado gave advice and donated supplies; Jake Mann supervised and assisted with power tools; Camilla Mann and Undine Lauer did proofreading and some typing.

Name(s)

Molly Mancina; Maya Pruthi

Project Number

J1717

Project Title

How Do the Mass and Height of Dominoes and the Distance between Them Affect the Speed at Which They Fall?

Abstract

Objectives/Goals

Our objective was to determine how the mass and height of dominoes and the distance between them would affect the speed at which they fell.

Methods/Materials

We set-up 20 mini dominoes each spaced 1/5 of their height apart. Next, we knocked them over and recorded how long it took for them to fall with a stopwatch. We repeated these steps three times. We repeated this step spacing the dominoes 2/5 and 3/5 of their height apart. We continued this procedure by repeating all steps using regular and large sized dominoes. We are going to run this experiment using 3D printed dominoes to hopefully increase the accuracy of our results. Our materials included dominos, measuring tape with millimeters, iPhone Stopwatch, and a Leveler. We will also use a 3D printer.

Results

Three of our four graphs contain the speeds at which the dominoes fell when spaced different increments of their height apart. The mini dominoes fell, on average, at .36 seconds, when spaced apart 1/5 of their height, .46 seconds when spaced apart 2/5 of their height, and fell .92 seconds when spaced apart 3/5 of their height. The regular sized dominoes fell, on average, at .5 seconds, when spaced apart 1/5 of their height, .63 seconds when spaced apart 2/5 of their height, and .79 seconds when spaced apart 3/5 of their height. The large dominoes fell at approximately .6 seconds when spaced apart 1/5 of their height, .86 seconds when spaced apart 2/5 of their height, and 1.27 seconds when spaced apart 3/5 of their height. Our other graph shows the effect of the mass and height of the dominoes when the distances were kept constant.

Conclusions/Discussion

Our hypothesis that the closer together the dominoes are, the faster they will fall, appears to be correct. We think this because the closer dominoes are to each other the sooner each domino hits the next. Our hypothesis that the mass of the dominoes would not affect the speed appears to be incorrect. As a general trend, the more massive the dominoes were, the longer it took them to fall. We think this was the result because the more mass the dominoes had, with the same force applied, the less acceleration the dominoes had.

Summary Statement

Our project tests how the mass and height of dominoes and the distance between them affects the speed at which they fall.

Help Received

Our parents helped pay for the dominoes.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Eleanor M. Mason

Project Number

J1718

Project Title

Determining the Color of Light That Has the Most Visibility in Fog

Abstract

Objectives/Goals

My project was to determine the color of light that has the most visibility in fog. I believed that yellow light would have the most visibility in fog.

Methods/Materials

I tested my project by taking a light meter, a lemonade container filled with water, and a light, and putting the objects in a line. I turned on the light and measured the brightness with the light meter. I placed different colors of light filters in front of the light to change the color of the light beam. For fog, I placed drops of milk in the water that was in the lemonade bottle. I measured the brightness of different colors of light that passed through set amounts of milk fog.

Results

I found that red light lost the least percentage of the light through fog, but yellow was the brightest filtered light through fog.

Conclusions/Discussion

My conclusion is that red or yellow light would be the best color of light to use in a headlight when in fog.

Summary Statement

My project is about determining the color of light with the most visibility when in fog, and with that, reducing the risk of accidents in fog.

Help Received

My mom helped me with the testing and with some of the typing. My dad helped set up the experiment.

Name(s)

Kiel A. Messinger

Project Number

J1719

Project Title

How Does the Distribution of Weight Affect the Speed of a Toy Car on a Downhill Slope?

Abstract

Objectives/Goals

My goal was to determine how the placement of added weight on a non-motorized toy car would affect the speed of the car on a downhill slope.

Methods/Materials

Two types of toy cars, labeled G and A, were used for the experiment. Four of each type, labeled 1 to 4, were raced on a downhill 4-lane toy racetrack. Four control races were conducted for each type of car before weights were added, alternating lanes to make sure that no lane gave an advantage. The cars that were labeled 1 were the control cars, with no added weight, for the whole experiment. Identical 15 gram weights were taped to cars labeled 2 (weight in front), 3 (weight in middle) and 4 (weight in back). Thirty-six experiment races were done for each type of car (G and A), again alternating lanes with each race. Cars were scored based on what place they finished for each race.

Results

The cars with added weight in the middle (A3 and G3) had the highest average score, meaning they were the fastest overall. The cars with added weight in the front (A2 and G2) finished in second place. The control cars (A1 and G1) surprisingly finished third place overall. In last place were the cars with added weight in the back (A4 and G4).

Conclusions/Discussion

From my experiment, I disproved my hypothesis that the cars with the weight in front would be the fastest going down a hill. Instead, I discovered that the cars with the weight in middle were the fastest, possibly because of the perfect balance of weight on the car and less resistance on the wheels. The cars with the weight in front were the second best, faster than the control cars with no weight, likely because the center of gravity was in the front. However, the cars with the weight in back were the slowest, slower than the control cars, possibly because of the resistance caused by the weight on the back wheels, or by the effect of gravity pulling on the back of the car. Thus, the extra weight itself was not the key factor, but the placement of the weight made a difference. This experiment shows that there are many things that affect speed.

Summary Statement

My project proved that the location of added weight (to the front, middle or back of the car) had an impact on the speed of a toy car on a downhill slope.

Help Received

Mother and Father helped with proofreading. Mother helped with graph software. Mrs. Anthony (science teacher) provided guidance.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Grady P. Morrissey

Project Number

J1720

Project Title

How Does the Shape of a Telescope's Mirror Affect the Size of Image Produced?

Abstract

Objectives/Goals

This study determines how the Coefficient of Deformation of a telescope's mirror affects the size of image produced (Transverse Aberration). Coefficient of Deformation is a number that describes the shape of the mirror, and size of image produced (Transverse Aberration) is a measure of the sharpness of the image. For a reflecting telescope mirror, the goal is a parabola with a Coefficient of Deformation -1. My hypothesis was that at a Coefficient of Deformation -1 the size of image produced would be zero, meaning that once the mirror was parabolic, the best image quality would be achieved. Throughout this project, the mirror was polished using specific techniques in order to test different mirror shapes.

Methods/Materials

In order to test my hypothesis, I ground and polished a 6-inch telescope mirror. Once it was reflective, it was tested for performance with the Foucault test. Foucault testing is finding the shape of a mirror by measuring its Radius of Curvature in each part, or zone. The mirror was placed on the test stand with a screen to isolate four zones, which were each tested separately. The Foucault tester was positioned so that its light source illuminated the full mirror. By moving the knife-edge across the return image, the focus of each zone could be determined, and the position of the knife-edge would be recorded. Each zone's measurements were then compared to each other. Using this information, the polishing stroke would be adjusted to correct the shape of the mirror. Each set of measurements, followed by corrective polishing, constituted one data point.

Results

At a Coefficient of Deformation -1, the size of image produced was 0.0145 mm, not zero as predicted.

Conclusions/Discussion

The results show that Coefficient of Deformation is an incomplete way of describing the shape of the mirror because it does not take into account surface defects. The shape of the mirror within each zone is also a large factor in the resulting size of image produced (Transverse Aberration).

Summary Statement

I built a telescope and investigated the image-forming properties of its mirror during fabrication.

Help Received

Mom documented the entire process (photos and videos), and Dad helped with the use of power tools and provided support through the mirror figuring process.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Jacob J. Pace

Project Number
J1721

Project Title
Up, Up, and Away?

Abstract

Objectives/Goals
The objective of my project is to explore how temperature affects the lifting ability of a helium balloon. My hypothesis is that when the helium inside the balloon is warmer relative to the surrounding air it will lift more.

Methods/Materials
Materials used: Three inflated Mylar helium balloons of the same shape and size, a #payload# of paperclips attached to each balloon with 24# of curling ribbon, thermometers, a stopwatch, and 5 different temperature environments. The number of paperclips each balloon could lift was recorded after 5 minutes at #room temperature,# as each balloon was taken into environments of 114F, 156F, 54F, 36F, and 6F, and again after 5 minutes in the new environment. Data was also collected as each balloon was taken back into #room temperature# and again after 5 minutes at room temperature.

Results
When a helium balloon is taken from a cooler temperature to a warmer temperature, it immediately lowers its payload to the ground. When a helium balloon is taken from a warmer temperature to a cooler environment, it is able to lift an increased payload of 1-2 paperclips.

Conclusions/Discussion
I was #buoyed# up after seeing that my data supported my hypothesis. The ability of a helium balloon to lift its payload increased when the helium temperature was warmer relative to the ambient air.

Summary Statement
The goal of this project is to discover the effects of temperature on the ability of a helium balloon to lift a #payload.#

Help Received
My father and mother helped type the project and transport materials to experimentation sites. Access to school kitchen#s walk-in refrigerator and freezer was granted by Carolina Amiott and her supervisor. George Brown permitted use of the sauna and steam rooms at the local GB3 Gym.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Conor T. Padmanabhan

Project Number
J1722

Project Title
The Effect of Temperature and Frequency on Sound Transmission

Abstract

Objectives/Goals
My objective was to determine if sound transmission is affected by temperature and frequency. I hypothesized that sound transmission is affected by temperature and frequency. I thought that colder temperatures would transmit sound better than warm temperatures. Sound requires air to travel, and cold air is denser than warm air. This means that there are more air molecules compacted into cold air than warm air. Also, I thought that sound transmission vs. frequency would differ depending on frequency, as the density of air would affect which frequencies transmitted well and poorly.

Methods/Materials
Using plexiglass, I built a box 121.92 cm x 60.96 cm x 60.96 cm. Inside the box, I placed two mini electric fans to mix the air, two thermocouples, and two heat lamps that I used to alter the temperature. Outside the box, I had a digital thermometer, which connected to the thermocouples and showed the temperature at two different places inside the box. Also, on my Apple computer, I used the application FuzzMeasure to produce sound from 80 Hertz to 10,000 Hertz. Finally, to project the sound into the box, I used a Bose speaker at one end of the box. To record the sounds made by FuzzMeasure, I used a Yeti Microphone at the other end of the box.
I heated up the air in the box to 21 degrees Celsius using the heat lamps and the fans to make sure the temperature was even. Then, I used FuzzMeasure to run a sweep of sound frequencies from 80 Hertz to 10,000 Hertz and plot the data on a graph. I repeated this procedure at 27 degrees, 32 degrees, and 38 degrees Celsius.

Results
My results showed that air at lower temperatures transmitted sound better than air at higher temperatures. I also saw that at lower temperatures, there were clear frequencies where sound transmitted particularly well, whereas at higher temperatures, sound transmission varied much less with frequency.

Conclusions/Discussion
I concluded that temperature and frequency do affect sound transmission. The air at lower temperatures transmitted sound better than the air at higher temperatures. Also, higher temperatures seemed to diminish the effect of changing frequency on sound transmission.

Summary Statement
The central focus of my project was to learn whether temperature and frequency affect sound transmission.

Help Received
My dad bought all the materials needed, helped me construct my box, and helped me drill holes in the plexiglass. My brother taught me how to use the FuzzMeasure software application, and my mom helped me proof my write-up and abstract.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Nicholas L. Pinto

Project Number

J1723

Project Title

Ion Propulsion Efficiency

Abstract

Objectives/Goals

To find the most fuel efficient combination of plate charge and plate distance in a gridded ion engine.

Methods/Materials

Materials: A computer old enough to run Java plugins, and an Ion engine simulator with manipulatable plate charge and plate distance variables (JPL).

My experiment has 2 Independent variables each of which has 90 and 100 possibilities, I staggered them in increments of five, this brought the possible combinations from 9,000 down to 360.

Procedure:

1.Simulate all combinations

2.Collect Impulse (Efficiency) data

3.Heat map results (Plate distance x) (Plate charge y)

Results

See data at my display board due to the space requirements

Conclusions/Discussion

Data Analysis and Conclusion

The data shows that 30 and 35 plate distance both share peak efficiency at charge 100 (173 impulse). This implies that better efficiency could be achieved at plate distances between those numbers, although I lean more towards 30, because the data shows higher efficiency at 30. Slow and steady wins the race. Plate distances 40 and 45 are beating the others at 50 to 65 plate charge, but shortly after, their efficiency declines. This only gets worse; as plate charge is increased the sharp decline at the higher charge region and the sharp increase at the lower charge region are more extreme. I think the peak efficiency possible is probably at 32, 100. The fact that the peak is at 100 plate charge implies that if more charge were possible higher impulses could be reached.

Summary Statement

This project is about increasing efficiency in a relatively new propulsion technology, ion propulsion, in order to make space travel less expensive and more accessible.

Help Received

n/a

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Drew L. Quishenberry

Project Number

J1724

Project Title

The Visualization of Sound

Abstract

Objectives/Goals

This experiment explored the visualization of sound. To investigate what sound looks like with limited resources, it was necessary to apply sound waves themselves to different materials. To do this, I constructed two instruments, a Ruben#s tube and a tonoscope.

Methods/Materials

These were made out of various plastics, rubbers and metals. The tonoscope uses its long PVC canal to direct the voices sound waves up towards a flexible membrane. This membrane is covered in salt and as the sound vibrates the membrane the salt #jumps# across it. As one sings into this instrument, you will inevitably come across one of this membranes natural frequencies. This phenomenon creates intricate patterns made visible by the salt. The Ruben#s tube uses its hollow body to hold gas. This gas is used to fuel tiny flames.

Results

These flames themselves are the points that visualize the sound. The fire responds to points of compression and rarefaction that are caused by sound waves. When different frequencies are played into the tube, a standing wave may appear which causes these small flames to form into peaks and troughs. The recurring theme of this experiment was as the frequency played into either instrument increased, the results became smaller or more intricate in a way. The tonoscopes patterns became more intricate yet less precise. The standing waves on the Ruben#s tube became shorter and more compact.

Conclusions/Discussion

This experiment proved that the lower a pitch, the more space between the points of compression and rarefaction and the fewer vibrations per second.

Summary Statement

My project is about using instruments to visualize sound waves.

Help Received

Dad helped build instruments, teacher supervised report writing, parent supervision when using hazardous materials.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Jasmine N. Ramirez

Project Number

J1725

Project Title

The Spacing Need for Domino Speed

Abstract

Objectives/Goals

The objective of my project is to determine how distance between falling dominoes affects the speed of their fall.

Methods/Materials

I used domino tiles, a measuring tape, a ruler, a stopwatch, and a piece of lumber to test my hypothesis. I measured the time it took domino tiles to fall down at six different spacing distances.

Results

The findings for the relationship of spacing and speed were mixed. When the spacing between dominoes was increased, the falling speed of the tiles decreased during three trials. But, the speed also increased during two of the trials.

Conclusions/Discussion

My conclusion is that if I want to understand the best spacing for a falling domino to have the greatest effect on the next tile in a row of dominoes, I need to take a closer look at how "force" (an action that changes or maintains the motion of an object) can be measured.

Summary Statement

My project is about domino distance and speed.

Help Received

My father helped me to line up the dominoes and measure the time the dominoes fell. My mother helped me to understand how I could show my data in the form of a table or chart.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Vineet A. Ranade

Project Number

J1726

Project Title

The Sweet Spot

Abstract

Objectives/Goals

My project involves understanding how the impact point on a swinging wooden cylinder affects the force with which it hits a stationary object like a marble. I hypothesized that the force with which the cylinder hits the marble will increase linearly as the impact point distance increases.

Methods/Materials

To limit the number of factors that affect the outcome of my experiment, I designed and built a custom rig. The rig allowed me to change the impact point on the cylinder in steps. The independent variable is the impact point distance, which is the distance from the hanging end of the cylinder to the impact point. To limit the distance the marble travels after impact, I incorporated an incline plane while designing the rig. The dependent variable is the distance the marble travels on the incline plane after impact. Also, for each trial, I pointed a high speed camera at the expected region on the incline plane. Each time I released the cylinder, I started the high speed camera. Then I reviewed the pictures and chose the one where the marble was least blurred since it indicated the farthest point the marble reached. Next I took a visual estimate of where the leading edge of the marble aligned with a specific millimeter marking on the ruler already placed on the incline plane.

Results

From my experiment, I realized that for smaller impact point distances, the distance the marble travelled grew at a steady rate. However for larger impact point distances, the distance the marble travelled started to grow at a slower rate. In fact, for impact point distances closer to the length of the cylinder, the distance the marble travelled started to decrease. I realized that the marble travelled the farthest when it was hit at the #sweet spot# on the cylinder.

Conclusions/Discussion

Through my experiment, I found out that my hypothesis was incorrect. My analysis showed that if the impact point is above the sweet spot, the cylinder rotates clockwise after impact. If the impact point is below the sweet spot, the cylinder rotates anti-clockwise. If the impact point is on the sweet spot, the cylinder does not rotate at all right after impact. This is because maximum impact energy is transferred from the cylinder to the marble, and the marble travels the farthest. The most important factor that determines the distance the marble travels is the total momentum of the cylinder above and below the impact point.

Summary Statement

My project involves understanding how the impact point on a swinging wooden cylinder affects the force with which it hits a stationary object like a marble.

Help Received

I would like to thank my dad for helping me design and build the test rig to conduct my experiment.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Sarah C. Schmidtler

Project Number
J1727

Project Title
Measuring the Earth's Acceleration Constant and Mass

Abstract

Objectives/Goals
My objective was to measure the acceleration constant and mass of the earth to within 10% accuracy using a non-automated system.

Methods/Materials
I manually timed how long it took for an object to drop, and I manually timed the oscillation of a pendulum. I repeated the drop time experiment 60 times, and then pendulum period experiment 60 times. Then I timing 600 oscillations of the pendulum and divided my results by ten. I estimated the error of my combined results by randomly sampling g-values according to the mean of the individual experiments.

Results
The results I measured were within 3.4% accuracy.

Conclusions/Discussion
I have concluded that it is possible to measure the earth#s acceleration constant and mass within 10%. The data also showed that without an automated system it is much more accurate to measure the acceleration constant of the earth by timing the oscillation of a pendulum rather than by timing the drop of a ball. This was because I was able to reduce the systematic error by counting 10 oscillations in one measurement and dividing the total time of those oscillations by 10. This reduced the systematic error that corresponded with my human reaction time. In the Pendulum Experiment, I only had to react to visual stimuli. Research shows that humans react faster to visual stimuli and this played a factor in my experiment every time I started and stopped the stopwatch.

Summary Statement
This project measured the earth's acceleration and mass to within 3.4% accuracy with a non-automated system.

Help Received
Dad- helped me understand the math and show me how to program my results; Mom-invited the neighbors over to listen to my presentation and ask me questions; Eva- helped me retrieve the ball

Name(s)

Zachary T. Smay

Project Number

J1728

Project Title

Roller Coaster: From What Height Must One Release a Ball in Order for It to Complete a Loop?

Abstract

Objectives/Goals

The purpose of this project was to see from what height a ball must be released in order for it to complete a loop without falling. After carefully considering gravitational potential energy, translational kinetic energy, the moment of inertia of a sphere, angular velocity, rotational kinetic energy, conservation of energy, and centripetal force, it was hypothesized that the ball should be dropped from 10 cm higher (to account for friction) than the height of the loop plus 7/10 of the radius of the loop (or h of release = h of loop + (7/10)r + 10cm).

Methods/Materials

After the balls were massed, a cut PEX pipe (like PVC pipe, but more flexible) was screwed down to two, 2x4 pieces of wood that were connected together by a door hinge. The PEX pipe was sanded down to make a smooth and even track. A frame was built, a loop was formed from the PEX pipe, and this loop was attached to the framing. After measuring the diameter of the loop, the drop height was measured to determine from how high to drop the marbles in order to complete the loop without falling out. This was done multiple times and the results averaged.

Results

Although the hypothesis was incorrect (if 20 cm were added instead of 10 cm to account for friction, then it would have been accurate), the project was considered a success because for the most part, the masses of the balls did not matter (which matched the calculations).

Conclusions/Discussion

Even with the elimination of vibrational energy by attaching the track to the 2x4s, and the attempt to take out friction by having the ball ride on the edge of the PEX pipe (and by sanding down the pipe), the friction had more of an effect than originally thought. But it was shown that the masses of the balls did not matter in the drop height, as was calculated in the hypothesis (the masses canceled out). It just turns out that friction was too hard to overcome.

Summary Statement

The purpose of this project was to see from what height a ball must be released in order for it to complete a loop without falling.

Help Received

Father and neighbor cut the PEX pipe with a table saw (I simply fed it through, while they operated the blade)

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Evan G. Vail

Project Number

J1729

Project Title

The Groovy Gratings Experiment: Using Diffraction Patterns to Measure Data Track Spacing on CDs and DVDs

Abstract

Objectives/Goals

The objective of this project was to accurately choose and derive the correct diffraction grating equation (there are many forms) and to analyze the laser diffraction patterns from CDs and DVDs to prove that DVDs have smaller data track spacing than CDs.

Methods/Materials

The materials used in this project were a laser, CD, DVD, laboratory clamp, measuring tape, pencil, copper pipe, machinists vice, and a wall. I inserted the pipe inside the vice, and fastened the laboratory clamp onto the pipe. I placed the laser inside the clamp, placed each disc up against the wall, and turned the laser on. I used the machinist vice to position the laser aperture so that all beams grazed the wall for easier viewing and measurement. I measured the rise and run of all beams and calculated their angles. To create multiple trials, I varied the incident beam angle to see if the grating equation would hold true.

Results

Before performing the experiment, I derived the correct diffraction grating equation to prove that it worked for CD and DVD diffraction. I proved my hypothesis true because DVDs had an average data track spacing of 737nm, compared to a 1548nm average for the CD. It was impossible to find the track spacing of a blu-ray disc as only beam reflection occurred.

Conclusions/Discussion

My work showed that DVDs have about half the data track spacing of CDs. This shows that as the gaps between the individual data tracks became smaller, the angle of the diffracted beam became bigger, as the increased differences in the sines of the incident and diffracted beams served as the denominator, but the numerator remained constant. I also found that the DVDs had less diffracted beams than the CDs because the increased number of data track spaces in the DVD created more wave propagation, leading less constructive interference. This is consistent with the grating equation, showing lower diffracted wave orders (m) as spacing (d) decreases. The blu-ray disc showed only specular reflection. My research shows that blu-ray discs have a track spacing of 320nm, which may be why light waves from my 650nm laser were not diffracted. Most blu-ray players use 405nm violet lasers to obtain diffraction.

Summary Statement

I derived the best diffraction equation, shined a laser at the surface of a CD and DVD, measured the angles of the diffracted beams from each disc, and used my equation to prove that DVDs have smaller data track spacing than CDs.

Help Received

My father helped me to understand the concepts of a mathematical proof and trigonometry; friend and scientist Mr. Bob Stiffler provided research materials.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Luke J. Campos

Project Number

J1799

Project Title

How Do Underinflated Tires Affect the Difficulty of Riding a Bike?

Abstract

Objectives/Goals

My objective is to use a Newtons spring scale to measure how tire pressure affects the force required to pull a bike in a straight line.

Methods/Materials

This science project requires a bike, a volunteer with a bike and steer in a straight line, a Newtons spring scale to measure force, and a person to pull bike in a straight line, 3 large zip tires to attach the Newtons spring scale to bike and a graph to map results. My method consisted of testing the bike being pulled at 40,30,20, and 10 psi.

Results

My results showed that the lower the tire pressure the more force needed to pull the bike in a straight line. The higher the tire pressure the less force needed to pull the bike in a straight line.

Conclusions/Discussion

My hypothesis was correct. The tire pressure does make difference in the amount of force needed to pull a bike in a straight line.

Summary Statement

Tire pressure will affect the degree of difficulty in riding a bike.

Help Received

Uncle taught me about the importance of psi. My family participated in experiment.