CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Connor Ashton

Project Number

J1701

Project Title

Good Vibrations: The Effect of Sympathetic Vibrations on a Bass Guitar

Abstract

Objectives

I wanted to explore the impact of sympathetic vibration or resonance on a bass guitar. My hypothesis was that the A note would cause the most sympathetic vibration.

Methods

The procedure is to tune the bass guitar to standard tuning, and set the guitar and amplifier settings to mid-levels. Use the NIOSH sound app on an iPhone to measure the background noise, then play the note, wait 2 seconds, dampen the note and record the played note and resonant note sound levels. Repeat for all 5 notes, and then 20 times for 100 valid readings.

Results

The experimental result proved my hypothesis that the A note on the bass guitar would cause the largest sympathetic vibration measured by the smallest percent drop in sound level at 89.9%. Although the A note had the most sympathetic vibration, the E and D notes were very close at 88.8% and 88.1% respectively. The G note and the B note had the highest percent drop in sound level with the G at 82.8% and the B at 81.6%.

Conclusions

The science in general supports the experimental results. There are four characteristics that impact the amount of sympathetic vibration or resonance: the matching frequency at any harmonic between the string played and another string, the harmonic number on the string played and the harmonic number on the sympathetic string, and the distance between the played and sympathetic strings. The A and E notes have the most matching harmonic frequencies at the 3rd, 4th, 6th, and 8th harmonics, and the D note is close behind with 3 matching (3,4,8). Based purely on science, the A and E notes would have the most sympathetic vibration, closely followed by the D string, while the G and B strings would have the least. This project demonstrates the importance of resonance and how it should be accounted for in every day life. There are positive impacts such as in the medical field using MRIs, and negative when resonance causes bridges or rockets to fail.

Summary Statement

The project is about testing the effect of sympathetic vibrations on a bass guitar and determining which note causes the most sympathetic vibrations.

Help Received

My bass guitar teacher, Fernando Montoya, brainstormed some initial ideas for the project.

Name(s)

Dominique Bhatti

Project Number

J1702

Project Title

Studying the Dynamics of Granular Materials

Abstract

Objectives

The objective of this project is to study the dynamic properties of granular solids by measuring angle of repose, packing density, and size separation.

Methods

3 different granular materials, flat board, tall cylindrical container, silicone mat, marbles, ruler, measuring cup, timer, erasable marker. Angle of Repose: place a pile of granular material on the mat on a board. Elevate until it starts to avalanche. Record height and calculate the angle of repose. Vibrating Size Separation: Combine 2 materials together in 1:1, 2:1 and 1:2 ratios and pour into the cylindrical container. Vibrate the container until the 2 materials separate and record elapsed time. Packing Density: Pour 1 cup of material into tall cylinder. Use erasable marker to mark its height. Vibrate at consistent pace. At 30 second intervals, examine how much the material compresses below the mark.

Results

For the angle of repose test, 5 trials were run for each material. Salt had the lowest angle at 15 degrees while the others measured about 25 degrees. For the Vibration Size Separation Part A, equal parts of materials were tested. All combinations had similar separation times of about 20 sec. For Part B, ratios of 2:1 and 1:2 were tested. 1:2(small:large) was 10-12 sec faster than 2:1. For Part C, all materials were tested with marbles.The marbles always surfaced, even in lighter materials. For the packing density test, the settling process was measured. The rice compressed the most, increasing density 20 percent.

Conclusions

5 different experiments were used to explore the dynamic properties of granular materials: vibrating size separation(3 parts), angle of repose and packing density. In the angle of repose test, salt had the finest grains that slid off themselves easier, thus having a lowest angle of repose. Vibration test Part A showed that no matter what 2 materials were tested, they separated in the same amount of time. Vibration Part B found that when there is less of the smaller material, the other material rises faster. Vibration Part C surprisingly revealed that size separation is independent of weight and buoyancy. The packing density test showed that rice increased in density the most because of its large, initial air pockets. These properties are applicable to mining, agriculture, and astrophysics.

Summary Statement

After conducting 5 different experiments, I found that granular solids have many surprising and dynamic properties.

Help Received

None. I designed and performed the experiments myself.

Name(s)

Reuben Broudy

Project Number

J1703

Project Title

Modelling Minimum Voltage to Acoustically Levitate Non-spherical Objects at Near-wavelength Dimensions

Abstract

Objectives

The objective of this study is to understand the relation between the geometry of an object and the amount of voltage needed to acoustically levitate the object.

Methods

I built an acoustic levitator and put different shapes inside of it. The shapes tested included triangular, square, hexagonal and circular prisms. Using a Buck DC converter, I was able to decrease the voltage and record when the shape fell out of the acoustic levitator. I called this voltage, the drop voltage. I then analyzed the relationship between drop voltage and the size of a shape (small, medium and large), and also the geometry of a shape (triangle, square, hexagon, circle). For each set of shapes, I had three replicates and measured the drop voltage five times. I used this datat to calculate average drop voltages and standard deviations. I then drew an exponential curve through the data to create an equation that represents the relationship between drop voltage and geometry (i.e, number of sides) of an object for non-spherical near-wavelength objects.

Results

The results showed that all small and medium objects had similar drop voltages. However, in the large set of objects, the results showed a difference--the large circle shape had a drop voltage of 6.45V, compared to 7.62V for the triangle and 7.46V for square.

These results were not surprising because Gorkov s law says if an object is much smaller than the wavelength, size doesn t matter, only its density. But for the objects near the dimensions of the wavelength, Gorkov s law doesn t apply, and I hypothesized there could be a difference in drop voltage between shapes of different geometries.

Further testing of the large set of shapes was performed in a more controlled environment. In this testing, the circle shape once again had the lowest drop voltage (5.66V) compared to hexagon (6.28V), square (6.61V) and triangle (7.6V). Standard deviations were calculated, and the differences in the voltages had a high level of confidence.

Finally, I was able to fit a curve to the data, having the equation: $y = 7.54(1.6)^{(-x)} + 5.6625$ (y=drop voltage, and x=# of sides on an object). The curve fit the data well with an $R^2 = 0.95$.

Summary Statement

My project modelled the relationship between the geometry of an object and the amount of force needed to levitate the object in an acoustic levitator.

Help Received

I built and programmed the acoustic levitator myself after studying how to do it on the internet. I performed all testing and analysis. My science advisor, Matt Bessler, helped ensure I completed my study on time. I interviewed Dr. Arezo Marzo Perez of University of Sao Paolo, Brazil, who helped clarify

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Holly Carter

Project Number

J1704

Project Title

Measuring Sound Speed with Acoustic Interferometry

Abstract

Objectives

The purpose of my experiment was to measure the speed of sound in gases through acoustic interferometry. Key objectives were to verify the expected temperature dependence of sound speed in air, measure the accuracy of interferometers of different lengths, and detect the change in the composition of a gas.

I used a cylindrical cavity with closed ends for my acoustic interferometer. When white noise is introduced into the cavity, resonant modes are excited. The resonant modes are those in which an integer number of half-wavelengths fit exactly within the tube. They are spaced equally in frequency, with the frequency spacing being directly proportional to the velocity.

Methods

I tested with three different tubes with lengths ranging from 0.3 m to 1.9 m. A speaker emitted white noise at one end of the tube and a microphone recorded sound at the other end. The temperature changes were monitored with a temperature logger. From each recording, I calculated a frequency spectrum and estimated the peak spacing, which yielded the sound speed.

Results

The sound speed of air increased from 333.3 to 341.1 m/sec between 280 and 291 K. My results were consistent with the expected thermodynamic behavior of an ideal gas and within 0.5% of accepted literature values. The three interferometers of different lengths yielded consistent sound speed measurements, with the longer interferometers having the best accuracy. To test if my interferometer could accurately measure the speed of sound in gases other than air, I tested with carbon dioxide. When carbon dioxide was injected into the interferometer, the sound speed decreased from 340 m/sec to 260 m/sec, close to the accepted value for carbon dioxide, and then gradually increased as air re-entered the tube.

Conclusions

In summary, I accurately measured the speed of sound in gases, including the temperature dependence, and detected the change in the composition of a gas. As an extension of my results, I would like to build an air quality monitor that could detect the presence of gaseous contaminants in air, such as carbon monoxide, by measuring the speed of sound. Because sound speed in air is sensitive to temperature, it is important to use a thermometer to compensate for thermal effects. For practical applications, I would make this device as small as possible, so I would investigate a more compact helical design.

Summary Statement

An acoustic interferometer was used to verify the expected temperature dependence of sound speed in air, measure the accuracy of interferometers of different lengths, and detect the change in the composition of a gas.

Help Received

I received advice finding spectral analysis tools from my father.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Malia Chheng

Project Number

J1705

Project Title

Induction Heating

Abstract

Objectives

The purpose of my project is to figure out and determine the efficiency rate of using a copper coil as a heating element. In a sense, induction heating versus modern day stove tops and hot plates. The reason I am doing this experiment is to verify and figure out if induction heating is more effective at being the greater originator of heat, thus possibly in the process of showing that maybe new technology can look as if it is better yet, in all actuality whether it be old or new methods are still methods.

Methods

I am using different heating producers such as, stovetops, hot plates, and induction heating copper coil, and I will be also using 1.4 grams of galvanized steel wire. I will be using these products to determine if older methods of heating will surpass the more modern day stovetops and hotplates and better help the future with improving engineering methods for new age stovetops. I am using stovetops, hot plates, copper coil, and galvanized steel wire because the most basic household items included in a house is the stovetop.

Results

The results of my investigation on the efficiency of induction heating, using copper coil as a heating element versus modern day uses of heating, such as stove tops and hot plates (the electric ones) indicate that when concerning induction heating, the induction heating method is a faster and more efficient way regarding metal and heat.

Conclusions

After concluding my experiment on the efficiency of induction heating versus modern day heat producers, stove tops and hot plates, I found that my hypothesis of induction heating benefiting the party interested in heating metal, or similar aspects more than cooking induction heating would win the induction heating vs. modern day heating elements. When comparing the amount of time to turn the galvanized metal red the average for using an induction copper coil heater, was 24 seconds. On the other hands the average for using a stovetop was 12 hours 24 minutes and 58 seconds, and the average for using a hot plate was 12 hours 44 minutes and 21 seconds.

Summary Statement

Induction heating was more efficient way of heating copper.

Help Received

Joseph Linares, Jewely Lickey

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Landon Collins

Project Number

J1706

Project Title

Beware: A Ghost Will Follow You Home

Abstract

Objectives

The objective of this study is to learn more about Pepper's ghost effect, a method of creating holographic images using light and reflections, and how it works. I then put these studied ideas into a physical model of Pepper's ghost effect.

Methods

I first researched my topic of Pepper's ghost effect on the internet via images and videos. After gathering enough information, I made a prototype model using cardboard, a sheet of plastic, two flashlights, hot glue, black paper, black felt, white gauze, and black pipe cleaners. After making a list of pros and cons, I studied these and attempted a better model. The second model used many of the same materials, but there was no black paper used and instead I used duct tape and white felt. I then gathered data by asking four of my peers what they thought about how well my project worked and also how much they enjoyed the overall product.

Results

My results from my prototype model were not as successful as my results from my final model. The experiment I conducted for both was a simple turning on of my flashlight and noting the results. When I would turn on the flashlight, this would reflect off of my ghost model which is hidden from the viewer to their right. It would then make an image in a plastic sheet directly in front of a viewer at a 45' angle. The prototype's results were as follows: The hologram did work, but was blurred and hard to make out. I believe this was a result of the box being too small and the ghost too large. I took these into consideration in making my final model, which I made larger with a smaller, lighter-weight ghost.

Conclusions

Repeated trials of observing my model revealed that, through recording weaknesses in the prototype, I was able to craft a more-succesful model of Pepper's ghost effect. After doing this project, I have learned more about Pepper's ghost and have ideas as to how it could be utilized in new ways. Pepper's ghost has been used to create concerts of deceased musicians, but I believe that it could be used to revolutionize movie projecting. Similar to how these Pepper's ghost concerts work, the movies could be made on the computer and projected into a glass panel. This would then make a 3D image of these people.

Summary Statement

I created a model of Pepper's ghost effect which is used on the ride The Haunted Mansion at Disneyland.

Help Received

I received help from my parents in corrections to writing and cutting objects with tools I could not use independently.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Jason Dong

Project Number

J1707

Project Title

The Speed of Sound in Varying Gas Conditions

Abstract

Objectives

The purpose of my experiment is to determine how the temperature, gas type, and pressure affect the speed of sound.

Methods

To isolate the air in which the test will take place, I used a vacuum chamber; to heat up the chamber, I used an external heat source such as the bottom of a refrigerator to add heat or exposed it to cold ventilation to reduce heat. To change the pressure, I used a vacuum pump (which came along the vacuum chamber) to create a partial vacuum, which effectively reduced the air pressure. To change the molar mass, I would create a half vacuum and replace the missing atmospheric air with a different kind of gas- either carbon dioxide or helium.

After I changed the gas conditions, I used my contraption built inside the vacuum chamber to measure sound based off of maximizing resonance to find the wavelength.

Results

My results show that the speed of sound is inversely affected by the molar mass due to sound taking less energy to propagate lighter matter, the speed of sound was proportional to the temperature due to the air containing more energy as the temperature rises, and that the speed of sound is proportional to the pressure as the smaller distances between particles allowed for faster propagation.

Conclusions

There have not been many studies on how the speed of sound is affected by molar mass nor pressure, though there are some to test its relation to temperature. This project confirms previous conclusions of the relation of the speed of sound to temperature (positive) and makes new conclusions of its relation to pressure (positive) and molar mass (negative).

I hypothesized that the speed of sound to pressure and temperature was positive and that its relation to molar mass was negative, and these hypotheses were proven correct.

Summary Statement

I created a relation of the speed of sound to different gas conditions, including temperature, pressure, and molar mass.

Help Received

I designed most of the model, the use of a pulley idea discussed and approved by my teacher. He gave me the idea of the experiment, the speed of sound, and I furthered it to be about the relations of it with gas conditions.

Name(s)

Grant Gallagher

Project Number

J1708

Project Title

Investigating the Electrostatic Effects of Striking a Tennis Ball with a Tennis Racquet

Abstract

Objectives

The objective of this study is to determine whether charge forms on a tennis racquet and a tennis ball as a result of the racquet hitting the ball.

Methods

1. Construct electrodes to collect charge from the strings of a racquet. 2. Build a circuit that outputs a voltage based on the amount of charge collected by the electrode that is deposited on a capacitor. (The circuit design was obtained from the internet.) 3. Hit a number of tennis balls. 4. Apply an electrode to the strings, collect charge on the capacitor, and measure the resultant voltage. 5. Calculate the charge from the equation Q = CV, where Q is charge, C is the capacitance of the capacitor, and V is the voltage. 6. Create charge distribution maps by moving a small electrode to different positions on the strings. 7. Using a ball-shaped electrode, measure the charge on the ball.

Results

Negative charge as high as about 175 nC was observed on the strings of the racquet. Charge distribution images that map the charge with respect to the location on the strings were produced. The charge distribution images show a distinct peak in charge, which generally appeared on a vertical axis through the center of the racquet, but above the center of the racquet head. The peak may correspond to the location where the ball impacts the strings based on estimates from video obtained while hitting. Positive charge as high as about 40 nC was detected on the ball.

Conclusions

Negative charge can be formed on the strings of a racquet while positive charge may be produced on the ball as a result of the racquet hitting the ball. Interestingly, no observations of charging can be found on the internet, nor does such charging appear to be commonly known among players. The existence of charge, however, is not surprising. The strings comprised polyester, and the surface of the ball comprised nylon. Polyester and nylon are materials that produce a triboelectric effect. Polyester is known to generate negative charge while nylon is positive charge producing. Charge distributions maps show that the charge on the strings is localized. This is not surprising as polyester is a dielectric, and thus, charge does not flow freely. Mapping the charge distribution on the racquet can be useful in determining where the ball contacts the strings. Such information may help direct the player to change their swing to contact the ball more toward the center of the racquet head to enable the player to more efficiently produce ball velocity while decreasing strain on their body, thus potentially reducing injuries to the player's arm, back, or shoulder.

Summary Statement

Charge has been measured on the strings of a racquet, and charge distribution maps show that this charge is concentrated at a location that may correspond to where the ball contacted the racquet.

Help Received

My father provided me direction as to different techniques for plotting in Mathematica, as well as assistance in assembling the circuit, namely, soldering the op amp chips to the bread board adapters.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Conor Gard

Project Number

J1709

Project Title

The Winning Position: How Changing the Center-of-Gravity in a Race Car Impacts Velocity

Abstract

Objectives

This project explored how changing the center-of-mass in a gravity powered model race car (pinewood derby car) affected its speed. My hypothesis was that the car would go faster the farther back the center of mass was in the car.

Methods

To test the hypothesis I modified a wooden track with a 25 degree incline, a 4 foot vertical drop, and overall length of 32 feet. The modifications included a computer controlled solenoid starting gate and a laser diode timing gate at the finish line. I designed and 3-D printed a car that had a longer wheelbase than a standard pinewood derby car but kept the overall length consistent at 7 inches. The center-of-mass could be changed to different locations using 50 gram weights that were held in place with a threaded screw. The longer wheelbase was to compensate for the weight which when positioned very far back in a standard car s wheelbase, causes the front of the car to wobble (and loose speed).

Results

The car was raced 10 times in each of the 5 center-of-mass locations to get an average speed and standard deviation. The results were graphed to show the center of mass in inches (as measured from the front of the car) versus finish time (mS). The graph shows the average finish time and the standard deviation. The fastest average finish time was 2538.6 +/- 5.2 mS when the center of mass was in the far back of the car. The slowest time was 2571.5 +/- 13.1 mS which was measured when the center of mass was in the far front of the car.

Conclusions

The results confirmed my hypothesis by demonstrating that the farther back you put the center-of-mass, the faster the car goes and these velocity differences were statistically significant.

Summary Statement

The center-of-mass in a gravity powered race car was systematically varied to determine the position that produced the highest velocity; this was determined to be as far back in the race car as possible.

Help Received

My dad helped set up the track, helped with power tools, and showed me how to program in C++.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Noah Girdler

Project Number

J1710

Project Title

What Is the Buoyant Force of Helium?

Abstract

Objectives

The objective of this study is to establish if the relationship between helium and mass increases in a linear way.

Methods

Same size balloons, same lengths of string, various weights of similar size with lead weights, helium. Measure the volume of a 9" balloon using water, measure that water in a flask in order to calculate the mass. Fill ballon with helium until 9" in diameter, find resting point of balloon using different weights. Convert mass of helium to cubic feet.

Results

The experiments I conducted yielded a result that 1 cubic foot of helium weighs 1.43 ounces. I discovered that the relationship between helium and its buoyant force is linear.

Conclusions

Ten 9" balloons (2.3 cubic feet) have a buoyant force of 3.4 ounces. In other words, it took 3.3 ounces to equalize the lifting power of 2.3 cubic feet of helium. This equates to the lifting power of 1 cubic foot of helium to have a buoyant force (i.e. it weighs) of 1.43 ounces (weight divided by volume). That is how much lighter helium is to the air around us.

Summary Statement

I established the buoyant force of helium is 1.43 ounces per cubic foot and that the relationship between helium and mass increases in a linear way.

Help Received

I designed the concept for the project and executed all aspects of it, with the support of my dad, and my science teacher's review and input.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Samanya Girish

Project Number

J1711

Project Title

Autonomous Linear Accelerator with a Precise Measurement Technique

Abstract

Objectives

The objective of this experiment is to determine how the variability in the number of magnets affects the linear accelerator. After my research my hypothesis was, if the number of magnets is increased then the amount of time taken for the metal ball to reach the end of the linear accelerator will decrease.

Methods

One 109cm base board, two 90cm dowels, three rare earth magnets, seven metal balls, NXT (brick, lego pieces, cables, touch sensor, motor), glue, bubble wrap, and a laptop. I measured the time of three magnets, two magnets, and one magnet in the linear accelerator. I ran each trial five times.

Results

The trial with three magnets had the fastest time because of the greatest kinetic energy build up. I repeated each trial five times for accurate results. The time for each trial varied directly with the number of stages of magnets.

Conclusions

The performance of the three magnets for the linear accelerator was the most effective out of all trials. This means three magnets had the greatest effect on the linear accelerator.

Summary Statement

I showed that the time for each of the trials directly varies upon the number of magnets.

Help Received

I designed and performed this experiment on my own. My parents helped me understand the NXT programming.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Piercen Jones

Project Number

J1712

Project Title

Blood Spatter Matters

Abstract

Objectives

The objective is to determine if blood is dropped from a higher height would the diameter size of the blood spatter increase. In addition will the surface make a difference in the size of the diameter. I believe the size will increase because the velocity force will flatten out the blood drop making the diameter of the spatter larger.

Methods

I created a simulated blood using cornstarch, corn syrup and water and food coloring. I used an eye dropper to drop the blood from different heights.

I let the blood dry to get its maximum size, and then measure it in millimeters

I also preformed the same steps on three additional surfaces wood, cloth, and tile.

Note: These are the same procedures used by the Bakersfield Police Department Crime Lab Investigations Division Unit.

Results

As the height increased the velocity increased creating a larger diameter size of the blood spatter on all surfaces. The change in surfaces did produce different diameters sizes of the blood spatter. All the spatter samples were in a circular shape with no jagged edges with the exception of wood, which yielded a satellite shape.

Conclusions

Repeated trials of dropping blood from different heights on different surfaces revealed the diameter size will indicate from what approximate height the blood drop fell from. The higher the drop height the larger the diameter of blood spatter will be produced, which is consistent with velocity force. It is concluded that the drop height of a blood drop affects the diameter size of blood spatter regardless of the surface.

Summary Statement

I showed the diameter size of blood spatter increased as the drop height increased regardless of the surface.

Help Received

Jeff Cecil, Crime Lab Supervisor

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Isabelle Katz

Project Number

J1713

Project Title

Characterizing Musical Instruments Using Waveform Analysis

Abstract

Objectives

Quantify the vague terminology that musical instrument experts use to qualitatively describe tone quality (e. g., creamy, bright and mellow) and categorize the timbre of different musical instruments and different brands of the same instrument (piano) using waveform analysis and a frequency domain color-fingerprinting technique I developed.

Methods

I recorded single notes (middle-C) from different instruments and from different piano brands. The procedure involved recording the musical note, trimming the time domain signal to a 3 second period that encompasses the attack, decay and sustain, and transforming the time domain function to the frequency domain, by using a Fourier transform algorithm in MatLab. In order to categorize the piano brand timbres I developed a color fingerprinting technique for characterizing the amplitude of the frequency domain peaks and created a tone metric by recording middle-C using bright and mellow settings on an electric piano.

Results

When comparing the data in the frequency domain, the major difference between the piano and the stringed instruments was the number and intensity of the high frequency peaks. On a comparative scale, the piano lacked high frequency structure, the guitar had a moderate level, and the violin had a rich structure. When comparing piano brands, Bosendorfer had the strongest fundamental peak relative to that of its first and second harmonic. Comparatively, while the Steinway fundamental is the strongest peak, it is only 1.5 times stronger than its first harmonic, and 5 times stronger than its second (whereas, the Bosendorfer fundamental peak was 50 times greater than its second harmonic). The Yamaha frequency spectrum shows a stark difference to the other brands because the amplitude of its fundamental frequency is less than that of its first harmonic.

Conclusions

Combining the color-fingerprinting technique and tone metric, I was able to: 1) distinguish between piano and stringed instruments; 2) differentiate among the various piano brands; and 3) categorize instrument tone color, ranging from mellow to bright. Music has a complex waveform, and while my project was based on data from a single note, the results are accurate and the analysis shows that the terminology used by music experts to describe the timbre of different instruments and different brands of pianos can be quantified by analyzing the note in the frequency domain.

Summary Statement

Musical instrument tone (timbre) is often described by experts using vague terms such as creamy, bright and mellow, so for my project I set out to quantify the timbre of these instruments and categorize their tone.

Help Received

I learned about sound waves from my science teacher, and read articles about the Fourier transform for analyzing sound waves. I watched MatLab videos on how to input and plot data in MatLab and how to calculate the Fourier transform in MatLab.

Name(s)

Shikha Kini

Project Number

J1714

Project Title

The Effect of Viscosity of Hydraulic Machines

Abstract

Objectives

My objective was to discover if the viscosity of liquid impacts the effectiveness of a simple hydraulic system.

Methods

In this project, I used 4 liquids of different viscosities, water, vinegar, diluted soap, and vegetable oil. I set up a simple hydraulic system using 2 200mL syringe and plastic tubing and filled up one syringe with a liquid. I placed a weight on top of the syringe and timed how long it would take for the other syringe to be completely filled, and repeated this 5 times with each liquid and found the average.

Results

The less viscous a liquid was, the more speedily the hydraulic system operated, which supported my hypothesis. Vinegar had an average of 3.692 seconds, water, 4.046, the soap had an average of 4.294 and vegetable oil was 9.07, which corresponds to their respective viscosity orders.

Conclusions

Using my data, we can conclude how to utilize liquids' viscosities in hydraulic systems without using excess electricity. In order to control a hydraulic machines speed just by using a liquid, we can change use a hydraulic fluid of a corresponding viscosity to the speed, like using a very viscous liquid to make the system move slower. Also, we could even incorporate force multiplier to utilize this concept even more, which shows that if we use a small syringe to apply force to a larger one, the force will become greater in order to keep the pressure constant throughout the system.

Summary Statement

As measured by how quickly all the liquid got transferred from one syringe to another, I discovered that the viscosity of liquids impacts the effectiveness of hydraulic systems.

Help Received

Prashanth Kini (my father), assisted me in this project in the construction of my hydraulic model by the drilling of holes and nails as well as other mechanical tasks.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Christopher Liebe; Liam Wright

Project Number

J1715

Project Title

Is Fire a Plasma?

Abstract

Objectives

This project determines if fire is a plasma by testing if a flame can carry an electrical current through an open gap. The flame is provided by a blowtorch. It is expected that when the flame is hot enough, (closest), the flame will be a plasma and will connect the circuit and the multimeter will show a conductive path.

Methods

Two alligator clips from a multimeter attach to washers clamping Tungsten filament (from a lightbulb) over an open gap of 2cm. A blowtorch is held at varying distances away. The distance is measured in centimeters and is determined from a ruler running from the base of the flame to the Tungsten filament.

Results

From nine or more centimeters away from the base of the flame, a plasma was not present. However, when the base of the flame was eight or fewer centimeters away from the Tungsten filament, the flame was hot enough for a plasma to be made and the multimeter to show a reduction in resistance.

Conclusions

In conclusion to this experiment, a flame can be a plasma where it is hot enough. When the Tungsten is zero to eight centimeters from the base of the flame, the flame creates the plasma environment. However, the relationship isn t proportional. This could be from the added resistance of Tungsten as a conductor caused by the heat of the flame. From nine or more centimeters away from the Tungsten filament, the flame is unable to produce a plasma because it is not hot enough.

Summary Statement

Using electrical resistance to determine the state of matter of a flame.

Help Received

Our parents helped us to handle the blowtorch safely and how to use the multimeter correctly. We obtained lightbulb filaments, built the test stand and conducted the experiments ourselves.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Joshua Lipman

Project Number

J1716

Project Title

Energy Gain in the Gauss Accelerator

Abstract

Objectives

The gauss accelerator is a simple device that accelerates a ball bearing using magnets without an external power source. This project investigates the factors that affect the energy delivered by the gauss accelerator. The project hypothesis was that the initial speed of the ball bearing will have no effect on the amount of energy delivered by the gauss accelerator, and that increasing the separation of the magnets would lower the energy gained.

Methods

A wooden rail was constructed, connected to a wooden ramp. 5 Neodymium magnets were placed at equal spacing along the track, with a single ball bearing on the exit side of each magnet. A ball bearing was released at varying heights on the ramp. The starting speed of the initial ball bearing, and the exit speed of the final ball bearing was measured. 10 trials were taken with 5 different starting speeds, and 5 different magnet separations for a total of 250 trials.

Results

In all but one of the separation distances, as the starting speed was increased, the energy gained was decreased (refuting the hypothesis). At 4cm, 6cm, 7cm, and 8cm separation the difference in energy gain from lowest to highest starting speed was 54%, 60%, 73%, and 62% respectively. At 5cm separation the difference was 139%. This experiment explores the possible reasons for this difference. The maximum energy gain was achieved at 0.7 m/s starting speed and 6cm magnet separation.

Conclusions

Although the gauss accelerator is simple the factors are complex, and the results of this project may be helpful in designing real world magnetic accelerators for use in real world applications.

Summary Statement

How does changing the initial ball velocity and magnet spacing in the Gauss Accelerator affect the energy delivered to an accelerated ball bearing.

Help Received

My father helped me with constructing the wooden rail and ramp.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Roxy Luster

Project Number

J1717

Project Title

Fog, Fog on the Wall: Which Color Shines the Brightest through Fog?

Abstract

Objectives

My objectives or goals are to go to the fair and do a good job with my presentation and maybe get a place award in the award ceremony but, if don't I'm glade that I went.

Methods

I tested different colored lights through fog to see which one would shine the brightest through fog. My materials used were a plastic tote with a lid for a box to provide a constant environment, a light that had the capability of changing colors, a fog machine that I borrowed from a friend, my iPhone for a timer, a GoPro camera, and an image.

Results

I timed how long it would take for the image to disappear completely through the fog once the fog machine was turned on. I tested this five times each time with nine different colors (White, Red, Orange, Yellow, Green, Light Blue, Dark Blue, Purple, and Pink).

Conclusions

I was able to see the image the longest through the fog using white light. The implications on using this information are people who live in foggy areas like San Francisco or the coastal regions where fog is frequent.

Summary Statement

My project is about, testing which color shines the brightest through fog.

Help Received

I did the project alone I designed the project, I did the experiment but, had help buying everything and had parent supervision.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Emi Maeda

Project Number

J1718

Project Title

The Art of Skipping Stones: Favorable Angle and Shape of Stone

Abstract

Objectives

Skipping stones is to throw stones in such a way that the stones bounce off the water several times.The objective of this experiment was to find the favorable angle and shape of stone for skipping stones.

Methods

Rubber bands, can, tripod, and clay. After molding the clay into the same shape and size, make a device out of the rubber bands, can and tripod. Test near a body of water at the angle you wish to find. To test which shape of stone skips most, mold clay into different shapes and have a human throw them. Observe and record data.

Results

After testing, upwards 20 degrees was the best angle when skipping stones with an average of 1.4 skips. Upwards and downwards 45 degrees had the worst outcome at no skips at all. The best shape of stone were flat circles 5 cm in diameter, this had a 3.4 average skip. The 3D shapes never seemed to skip more than once.

Conclusions

For skipping stones, upward 20 degrees was the best angle because it is not too steep that is only penetrates through the water, but no too low that is does not have enough force to skip again. Circles skipped most because it does not have any corners and has enough surface area for skipping. Therefore, skips across the water more times. In final analysis, it is best to skip stones at 20 degrees upward with a circular shaped stone.

Summary Statement

The experiment found the angle and shape of stone that skips the most times.

Help Received

I made the device and conducted the experiment myself. My science teacher, Mr. Espinoza gave me advice on the writing portion.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Arsh Muhib

Project Number

J1719

Project Title

Building a 360 Degree Periscope

Abstract

Objectives

Build a 360-degree periscope with no image disorientation, max observer comfort, max ease of use and min space requirement

Step 1 I was able to create a rotating top periscope where the bottom mirror was fixed. I could see in all directions, but the images were distorted.

Step 2 I was able to fix the image disorientation in my periscope by using dove prisms. When the top mirror was rotated by X degrees, the dove prisms were rotated by X/2 degrees in the same direction. This was a manual process.

Step 3 - In its current configuration it is almost impractical to use in real scenarios, is very bulky and is very fragile. To get an image with no disorientation, for every position of the top mirror of the periscope, I had to figure out its deviation from normal position and then rotate the dove prism by half that amount in the same direction. This made it very difficult to use. I would like to control the rotation of the top mirror of the periscope and the rotation of the dove prism with a single control.

Methods

I redesigned my 360-degree periscope with the following criteria-

1. The top mirror of the periscope should be able to rotate in all directions
2. When the top mirror of the periscope is rotated by X amount of degrees, the dove prism should rotate by X/2 amount of degrees, automatically.
3. The plane of rotation of the top mirror of the periscope should be perpendicular to the place of rotation of the dove prism of the periscope
4. Direction of rotation should be same
5. There should be no image disorientation

I used a spur gear assembly to translate the horizontal rotation of top mirror of the periscope to vertical rotation of the dove prism.

Conclusions

My periscope can make the life of sailors in submarines and the life of soldiers in armored vehicles very easy by saving on space and providing a 360 view of the surrounding without the observer having to move from his/her position

Summary Statement

Build a 360-degree periscope with no image disorientation, maximum observer comfort, maximum ease of use and minimum space requirement to be used in submarines and armored vehicles

Help Received

I received help from Mr. Jay McKoy to cut wood in the shape of spur gears of different sizes.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Wyndia Ohm

Project Number

J1720

Project Title

Gravitational Anomalies: (a) A Novel Multiphysics Approach with Data from NASA, and (b) A Novel Multi-measurement Device

Abstract

Objectives

Many magazines like Via (published by AAA), Bay Area Parent etc. claim that there is a gravitational anomaly at Mystery Spot. There are other such claims of gravitational anomalies: The Oregon Vortex and the movie Interstellar. The claim made by Mystery Spot is that there is a gravitational anomaly and at some places one can lose about 6in in height. The first goal is to determine if there is a gravitational anomaly that could cause a 6in height reduction claimed by Mystery Spot. To meet this goal this project combines three equations: the Gravitational Law, a proportionality equation for height loss, and a fluid pressure equation. A second goal is to build an inexpensive gravimeter that can be used to measure gravity. This new device turns out to be an innovation platform that can be used for other measurements such as friction.

Methods

A small weight, and a thin string are used to create a pendulum. For the novel Gravity Measurement Device (GMD): two tubes, conducting tape, wires, batteries, and a timer device(timer/oscilloscope/arduino) are used.

Since F= GMm/r^2, the control variable is r the distance from the location to earth s center. Other forces such as magnetism are eliminated by using non-magnetic materials. First the number of cycles and the length of pendulum needed for an accurate (less than 5% error) measurement of gravity is tested and chosen: 10 cycles with length >= 25cm. Four control locations and four test locations of similar altitude is chosen. At each test location the 10-cycle period is collected using four trials for each length. Since seven different lengths are used the total number of measurements at each site is 7*4=28. The difficulties involved in field testing (wind effects, and human error) cause an innovation: a new Gravity Measurement Device that eliminates human error and mitigates the effects of wind. A proportionality problem approach is taken to create a model that relates height loss to increase in gravitational acceleration. The coefficient of proportionality is chosen from data provided by NASA. The impact of the gravitational acceleration on blood pressure is then modeled using the pressure equation P = d*g*h where d is the density of blood, g is the gravitational acceleration and h is the height of the person visiting Mystery Spot and other places where there is supposed to be an anomaly.

Results

The results show that the measured gravity averaged over 112 measurements for the control group is about the same as that measured at Mystery Spot using 112 such measurements. The claim of gravitational anomaly is not supported by experimental data. The new device measures gravity accurately and this device

Summary Statement

By combining Gravitational Law with a proportionality equation for height loss, fluid pressure equation and data from NASA, this project shows that if the gravity were so anomalous people can t bear it.

Help Received

I used internet resources on how to use an oscilloscope and how to program the ARduino MCU. NCERT textbooks and web resources were used to understand the multi-physics. Data was obtained from NASA studies.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Weston Peterson

Project Number

J1721

Project Title

Measuring Radiation

Abstract

Objectives

My project measures the amount of beta, alpha, and gamma rays emitted by polonium 210, americium 241, and an unknown mix from an antique lamp. The experiment then compares the samples based on their emissions.

Methods

I made a cloud chamber for an approximate alpha measurement. I also used a Geiger counter combined with an electronic counter for gamma and beta ray counts. I used the electronic counter to convert the clicks of the Geiger counter into a direct number.

Results

The results of this experiment are given in detail in my notebook. Here is a sample.

Americium (obtained from a smoke detector)

Alpha- Approximate 240 CPM
Beta- 779 CPM
Gamma- 9.75 CPM

Conclusions

We should know what kinds of radiation these radioisotopes emit because it will allow us to keep people who work with them in the safer workspaces. It will also allow us to find new uses that are yet to be discovered.

Summary Statement

My project counts alpha, beta, and gamma ray emmisions of three different radioisotopes.

Help Received

Arnold Peterson (engineer and dad) advised me on building the cloud chamber and I had access to his Geiger counter.

Name(s)

Andrew Pool

Project Number

J1722

Project Title

Space Particles from Space: Altitude's Effect on the Number of Subatomic Particles Viewed in a Wilson Cloud Chamber

Abstract

Objectives

The objective of this study is to determine if a change in altitude influences how many subatomic particles are observed in a Wilson's Cloud Chamber.

Methods

Utilized a homemade Wilson Cloud Chamber, a device used to visualize subatomic particles, at two different altitudes. Five minute tests were performed three times at each altitude and filmed. Subatomic particle trails were counted while reviewing the film.

Results

More subatomic particles were viewed at a higher elevation (average of 29 per test) than at a lower elevation (average of 15 per test).

Conclusions

Repeated Trials at each altitude level proved that more background radiation can be viewed at a higher altitude. This proves that higher altitudes contain more airborne radiation than at lower altitudes.

Summary Statement

I observed more subatomic particles at an altitude greater than 5000 ft than at an altitude lower than 700 ft, viewed through a Cloud Chamber.

Help Received

I used a blueprint of a Wilson Cloud Chamber via Sciencebuddies.org and a project I did two years ago. I had my mother help me with the recording of the experiment as well as the total count of subatomic particles viewed from this recording

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Jared Saal

Project Number

J1723

Project Title

How Particle Size Affects Viscosity of Chocolate

Abstract

Objectives

My goal was to determine how particle size affects viscosity of chocolate.

Methods

My project materials are: stir sticks, micrometer, baking pan, chocolate (sugar, cocoa nibs, cocoa butter), oven, timer, measuring spoon, IR thermometer, chocolate refiner, ruler, scale. To conduct my experiment I got the same batch of chocolate with different particle sizes. The first size was 107 microns, my second size was 36 microns and my third size was 23 microns. For my control the particle sizes were 27, 24 and 16 microns. I heated all the batches to 60°C which is higher than the melting temperature of chocolate. I also heated the measuring spoon and pan to 60°C with the chocolate. Then I took everything out and measured one tablespoon of chocolate and poured it on the pan when it was flat. After I put the pan at a 55 degree angle. Then I let the chocolate flow for 60 seconds and then measure how far the chocolate has traveled. I do that process three times for each batch and then average them out.

Results

Three samples of 70 and 100 percent dark chocolate were tested, each with only the particle size changing between them. The results showed that the bigger particle size flowed better than the smaller in 70% dark chocolate but in 100% dark chocolate (with no sugar or cocoa butter) it was the opposite.

Conclusions

By testing the three ingredient 70% dark chocolate, I concluded that the smaller particle size chocolate is more viscous than the bigger particle size chocolate. The reason this happens is that there is cocoa butter in the chocolate and the cocoa butter coats the sides of the particles which allows them to flow. The reason that the bigger particle size chocolate is less viscous is because the total surface area of the particles is much less. Therefore, the cocoa butter is able to coat more which allows the chocolate to flow better. Also, I concluded that if you have 100% dark chocolate(with no added sugar or cocoa butter)it is the opposite than the 70% dark chocolate. This is because when the particles are ground up, they release cocoa butter from the cells and the more cocoa butter you release the better it will flow.

Summary Statement

By measuring the distance that chocolate traveled, I determined how the viscosity of chocolate changes at different particle sizes.

Help Received

My Dad helped me make the chocolate samples with his chocolate refiner.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Hannah Shu

Project Number

J1724

Project Title

Using Physics to Determine the Audio Frequencies to Evaluate the Acoustics of the Violin

Abstract

Objectives

The purpose of this project is to research the acoustic of violin and guide violin buyers using fundamental of Physics and smartphone to help find a perfect violin. This project is to investigate 24 violins with different price ranges.

Methods

24 violins with price ranges from $28 to $16K, LG V20 (Android Smartphone). Software includes VisualAudio smartphone App, Octave, Audacity and Double Elimination Tournament using bracketcloud. com.

Results

Higher Price Range (HPR) violins have a higher amplitude of power than Lower Price Range (LPR) violins in higher frequencies (2000Hz+) which makes violin sound bright and clear. LPR violins have higher power in frequencies between 1000Hz to 1800Hz than HPR which give nasal tones. HPR violin's fundamental notes and overtones lines are clear and brighter than LPR violins in Spectrogram graphs. HPR violins have a more powerful sound projection than the LPR violins.

Conclusions

I was able to see the patterns and characteristics in Spectrogram, Power Spectrum graph and sound pressure level between the higher price range violins and the lower price range violins. Using techniques and analysis in this study, I was able to find a few good violins from lower price range violins that have similar spectral characteristics and projected loudness as some of the higher price violins.

Summary Statement

I showed spectrum characteristics and sound projection of violins in different price ranges using smartphone and various free audio spectrum analysis software.

Help Received

Dr. Daphne Kapolka from the Naval Postgraduate School explained me Fourier analysis and Octave code. Dr. Julius Smith from Stanford University and Dr. Jim Woodhouse from Cambridge University explained me on Spectrogram. Mr. Joseph Curtin gave suggestions on ranking violins.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Dana Soibel

Project Number

J1725

Project Title

The Study of Optical Properties of Artificial Colors

Abstract

Objectives

The objective of this experiment is to find a technique to measure concentration of food coloring in the solution using optical methods.

Methods

I built a compact home-built spectrophotometer that uses a three-colored LED and a photoresistor.I wrote the code for the Arduino board that controls the spectrophotometer. Using this instrument I investigated the light transmission through solutions containing one of the three food colors; Red 40,Blue 1, Carrageenan (green). The light transmission was measured at three wavelengths; red, blue, and green. For each light color, I measured the transmission versus the concentration. From these measurements I found the absorption coefficient for each light color and food coloring.

Results

I found for the given food colors, the absorbent coefficient strongly depends on the wavelength. For example, for the solution that consisted of red food coloring the absorption coefficients for the three lights was 0 for the red light and 353 for the blue and green light. In addition, the absorption coefficient of each light depends on the food color it passed through. For example, the absorption coefficient for the red light was 0 and it increases to 128 and 563 when it passed through the solutions that consisted of green food coloring and blue food coloring respectively.

Conclusions

In conclusion the absorbent coefficients of each food color depends on the wavelength.The absorption depends on the concentration. Therefore concentration can be found by measuring transmission of the light through the solution. This can be used in the real life world by looking at the transmission since each chemical absorbs a set of specific wavelengths and from there you can detect the presence of a certain chemical.

Summary Statement

A home-built spectrophotometer can be used to study the optical properties of artificial colors.

Help Received

I built the spectrophotometer, wrote the code, and preformed the experiment myself. My scientific adviser explained to me concepts of optical absorption and helped me with troubleshooting the code and electrical wiring.

Name(s)

Shane Wilbur

Project Number

J1726

Project Title

Given the Same Stimulus, Does the Type of Liquid Placed in a Wine Glass Affect the Frequency of the Note Produced?

Abstract

Objectives

The objective is to determine if different liquids placed in a crystal wine glass would emit different notes when tapped with a metal spoon or rubbed on the rim with a wet finger. I predict that the denser the liquid, the lower the sound.

Methods

Five identical crystal wine glasses were filled with the same measure of liquids varying densities: water, whole milk, regular Coca-Cola, cooking oil, and corn syrup. Each glass was struck with a metal spoon and rubbed on the rim with a wet finger to produce a note. The frequency of each note was identified using a Korg CA-2 chromatic tuner and verified with my keyboard. Each test was repeated 3 times.

Results

Striking the glass or rubbing the rim produced the same tone because each glass vibrated at a specific pitch regardless of what started the movement. Different liquids did produce different notes; however, some notes were duplicated, and all were very close on the musical scale. Two of the liquids with higher viscosity produced a higher note then two other liquids with lower viscosity.

Conclusions

The general trend of my testing answered my question but did not provide full support for my prediction. Since I followed the scientific method thoroughly and repeatedly, perhaps further research would provide insight into my results. This experience created more questions than answers and lead me to carry out two more experiments, included in this project. Being a musician (guitar and piano), I was curious in investigating sound production and how sound can be manipulated.

Summary Statement

I wanted to determine if different types of liquids placed in crystal glasses produced different notes.

Help Received