CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Darby L. Adler

Project Number
J1901

Project Title
Chill Out

Abstract

Objectives/Goals
To study if distance between warm bodies placed together and then apart affects their cooling rate.

Methods/Materials
I studied the cooling rate of one warm body with respect to the cooling rate of two bodies and then three bodies touching the maximum surface area. Then I studied if placing the warm bodies at a distance from one another would affect their cooling rate and what that affect would be. Glass bottles of equally warm water were used to simulate the warm body and temperatures of the bottles were taken over time at equal intervals (2-10min.).
MATERIALS LIST
Three glass bottles of exactly the same size and shape; # Three laboratory thermometers scaled up to 200°F; # Metal Pot; # Stove Top; # Plastic Wrap; # One Timer; # Measuring cup; # Grid sheet with intervals of one(1) inch; # Towel; # Oven Mitts.

Results
The triple bottles touching retained the most heat over time
The double bottles touching retained the second amount of heat over time
The single bottle lost the most heat.
The triple bottles on inch apart retained a little more heat and showed some benefit to staying close without contact for retaining heat.
The 2 bottles touching were almost four percent warmer.
The three bottles touching were almost 5 percent warmer than the one and one percent warmer than the two

Conclusions/Discussion
Conclusion: I conclude that my hypothesis #If I place a greater number of warm bodies together, then I believe that they will retain a higher percentage of body heat than a smaller group of bodies# is correct.
The largest amount of warm bodies tested in my experiment stayed the warmest over time.
The single warm body in my experiment lost the most heat
The warm bodies that were placed next to each other without touching lost the most heat.
Therefore, I conclude that to retain body heat in situations of heat loss, it is beneficial to stay in contact with another warm body. It is more beneficial to stay in contact with more than one warm body. If this trend is correct, then it would seem to stay warm in heat loss situations, that a higher number of warm bodies would help retain heat better.

Summary Statement
Heat loss and retention of warm bodies with respect to distance btween the warm bodies.

Help Received
Parents assisted typing results and formulating some graphs on computer.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Emily L. Aiken

Project Number
J1902

Project Title
Testing Gas Laws

Abstract

Objectives/Goals
My goal is to determine the effect of pressure and temperature on the volume of air. I hypothesize that higher temperatures and lower pressure increase the volume of air noticeably, even in common, everyday situations.

Methods/Materials
I used ordinary balloons of several different sizes: small, medium, and large. I experimented with the effect on volume of taking the balloons underwater and to high altitude, as well as heating them in an oven and cooling them in a refrigerator. For each experiment, before, during, and after the test, the circumference of the balloon was measured and used to compute the volume. Every experiment was repeated up to four times for each size balloon.

Results
I found that balloons increase by 1% in volume per 100 meters of elevation gained, decrease by 6.9% per meter underwater, and decrease by 0.4% per degree Kelvin of cooling.

Conclusions/Discussion
As expected, the volume of the balloons increased with less pressure or higher temperatures and decreased with more pressure and lower temperatures. The most interesting finding is how large these changes are even under everyday circumstances: small changes in elevation, very shallow water, and typical temperature changes make a significant difference in the volume of balloons.

Summary Statement
My project is about the volume of air at different pressures and temperatures.

Help Received
My brother took the photographs; my parents supervised the underwater and oven experiments, provided transportation, and proofread my write-up; my Dad checked the equations; my science teacher, Mr. Roth, gave me suggestions.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Claire V. Appelmans

Project Number
J1903

Project Title
Seeing Through the Haze: What Light Penetrates Wildfire Smoke?

Abstract

Objectives/Goals
My objective was to find out how light of different wavelengths penetrates smoke. The hypotheses that I tested were that light penetration through smoke is independent of the a) type and b) amount of smoke it passes through.

Methods/Materials
Two different types of smoke were obtained by burning canola oil and juniper needles. A beam of white light was passed through the sample of smoke, and the amount of light at different wavelengths transmitted through the smoke was measured with a homemade spectrometer. An attempt was made to control the amount of smoke (high, medium or low density) per sample.

Results
The two different types of smoke did not have the same pattern of light transmission. At high densities (Approx. 20% light transmitted) canola oil smoke allowed more light of blue wavelengths to pass through. However at lower densities transmission of reds was equal to blue and yellow and green were less favorable. At high densities, juniper needle smoke had the same pattern as the canola oil sample. At the lowest density of juniper needle smoke red wavelengths were transmitted more than blue reversing the high density trend.

Conclusions/Discussion
I found that light penetration through smoke is dependent on the type and amount of smoke. The density dependence is surprising to me, maybe smoke particles interact when they are at high densities producing a different pattern. I will collect more data on smoke from different materials found in forest fires. This information can be used to help develop climate studies that model absorption of carbon dioxide by plants. Forest fires are predicted to increase as global climate change progresses. Plants that are starved of certain wavelengths due to the smoke created from forest fires could display stunted growth and lower uptake of carbon dioxide, a greenhouse gas.

Summary Statement
Measuring light penetration through smoke to understand the relationship between plant growth and climate change.

Help Received
Dad made home made spectrometer, faculty at Humboldt State University gave me idea about project.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Jamie M. Bizzini

Project Number
J1904

Project Title
Evaporation Sensation

Abstract

Objectives/Goals
This project investigates the effect of incandescent light bulb color upon the evaporating rate of rubbing alcohol. In my experiment, I took an incandescent light bulb, turned it on, dropped one drop of rubbing alcohol near the bulb, and observed the time required to evaporate the drop of alcohol.

Methods/Materials
Four different colored incandescent light bulbs (blue, green, red, white - all were 25 watts)were turned on one-at-a-time when I dropped the alcohol drop onto the index card, which was positioned 4 cm. from the bulb for each test. I used a stopwatch to time how long it took the alcohol drop to evaporate. I repeated the test 10 times with each light bulb. There were 40 tests altogether.

Results
The green incandescent light bulb took the longest time (4 minutes and 48 seconds) to evaporate the alcohol, the blue bulb was next (4 minutes and 26 seconds), then the white (3 minutes and 57 seconds), and the red bulb won at 3 minutes and 45 seconds. The red bulb evaporated the alcohol in the shortest amount of time. These were the average times for tests two through ten.

Conclusions/Discussion
My conclusion was that the red incandescent light bulb caused the rubbing alcohol to evaporate the fastest. The red incandescent light bulb had an average time of 3 minutes and 45 seconds.

Summary Statement
My project is to determine which colored incandescent light bulb will make the rubbing alcohol evaporate the fastest.

Help Received
My mom bought all needed supplies, started the stopwatch during the trials, and typed all of my information.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Nicolle D. Carbon

Project Number
J1905

Project Title
Ruben's Tube

Abstract

Objectives/Goals
If the smaller the holes on top of the tube would it differ from the size of the flames and the volume?

If I drilled the holes 1/2inch from each other, then how about if I do it in a differ measurement will it change any part of the experiment?

If I use a smaller tank of propane verses a bigger tank of propane will it make a difference to the size of flame that will be emitted from the tube?

What if I want to measure the wavelengths of the soundwaves is it possible to measure it with the use of an algebraic equation to figure out the solution?

Methods/Materials
Ventilation Ducting Brackets x2 Propane Tubing Hose T Connector Hose Splicers x2 Latex Sheets Scrap Wood Drill Hammer Tape Measure Knife or Scissors Silicone Sealant Epoxy Putty Duct Tape Masking Tape Teflon Tape

Results
1 The smaller the hole the less gas escapes the tube but there's more pressure inside the tube thus the emitted flame is more defined.The bigger the hole more gas is being let out so there's lesser pressure and less defined flame.
2 Spacing the holes 1/2inch apart made the flames more well defined and uniform than using hole 1/4 inch apart.
3 I made another replica of another Ruben's Tube and had a smaller tank of propane it showed that there wasn't enough gas transmitting into the tube, making the flames not go any higher then 1/2inch thus a smaller tank of propane couldn't be more effective than a regular size tank.
4 The speed of sound is about 340 meters per second at sea level. Sound is a vibration so it would be measured by hertz (Hz) -the SI unit of frequency equal to one cycle per second. The frequency(f)=to the speed (v) of the wave then dividing it by the wavelength (lambda) of the wave(Frequency is = speed/wavelength f=v/lambda)
Now to find the wavelength I multiplied by lambda and divided it by (f) to get-
Lambda= v/f To test this I used an example of 360 hertz and used the rough speed of sound as(v)
Ex)lambda=340(m/s)/360 hertz. It gave me the value for lambda as 0.94meters

Summary Statement
The Ruben's Tube is a physics experiment demonstrating standing waves and the relationship between air pressure and sound waves.

Help Received
mom helped with report,dad and sister helped with constructing,tito charles and family with their tools for building.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Forrest D. Csulak

Project Number
J1906

Project Title
The Metal Meltdown: Using Metal's Thermal Conductivity to Melt Ice Cubes

Abstract

Objectives/Goals
The purpose of my science project was to see if the density of different metals has a correlation with their thermal conductivity.

Methods/Materials
To test my experiment, I constructed 18-1 cm^3 cubes of various metals (aluminum, brass, copper, steel, and zinc) into blocks measuring 3x3x2 cm^3. I weighed each block to determine the density of each metal. After the density of each metal was determined, I marked the surface of each block black to equalize possible radiation due to their naturally occurring color differences. I then placed an ice cube onto each block and timed how long it took the ice cube to melt completely. I performed this test eight times for each metal at this volume, also with blocks measuring 4x4x1 cm^3 and 5x4x1 cm^3. A control variable for each test was used by constructing blocks of wood with the same dimensions.

Results
The results of my experiment determined that the density for each metal remained consistent for differing volumes and masses. Of the metals tested, copper has the greatest density followed by brass, steel, zinc, and aluminum. The results for the time to melt ice of the 3x3x2 cm^3 blocks were copper, brass, zinc, aluminum, and then steel. The results for the time to melt ice of the 4x4x1 cm^3 blocks were zinc, brass, copper, aluminum, and then steel. For the 5x4x1 cm^3 blocks, the results were copper, brass, zinc, steel, and then aluminum. The results for the overall average for the metals' thermal conductivity were that copper melted the ice the fastest followed by zinc, brass, aluminum, and steel.

Conclusions/Discussion
I thought that there would be no correlation between the density and thermal conductivity of the metals tested and that copper would melt the ice the fastest followed by aluminum, zinc, brass, and steel. My hypothesis was partially correct. The time it took the ice to melt did not follow the order of densities; however, it did not follow the order of researched thermal conductivities either. Additional testing and further calculations in specific heat capacity and thermal diffusivity are needed to better understand the results. In addition, further investigation is needed into water's reaction with different metals causing differences in surface tension strong enough to allow the ice to float before the water drains from the metal blocks.

Summary Statement
This experiment was conducted to determine if the density of certain metals (aluminum, brass, copper, steel, and zinc) would have any correlation with their thermal conductivities by melting ice on 20cm^3, 18cm^3, and 16cm^3 metal blocks.

Help Received
My mom bought the materials, assisted in monitoring the stopwatches used for the timings, and helped design my board. My grandma let me use her computer with all of the printing supplies necessary and let me use her house to conduct the experiment.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Clarke J. Esmerian

Project Number
J1907

Project Title
Across the Universe

Abstract

Objectives/Goals
The objective of this scientific investigation is to calculate the constant velocity at which a person in a spaceship would have to travel to get from earth to the edge of the portion of the universe visible from Earth, which is about 13.7 billion light years.

Methods/Materials
In this project I used a pencil, paper, a scientific calculator, and a textbook on Astronomy titled "The Cosmic Perspective". I applied the time dilation formula of special relativity which I found in the textbook mentioned above, to calculate how fast one would have to go to travel 13.7 billion light years in what they perceived to be one day in their relative time. This is the distance from Earth to the edge of Earths visible universe, which is the portion of the universe that an observer on Earth could possibly observe.

Results
My results were that to travel 13.7 billion light years in one day, you would have to go at aproximately the square root of (1- 10^-26)multiplied by the speed of light. I keep this number in radical form, because the number under the radical sign is very close to 1, and seeing as the square root of 1 is 1, the square root of a number that is close to 1 is going to be even closer to 1, so it is more convinient to leave the number in radical form.

Conclusions/Discussion
This demonstration shows how even though for massive objects it is not possible to go the speed of light or faster, it is possible to travel great distances in very short amounts of time. This is because as an object travels at a faster and faster pace, its relative passage of time becomes slower compared to the passage of time of an object that is not moving, and so therefore can travel across distances that are great in short amounts of time. This is in effect a form of non-instantaneous time travel. For example, in this project a person could travel a distance in what the traveler would perceive to be one day, but the rest of the universe would think it took 13.7 billion years, so you are aging one day in 13.7 billion years! The only drawback of this time travel is the fact that you could not go back, so, if you were to go to the edge of Earths visible universe and back in what you think is two days, you would see the earth and all the people on it as aged 27.4 billion years, so everyone you know, and the civilization you know would be long gone.

Summary Statement
For my project, I determined how fast you would have to go to travel from Earth to the egde of Earth's visible universe (which is a13.7 billion light year distance) in one day.

Help Received
My dad checked my calculations to make sure I hadn't made any mistakes, and he checked my grammer and spelling on this project.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Sydney L. Flak

Project Number
J1908

Project Title
Freeze Frame

Abstract

Objectives/Goals
Goal: By the use of strobe photography, the goal of this experiment was to determine whether objects of greater mass would fall through air at a faster acceleration rate than objects of a lesser mass.

Methods/Materials
Three balls of identical shape and size, but of varying mass were prepared for the experiment. The balls were dropped from the top of a ladder and photographed in a dark room against a dark background with a simple "party" strobe light pulsing at about 10 times per second. A digital camera was used to capture multiple images of the falling balls. By measuring the distance between successive images, acceleration was calculated and compared.

Results
It was determined that acceleration due to gravity was greater for heavier objects.

Conclusions/Discussion
The conclusion was contrary to the hypothesis. It was expected that all three balls would fall at the same rate, just as in a vacuum. In fact, it turns out that the force of air resistance is a function of mass, such that heavier objects fall faster in air than lighter ones.

Summary Statement
This project is about measuring the effect of mass on the acceleration of objects falling through air.

Help Received
My father helped me design and conduct the experiment, and make calculations from the data.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Spencer G. Ford

Project Number
J1909

Project Title
Are There More Cosmic Rays at Higher Altitudes?

Abstract

Objectives/Goals
The purpose of my experiment is to find out if there are more cosmic rays at higher altitudes than at lower altitudes. I believe that there are going to be more cosmic rays at higher altitudes due to the thinner layer of atmosphere. For detecting the cosmic rays, I will build a cloud chamber.

Methods/Materials
To perform this experiment, I took the cloud chamber to three locations in San Diego County. Each one was at different altitudes, varying by about 3000 ft. At each location, I recorded the number of cosmic rays that I saw pass through the cloud chamber in twenty one-minute intervals. I calculated the average number of cosmic rays at each location.

Results
The average number of cosmic rays during the first session at about 6000 ft. was 20.1 per minute. The average number at about 3000 ft. was 19.8 per minute. The average number at sea level was 7.35 per minute. During the second session, the average number of cosmic rays at about 6000 ft. was 25.8 per minute. The average number of cosmic rays at sea level was 11.65 per minute.

Conclusions/Discussion
In conclusion, my hypothesis was proved correct. I thought that there would be more cosmic rays at higher altitudes. My experiment showed that the average number of cosmic rays at higher altitudes was more than at lower altitudes. I believed that there would be more cosmic rays at higher altitudes due to the thinner layer of atmosphere at higher altitudes.

Summary Statement
My experiment is to find out if there are more cosmic rays at higher altitudes than at lower altitudes, by using a cloud chamber.

Help Received
Parents drove me to test locations, and held the stopwatch and flashlight. They also reviewed my report, and helped with photography and layout of backboard.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Courtney N. Friesen

Project Number
J1910

Project Title
Does Horizontal Speed Help Your Vertical Jump in High Jump?

Abstract

Objectives/Goals
The objective of my project is to analyze how the approach speed and center of mass of a high jumper relates to the vertical height that the athlete will clear.

Methods/Materials
A high jump pit was set up on a grass surface and a starting point was marked 37 feet from the bar. Sixty jump attempts were made over a four-day period and the speed of each jump was recorded along with the success of the jump measured on a one to four scale with four being the best. On one set of jumps, the center of mass of the body was recorded through the use of a measuring bar placed in front of a video camera that recorded the jumps. Information from elite high jumpers was also researched and analyzed.

Results
The results of the horizontal speed test were plotted on a graph and the resulting trend line showed that the medium to fast approach speeds produced the best results. Bar charts also supported this conclusion. The success rate of the jumps dropped a little on the fastest speeds and dropped a lot faster on the slower approach speeds. The center of mass test consistently showed that the vertical jumps were better when the body#s center of mass was lower.

Conclusions/Discussion
My conclusion is that fast approach speeds and lowering the body#s center of mass will improve the success rate of a high jump. The horizontal speed can be converted into vertical speed as long as it is done in a controlled manner. The study of elite jumpers and my own experiment showed that faster and lower is better. Strength and speed training can help improve both of these areas.

Summary Statement
I wanted to determine how horizontal speed and the body's center of mass affect the vertical jump in high jump.

Help Received
Dad helped type report and record high jump experimental information

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Tai Li Harrill

Project Number
J1911

Project Title
Which Diameter String Has the Purest Tone?

Abstract

Objectives/Goals
My objective to to discover which set of violin strings will create the purest tone. I will test three different sets of strings, each set is a different diameter to try and prove my hypothesis that the thinner diameter strings will create the purest tone.

Methods/Materials
The most important and main part of my project is the string sets and different size strings because each string has a unique sound and creates a different no mater what diameter.
Materials: String sets E,A,D,G; online ocilliscopes; Zelscope; Raven 1.0; 4/4 size violin; 4/4 size violin bow; Electric tuner; Computer.
Method(steps): 1.Put soft set on violin; 2.Electronicaly tune; 3.Test on ocilliscope; 4.Record results; 5.Put medium set on violin; 6.Electronicaly tune; 7.Test on ocilliscope; 8.Record results; 9.Put orchestra set on violin; 10.Electronicaly tune; 11.Test on ocilliscope; 12.Record results; 13.Take all three test results and graph them; 14.Make your conclusion.
Tip
Remove strings one at a time.
Never take all four off at once or else the bridge might fall off.

Results
For my results of my experiment, the orchestra set had the purest tone. If I were to demonstrate this to you I would use a household item such as a rubber band. A rubber hand is so similar to the orchestra set you can just pluck it and hear a very pure tone. The reason why the orchestra set is the purest is because the stings are of thicker diameter. For the orchestra set,the results of E,A,D,G are on my poster board. The results for E string soft is 661.1 HZ at its top peak,the A string soft was 435.0 HZ at its peak, the D string has a frequency of 292.9 HZ at its peak. The last string is the G string which had a peak of 395.3 HZ. After testing the soft set of strings, I moved on to the medium set. The medium set results are as follows. The E string peak was 1320.7 HZ. The A string peak was 657.5 HZ, the D string was 289.2 HZ and the G string frequency peak was 385.1 HZ.

Conclusions/Discussion
After testing, I have come to the conclusion that the orchestra set, the 0.014 mms set has the purest tone. From the evidence I have and from the tools that I have it is clear that my hypothesis was clearly wrong. My hypothesis was that the soft or thinnest diameter string would create the purest tone, From my graph you can see the evidence of my investigation.

Summary Statement
Which set of violin strings, (diameter) soft 0.012mm, nedium 0.013mm or orchestra 0.014 mm creates the purest tone.

Help Received
George Lambadakis (friend and electrical engineer) taught me to use and read ocilliscope.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
David Koh

Project Number
J1912

Project Title
A New Perspective with a Digital Pinhole

Abstract

Objectives/Goals
The objective is to determine which pinhole size will produce the best resolution for a Nikon D200 digital pinhole camera.

Methods/Materials
The digital pinhole camera was made by piercing a hole in the body cap. The lens was removed and an aluminum foil with a pinhole was taped to the body cap. A total of eight pinholes were made. Exposure was taken several times for control of brightness. Out of all of the pictures taken, only eight best pictures (one for each pinhole) was printed out. The resolutions were then measured on a scale of 1-10, where 10 was the best resolution outcome and 1 was the worst resolution outcome.

Results
Five objects were tested: chair, eye chart, eye chart-2, fence, and a house. The eight different pinholes have a size of 0.005mm, 0.01mm, 0.2mm, 0.3mm, 0.4mm, 0.8mm, 1.3mm, and 2mm. The largest pinhole with a diameter of 2mm allowed in too much light making the image blurry. On the other hand, the smallest pinhole with a diameter of 0.005mm allowed in too little light that the light rays overlapped each other causing diffraction. It turned out that a pinhole with the size of 0.2mm produced the most effective resolution.

Conclusions/Discussion
This experiment helped to achieve the objective. A pinhole that was either too small or too large had bad resolution and could not be seen well. The next pinhole that was almost as equally clear as the first one had the size of 0.01mm. This suggest that any pinhole size between the range of 0.01mm and 0.2mm will have a clear resolution while anything else above or below will not have such good resolution image due to diffraction.

Summary Statement
A pinhole with the size of 0.2mm gave the best resolution image for a Nikon D200 digital pinhole camera.

Help Received
Professor Steve Sprangler gave many helpful advices; Dad helped in taking pictures and choosing the best one for each pinhole.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Brandon T. Nguyen

Project Number
J1913

Project Title
Sink or Float: Effect of Salinity on Fluid Density and Buoyancy

Abstract

Objectives/Goals
The objective of this project is to determine the required salt concentration to make an object of varying weights float in three different fluids: tap water, distilled white vinegar, and 7 Up. The goal is to demonstrate Archimedes's principle by showing the effect of salt concentration on fluid density and buoyancy.

Methods/Materials
The materials involved consists of a test container, a plastic container with variable weights, a scale, a floating thermometer, stirring sticks, salt, tap water, distilled white vinegar, and 7 Up. I conducted tests to determine how much salt is needed for an object to float in each test fluid as the mass of the object is increased. For each fluid, I started with an object that floats in fresh fluid (no salt) and increased the mass of the object five times, each time by ten grams.

Results
The results clearly show that, as the object mass is increased, more salt is needed to keep the object afloat. Furthermore, vinegar and 7 Up, which are denser fluids, require less salt than water to float an object of the same weight.

Conclusions/Discussion
The experiments demonstrate that the higher the density of any fluid, the greater the mass of the object that can float in it. In the water experiment, as the object mass is increased, more salt has to be added to the water to increase its density. The same observations can be made with two other fluids with higher densities than water, vinegar and 7 Up. As more salt is added to these two fluids, their densities increase, and an object with a greater mass can float in them. The experiments with vinegar and 7 Up also show that these two fluids can float object with greater mass than tap water, since they have higher densities than water.

Summary Statement
This project demonstrates the effect of salt concentration on the density of a fluid and the buoyancy of an object floating in the fluid.

Help Received
Mother helped format my poster board; Father helped set up and run experiments.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Steven H. Park

Project Number
J1914

Project Title
Proving Universal Gravitation by Warping Space-Time

Abstract

Objectives/Goals
The objective of my project was to determine if two masses would attract each other through the force of gravity, as predicted by Isaac Newton's law of universal gravitation.

Methods/Materials
I built a rudimentary Cavendish-style experiment to control the variable caused by earth's gravitational influence. First, I suspended a slim horizontal beam above ground by a nylon wire. At each end of the beam, I placed a 1 pound lead mass, making certain the beam remained level, plumb, and stationary. On the floor and at the same height as the suspended smaller masses, I placed a 6 pound lead mass, experimenting with the distances at which each larger mass was placed away from its respective smaller mass. The distances ranged from 3 to 6 inches. To prevent movement by any other force other than gravity--e.g., air or vibration, I covered the experiment with a sheet of plastic, turned off the thermostat, and prevented people from entering the room. I watched remotely the experiment via video.

Results
What I found, both mathematically and observationally, is that the closer the objects were to each other, the stronger their gravitational force. And conversely, the further the objects were from each other, the weaker their gravitational force. I discovered through trial and error that a 1 pound lead mass suspended in air will be attracted to a 6 pound lead mass only if they were less than 3 inches apart. Any distance further apart and the smaller masses were motionless.

Conclusions/Discussion
I concluded that Newton's theory of universal gravity is correct, that all bodies attract each other with a force of gravity directly proportional to the product of their masses and inversely proportional to the square of their distances.

Summary Statement
My project proves that two masses will attract each other through the force of gravity, as predicted by Newton's law of universal gravitation.

Help Received
Father helped explain some concepts and proofread/typed my report.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
She'ifa Z. Punla-Green

Project Number
J1915

Project Title
The Mathematics of Sympathetic Vibrations

Abstract

Objectives/Goals
Which notes on a piano can induce sympathetic vibrations on an open string? Mathematical relationships between test note and open string frequencies will be used to predict which notes cause sympathetic vibrations. I predict the three test notes in my sample that are harmonics of the open string will resonate the longest.

Methods/Materials
Materials used were: a piano, a stopwatch, a frequency chart, and a helper. I depressed a piano key, the damper lifted and the string was "open," or free to vibrate. I played all the notes in one octave higher than the open string. My helper timed the durations of the tone coming from the open string. I averaged and graphed the results.

Results
The thirteen test keys in each sample caused the open string to resonate. Seven test keys caused brief resonance; the vibration inside the sound box caused the open strings to produce a tone. Three test keys produced tones of intermediate duration, due to the fact that the frequencies of their harmonics were equal to the frequencies of the open strings' harmonics. However, as predicted, three test keys with a frequency equal to a harmonic of the open string produced the longest resonance.

Conclusions/Discussion
As a musician, I think it is important to understand the physics of sound and hearing. After doing the experiment, I understand why performers should hold their open strings closed, why differing pianos produce varied sounds and "color", and why digital pianos cannot mimic the sound of real pianos.

The physics of sympathetic vibration go beyond music. Some scientists believe that "the universe consists solely of waves of motion," or "there exists nothing other than vibrations." An understanding of sympathetic vibrations is a good place to start understanding the physics of the universe, from subatomic particles to the workings of the inner ear to bridge construction to astronomy.

Further experimentation would include testing more keys with different frequencies, especially higher notes. I would like to test keys more than one octave higher than the open string to determine when the sympathetic vibration ceases to be audible. Because of the mathematics involved in an even-tempered scale, I am curious to know if I would get the same results for every open string. I would also like to broaden my understanding of the mathematics in music to include chords, intervals, progressions, and

Summary Statement
My project explores the mathematics of sympathetic vibrations on piano strings.

Help Received
Teacher edited work; Father was my helper and helped edit; Mother helped edit; Used the piano at Pacific Union School; Parents helped glue display board.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Effie A. Striem

Project Number
J1916

Project Title
Glassic Music

Abstract

Objectives/Goals
The question: How much water is needed to put into a glass container to create the right frequencies to play a one octave scale?
The hypothesis: The more water added to the glass the higher the pitch would get.
The vibrations caused by rubbing a wet finger on the rim create sound-waves in the glass. Not all glasses are exactly the same. In order to change the pitch, different amounts of water are needed or different glasses have to be used.

Results
Preliminary trials have tested the capability of individual glasses. Filling the selected uniform glasses with different amounts of water created a scale to play a note on each glass to complete an octave for the 1st time. Five crystal red-wine glasses and three champagne glasses were needed. Tracing a line on the glasses at the water level allowed refilling the glasses to approximate water volume. Repeated trials to fine tune the exact notes were made using measuring utensils to measure the exact amount of water in every glass separately.

Conclusions/Discussion
Conclusion: The initial hypothesis was incorrect. The more water that was added, the lower the pitch became. This happened because the friction energy from the rubbing was absorbed and reduced much more with more water, making the notes go lower. The empty glasses had the highest pitch.

Summary Statement
How to play an 8 note octave on a set of wine glasses

Help Received
Dad helped record measurments

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Stewart H. Wirick

Project Number
J1917

Project Title
Will a Guitar String Vibrate Forever in the Vacuum of Space?

Abstract

Objectives/Goals
Of the three factors that stop a guitar string from vibrating, air resistance, absorption by the guitar, and absorption by the strings, the purpose of my experiment is to determine the importance of air resistance. My hypothesis is that in a vacuum, a guitar string will vibrate much longer than in regular air conditions.

Methods/Materials
I built a vacuum chamber and special electric guitar that fit into the chamber. The design of my experiment was first to pluck a thick guitar string, and a thin guitar string under normal air conditions, and measure how long the string vibrated by connecting the guitar pickup to a computer. I then created a vacuum in the chamber, and plucked again, measuring how long the string vibrated.

Results
Large Diameter String: 72 to 77% longer vibrations in a vacuum than normal air

Small Diameter String: 30% to -5% longer vibrations in a vacuum than normal air

Conclusions/Discussion
The result of my experiment is that the smaller diameter guitar string vibrated about the same in a vacuum than in normal air pressure, however the thick diameter string did not. The smaller string was not affected nearly as much by air resistance, and thus acted almost the same in a vacuum. However, since the thick string has more air resistance, it was affected greatly when in a vacuum, and vibrated 77% longer. This proves my hypothesis correct, that a guitar string will vibrate longer in a vacuum than in regular air conditions. In conclusion, of the three factors that stop a guitar string from vibrating, air resistance, absorption by the guitar, and absorption by the strings, air resistance is a very significant factor for thick strings.

Summary Statement
My project examined the importance of air resistance in stopping vibrations of a guitar string by plucking a hand-made electric guitar in a vacuum chamber and measuring how long the string vibrated with a computer.

Help Received
Dad helped with selecting and buying materials and working with power tools for woodworking.

CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
Cynthia L. Yin

Project Number
J1918

Project Title
How Do Varying Amplitudes, Weights, and Lengths Affect the Period of Motion of a Pendulum?

Abstract

Objectives/Goals
The objective of my project is to determine how amplitude, weight, and length affect the period of motion of a pendulum. My hypotheses were as follows:
1) Higher amplitude would result in a longer time for the pendulum to return to the original point of release at the maximum amplitude. This would result in a longer period of motion.
2) The effect of greater weight would be longer period of motion.
3) Longer string length would mean more surface area in contact with air. This would increase air resistance and period of motion.

Methods/Materials
A wooden frame for the pendulum was constructed. A cup with pre-determined weight and length was hung on the pendulum frame and released from an amplitude. I timed how long it took the pendulum to swing back and forth three times to its original point of release at the maximum amplitude. The amount of time was divided by three to obtain the average period of motion for one swing. I repeated multiple trials of this process for various combinations of amplitudes, weights, and lengths.

Results
After I collected data and graphed the amplitude versus average period of motion, weight versus average period of motion, and length versus average period of motion, I compared the results. I prove that length has a positive effect on the period of motion of the pendulum. On the other hand, there is an insubstantially positive relationship between amplitude and period of motion. In addition, weight affects the period of motion insignificantly.

Conclusions/Discussion
My hypotheses were that higher amplitudes, greater weights, and longer lengths would result in longer periods of motion. Based on my thorough observations, the pendulum's period of motion is significantly dependent on the length of the string, supporting my hypothesis. However, the results reveal negligible relationship between weight and period of motion, and a slightly positive relationship between amplitude and period of motion, contradicting my hypotheses.

Summary Statement
My project compares average periods of motion of a pendulum for varying amplitude, weight, and length to determine the effects of amplitude, weight, and length on the period of motion of a pendulum.

Help Received
My appreciation goes to Ms. Agapoff who lent me her scale. In addition, my parents' utmost and unwavering support and praise cannot be overemphasized. They assisted in constructing the pendulum frame and conducting the experiments.