CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Erin Brittain; Shannon Meadows; Stefanie Parsels

Project Number

S1501

Project Title

Sonic Collisions

Abstract

Objectives/Goals

By investigating the properties of constructive and destructive interference the capabilities of sound cancellation can be demonstrated. Sound travels through a substance and creates waves that propagate and resemble a sinusoid. These waves can be changed in order to create different phase relationships that react with each other. In the case of speakers, switching the input and output wires can create the inverse of a sinusoid that is exactly 180 degrees out of phase with an in phase sinusoid.

Methods/Materials

Source signal produced by a sine wave oscillator.
Source split and passed through 2 identical power amplifiers.
Sound produced by connecting identical speakers to each amplifier.
Detect sound level and phase by using an oscilloscope comparing the source signal and that picked up by a microphone with signal boosted by its own microphone amplifier.

Results

We discovered that noise cancellations occur at specific points. By presenting an identical tone that is in phase through two identical amplifiers, one connected with reverse polarity, the tones become 180 degrees out of phase with each other.

Conclusions/Discussion

Through empirical data collection we were able to demonstrate sound cancellation through phase relationship alteration through physical repositioning of the speakers. We not only proved our theory correct, but we were able to achieve a greater understanding of the properties of constructive and destructive interference.

Summary Statement

Investigating the properties of constructive and destructive interference of sound waves.

Help Received

Dad helped acquire equipment.

Name(s)
Joseph T. Chen

Project Number
S1502

Project Title

A Study of the Qualities that Determine Maximum CPU Cooling Efficiency

Abstract

Objectives/Goals
The purpose of this experiment was to determine what qualities of a heat sink were important in cooling a CPU.

Methods/Materials
Ten heat sinks were built using copper, bronze, and aluminum bases. Black, blue, and silver colored aluminum fins were tested with each base. Each heat sink had three trials, each trial consisting of a nine hundred second time period in which the CPU and heat sink temperature measurements were taken with BIOS and a Cooling Gate thermometer simultaneously.

Results
* Increasing surface area of heat sink results in Faster cooling of the CPU.
* The color of a heat sink minimally affects the cooling of a CPU under a forced convection situation.
* The heat sinks kept the CPU at relatively stable temperatures 300 seconds after the computer was turned on.
* A common trend: As the heat sink color became darker (silver/blue/black) , the temperature decreased in minute amounts with the exception of the Bronze Base + Silver Al. Fins and Al. Base + Silver Al. Fins heat sinks.
* The difference between the CPU and Heat Sink temperatures reflected the conductivity of the base metal.

Conclusions/Discussion
* The surface area of a heat sink directly determines its efficiency.
* It was known that darker colored heat sinks cool heat generating sources more efficiently than lighter colored heat sinks up to 3-8% during natural convection. However, in this experimentation, there was no strong evidence of this trend most likely because of the forced convection caused by the CPU fan.
* The mass of heat sink does not determine the efficiency of a heat sink.
* Highest to lowest conductivity between base metal:
1.) Aluminum Base with Aluminum Fins
2.) Copper Base with Aluminum Fins
3.) Bronze Base with Aluminum Fins

Summary Statement
This experiment ultimately demonstrated that a heat sink with the most surface area and highest conductivity would be most suitable in sustaining a minimal temperature of a CPU.

Help Received
Father helped setup Lab equipment.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Alexander J. Crawford-Kuhrts

Project Number

S1503

Project Title

Testing Tesla

Abstract

Objectives/Goals

Origanally my objective was to discover the difference in how electricity flows in open air and in a vacuum. However, I have expanded my objective after the Mendocino County Science Fair in order to test how electricity will flow in other atmospheres rather than just open air and inside a vacuum. My current objective is to discover how electricity will flow through different atmospheres including: open air, an empty vacuum, one filled with helium, and one filled with argon.

Methods/Materials

Tesla coil; 4 6-volt batteries (lantern batteries); Solid core hookup wire; Knife switch with screw connecters; 12-volt relay switch with soldering connecters; Wells 12 volt automotive ignition coil; Soldering wire; Soldering tools; Alligator clips; Mounting board; Vacuum tube; 6 in long by 3 in diameter clear plastic tube; Vacuum pump; Copper tubing; Various sealing valves; Argon; Helium.

Results

Electricity changes color in different atmospheres, and flows much farther in a vacuum than it does in open air. Results for how electricity flows in helium and argon are still pending and will be availible by the State Science Fair.

Conclusions/Discussion

I concluded that electricity flows much farther in a vacuum than in open air (which disproved my hypothesis)due to the lack of molecules that restrict electric flow. In open air there are so many more molecules, they restrict the flow of electricity, thus electricity cannot flow as far. At the county competition, judges recomended that various gases should also be tested in the vacuum chamber, so I decided to test helium and argon because they are more available.

Summary Statement

Using a tesla coil to test electrial flow in open air, in an empty vacuum chamber, and one filled with Helium & Argon gases.

Help Received

Paul Gilbert - Biology teacher, Mother & friend Karen Soberanis helped with board design and layout, Don Sinclair helped with electrial, vacuum chamber and gases.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Nichole M. Cubbage

Project Number

S1504

Project Title

The Spectrum and Its Relationship to Temperature

Abstract

Objectives/Goals

To determine and compare the temperature of two or more light sources by measuring each maximum intensity using the spectrum. the maximum intensity has a corresponding wavelength which will be placed in Wein's Law to find the approximate temperature. I also plan to contact the company of the light sensor to figure out a way to calibrate the results I received from the light sensor, to get the true temperatures of the light sources.

Methods/Materials

Vernier light sensor, manila folder, yardstick, flashlight, overhead projector, Macintosh computer, Data Logger program, diffraction grating, He-Ne Laser

Calibrate the diffraction grating, find the angle of diffraction for each ight source, receive the maximum intensity for each ligh source, calibrate the information, find the maximum wavelength, use Wein's law to get the temperatures, compare and contrast.

Results

The overhead projector had a lower wavelenth, and therefor a higher temperature, but only slightly. I also measured the spectrum of the sun, and the temperature came out way too low, especially compared to past research and tests. This caused me to research the light sensor to make a conclusion for now.

Conclusions/Discussion

The light sensor has an uneven spectal response, and contact with Hamamatsu, the manufacturer of the Vernier light sensor, is eminant before any further conclusions are made. If my results are calibrated, I can find and compare the true temperatures of the light sources, and new information on how to use the Vernier light sensor will be available.

Summary Statement

Measuring and comparing the temperatures of two light sources using their visible spectrums, maximum intensities and corresponding wavelengths, and Wein's Law.

Help Received

I used lab equipment at Rialto High School under the supervision of Mr. Timothy Bacon.

Name(s)

Cordelia D. Holmes

Project Number

S1505

Project Title

Determining the Type of Particle in an Air Sample by Using Laser Light Scattering

Abstract

Objectives/Goals

The purpose of the project was to correlate the type of particles in a sample by analyzing their laser light scattering properties. The hypothesis was that it will be possible to correlate the type of particles by measuring the laser light scattering properties.

Methods/Materials

A circular tube was set up so that air circulated through it and a laser was pointed through an opening in the tube. The digital camera was set up at an angle to the laser beam. The air was first cleaned by placing a filter on the in valve. Three pictures were taken of the "clean" air as a control. A sample was then placed inside the in valve and the fan turned on. Four pictures were taken of the air with the sample in it. The pictures were then downloaded onto the computer and the program was used to find the brightness of the beam for each angle number. The values were then graphed.

Results

The graphs of the brightness vs. angle number were different for all four samples. When the air was cleaned, there was almost no brightness. The graphs of the flour and sawdust both peaked at a brightness level of 255, which was the camera's limit.

Conclusions/Discussion

The hypothesis was partially correct. Using the tools available, it is extremely difficult to measure exact particle size. The set up was simply not sensitive enough. It was possible to use the other set up and find the intensities of the beam at different angles. By plotting these on a graph, one can see a difference in their graphs. The samples whose composition was more uniform had smoother graphs while the samples that had larger particles mixed with smaller particles had more difference between the highs and the lows. Once the graphs of a certain particle are found, they can be compared with a graph of an unknown substance and then matched to determine what the unknown substance is. In that manner, it is possible to determine the type of particles in a sample by using laser light scattering.

Summary Statement

To find whether the relative size of a particle can be determined by the scattering of laser light and to correlate the type of particles in a sample with their intensity vs. angle graphs.

Help Received

Mother helped set up board, Father wrote program and helped construct testing apparatus.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Alex J. Keimach

Project Number

S1506

Project Title

The Effect of Reduced Pressure on the Yield Volume of Popcorn

Abstract

Objectives/Goals

The objective was to determine the effect of cooking corn kernels at reduced pressure on the volume of popcorn they would yield.

Methods/Materials

An apparatus was built for reducing the pressure at which popcorn was popped using a wok and vacuum cleaner. Two different levels of pressure, 101.35 kPa and 59.98 kPa, were used at which to pop the kernels. For each trial, 47.5 g of kernels were cooked at 176°C with 30 mL of corn oil. Excess corn oil was removed and the wok was allowed to cool to room temperature between each trial. At the completion of popping, when 3 seconds were heard between pops, the heat and vacuum were turned off and the yield of popcorn was measured using a beaker. Kernels that did not pop completely were removed and counted for each trial. Five trials were performed at each level of pressure.

Results

The experimental results showed an average 40% increase in the average volume of popcorn cooked at reduced pressure to that cooked at normal pressure. The average yield of popcorn popped at normal pressure was 1152 cm3, while the average yield popped at reduced pressure was 1614 cm3, a difference of 462 cm3. The popcorn cooked at reduced pressure also showed an average decrease in the number of unpopped kernels. A visible difference in the shape of popcorn was not observed, however the popcorn popped at reduced pressure looked lighter and fluffier when examined as a whole.

Conclusions/Discussion

The outcome of this experiment supported the original hypothesis, which stated that popcorn cooked at reduced pressure would have greater volume. This project has introduced a practical and more efficient method for popping popcorn which can be adapted for commercial or domestic use. It has also shown that reducing the external pressure of an explosion increases the size to which the explosion can expand.

Summary Statement

My project is about how reducing external pressure affects the expansion of starch in the process of a popcorn kernel popping.

Help Received

Father helped build cooking apparatus; Mother helped operate vacuum cleaner.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Janice S. Leung

Project Number
S1507

Project Title
Cosmic Ray Shower Array Reconstruction

Abstract

Objectives/Goals
My goals of this project is to analyze these events of these ultra-high energy cosmic ray showers and characterize their energies and apparent direction of origin.

Methods/Materials
The method is which I followed was to 1)Open web browser to www.chicos.edu/arraydata/showers/2)Open raw data file- list of sites involved in a shower.3)Create a map grid representing the sites that were hit. Sites that were hit are shown with color circles, corresponding with the legend.4)Create Intensity vs Time map 5)Use reconstruction software to analyze the data and open the reconstructor page (rextor).6)Tell the software to ignore the hits that seem to be accidental by comparing them with the other sites.
7)Make a LDF (Lateral Distribution Function) plot

Results
After months of reconstructing the showers, I loaded all the new information into web pages for easy access. The link itself shows the result of a shower; the TRG in the link is where the shower hit the hardest, therefore it should the pinpoint of the shower should be somewhat above the site along with the date and time from which it got hit. An example shower- [01-04-05 07:07:28 PST UTC: 3187696048 ns: 337624576, trg:MaranathaHS, trms:1.15, theta:36.03, phi:136.89]

Conclusions/Discussion
My hypothesis is both correct and incorrect. Most of the data showed that most cosmic ray shower pin point origins are from both west and north but the number of hits that occurred that wasn#t from the west and north regions also got numbers very close to west and north. There isn#t enough data to prove my hypothesis correct because it is not yet significant. But we are able to conclude that in between the years of 1992 and 2004, most the cosmic ray showers were pinpointed to have been from the north and west. For future research, I would like to continue analyzing further data received into Caltech archives daily; every minute there are new sets to data to be evaluate. I would also like to begin on finding possible pinpoint locations from space that would likely emit the most cosmic rays.

Summary Statement
The main purpose of my project is to provide a possible answer to the question where do ultra high energy cosmic rays originate from.

Help Received
Worked under the guidance of Theresa Lynn PhD. (CHICOS Project Coordinator) at Caltech

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Anna M. Loch

Project Number

S1508

Project Title

Effect of UV Light on Depressions on CH Plastic Films in Different Environments Using Different Ages and Thickness

Abstract

Objectives/Goals

The study of the effects of ultraviolet light on the depressions in CH (Carbon Hydrogen) plastic films takes place in this experiment.

Methods/Materials

I tested the CH film in a regular air atmosphere, a vacuum, an oxygen filled atmosphere, and a nitrogen filled atmosphere. There were two sets of plastic films; half of which were stored in a vacuum with no exposure to oxygen, and the other half were stored in the room. I also tested to see if thickness affects the depth of depressions as well as the effects of age.

Results

It was noticed that the change in the O-H bonds, which is one of the reasons of the depressions, was the smallest in the oxygen-free atmospheres, which were the nitrogen filled atmosphere and the vacuum. It was also discovered that the variables of age and thickness were not factors of the depths of depressions, but rather due to chance.

Conclusions/Discussion

The plastic films that were stored in the vacuum had smaller changes in the O-H bonds than the films that were stored in the room. The presence of oxygen over time has caused the film stored in the room to have a slight depression, even when in an oxygen free environment.

Summary Statement

The CH plastic films were exposed to UV light in four different environments to determine if the combination of oxygen and UV light have an effect on the depths of depressions in the films.

Help Received

Used lab equipment at General Atomics; had an internship at General Atomics

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Kowsigan Majuran

Project Number

S1509

Project Title

Simulation and Animation of the n-Body Problem in Two-Bodies

Abstract

Objectives/Goals

As the failure rates of satellites are increasing and becoming "space junk," the study of the gravitational 2-body problem is crucial. Trying to understand the n-body problem in a simpler form, such as the two-body problem, is a possible intermediate step in tracking the movements of satellites in space. Therefore, the goal is to create a computer program that simulates a special case of the n-body problem.

Methods/Materials

The program was manually written, tested, compiled, and debugged using C++ and Matlab, and included animation and user interface enabling control over simulation variables through Microsoft's OpenGL.

Results

Solving the 2-body problem numerically presented the most computationally efficient way to model the free bodies in real time. The software has a built in kinetic and potential energy indicator which displays the conservation of energy and ensured the accuracy of the program.

Conclusions/Discussion

Modeling and enabling a better understanding of special cases of the n-body problem could have applications in solving the general problem, which would not only be a monumental mathematical achievement, but would offer huge dividends in space-related industries.

Summary Statement

My project is to simulate and animate the n-body problem with the special case of the two-body problem.

Help Received

California State University Los Angeles for allowing me to use their facilities under the supervision of Dr. Charles Liu.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Daniel M. Parks

Project Number

S1510

Project Title

The Franck-Hertz Experiment

Abstract

Objectives/Goals

The purpose of the Franck Hertz Experiment is to test the hypothesis that the energy absorbed by gaseous atoms when they are excited is quantized.

Methods/Materials

To test this hypothesis, a thyratron tube, filled with a small amount of the gas to be excited, is used, consisting of a cathode, a filament, to heat and "boil electrons off of" the cathode, a positively charged control grid, and an anode, which has a slight retarding voltage. As the grid potential is increased, the current at the anode is measured and plotted on the Y-axis of an X-Y scatter graph, and the corresponding voltage is plotted on the X-axis. This can also be done on an oscilloscope.

Results

The graph of Anode Current versus Grid Potential yields an up down profile of a peak, a dip, a higher peak, a dip, and so forth. Limitations on the thyratron tube's design inhibit the maximum grid potential which can be applied for a sustained period. However, utilizing the oscilloscope, a quick increase in grid potential yields 9 dips before the gas only ionizes, yielding a sharp, unchanging increase in anode current.

Conclusions/Discussion

As such, the hypothesis was correct. If gaseous atoms were excited in non-quantized amounts, a steady, linear increase in anode current would be seen, however, this graph of peaks and dips occurs because the current will at first increase as the voltage at the grid does, but the current then drops, because the electrons colliding with the gaseous atoms will have enough energy to excite them, and will no longer have enough kinetic energy to reach overcome the anode's retarding potential and reach the anode.

Summary Statement

The purpose of this experiment is to determine if gaseous atoms are excited in quantized amounts.

Help Received

Used electronics laborotory at Ribet Academy.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Sara R. Weaver

Project Number
S1511

Project Title
Cooler Roofing

Abstract

Objectives/Goals
I set out to answer the following question: Which new roofing material, proposed to meet the requirements of recent California legislation, reflects the most light and reaches the lowest maximum temperature? I predicted that a white roofing material would reflect the most light and reach the lowest maximum temperature.

Methods/Materials
My materials included: a light meter, a heat lamp with 2 bulbs, 2 thermometers, 2 plastic storage boxes, 6 roofing samples including: white bitumen, black bitumen, granule bitumen, white plastic, black plastic, and tan plastic. To carry out my experiment I built and wired a heat lamp, placed one roofing sample beneath each bulb of the heat lamp, and recorded both sample's maximum temperature after 45 minutes using a standard barbecue thermometer. Each sample was tested beneath each side of the heat lamp for precision. I also visited a camera shop and used a light meter to measure the light reflected off of each material compared to a gray sample which had a reading of 7.0. To find which color of roofing material reflected the most light and reached the lowest maximum temperature, I tested different colors and two different types of materials.

Results
My experiments showed that white plastic roofing material changed least in temperature with a change of 28ºF, followed by tan plastic(37ºF) and white bitumen(38ºF). Of the two kinds of white material, the white plastic's maximum temperature was lower while the white bitumen reflected a little more light. The white bitumen reflected the most light in the light meter test with an average reading of 9.1.

Conclusions/Discussion
My experiments showed that overall, white plastic roofing reached the lowest maximum temperature while white bitumen reflected the most light. Although I predicted white to reach a lowest maximum temperature and to reflect the most light, this experiment allows me to see that an alternative colored roofing material can be used and have the same effects as a white material. This is shown in the tan plastic's temperature change of 37ºF compared to the white bitumen's temperature change of 38ºF. I find these measurements interesting, because they show an alternative, perhaps more aesthetically appealing and cleaner looking roofing choice for consumers that does not have the same negative environmental effects as a darker roofing material.

Summary Statement
My experiments tested the maximum temperature and light reflectance of roofing materials that have been proposed to meet the requirements of recent California legislation.

Help Received
My father helped me find a project idea, took pictures of me doing my project, and resized my pictures; Kanishka Reddy let me use his circular saw; Mike Hurley, Mike Melvin, and Sean Bammel pro0vided me with roofing samples; Roger N. from Samy's Camera helped me measure light reflectance.

Name(s)

David A. Woodbury

Project Number

S1512

Project Title

Magnetoresistance in Co/Al(2)O(3)/Co Granules/Cu Magnetic Tunnel Junctions

Abstract

Objectives/Goals

The objectives were to observe the tunnel junction magnetoresistance (JMR) of magnetic tunnel junctions (MTJs) and thereby investigate the magnetism of Co ranging from the sub-nanoscale granular level to the more familiar thin film level.

Methods/Materials

MTJs of structure 80Å Co/16Å Al2O3/3, 6, 9, 12Å Co/205Å Cu were fabricated by thermal evaporation and JMR was measured at room temperature (RT), 77K, and 4.2K.

Results

Samples consistently exhibited JMR of 0.6% and 1.5% at RT for 9Å and 12Å thicknesses of Co, respectively, and significantly higher ratios of 0.3%, 0.9%, 3.0%, and 2.8% for 3, 6, 9, and 12Å samples at 77K. Bias dependence of the JMR reveals a moderate decrease in JMR with increasing voltage and slight polarization asymmetry, which agrees with results for conventional junctions. JMR tests for 6Å samples at 4.2K reveal higher scattering and lower JMR than at 77K, possibly due to high resistance of Co granules to change of magnetic moment at this temperature. This indicates the blocking temperature (Tb), at which ferromagnetic behavior is "locked in", has not been reached.

Conclusions/Discussion

The shape of JMR curves was characteristic of superparamagnetic materials (Co granules), and increasing concavity was seen at increasing nominal Co thicknesses. Bias dependence tests showed results typical of traditional MTJs, and samples tested at 4.2K reveal a Tb<4.2K, which indicates a low temperature of ferromagnetic stability, a desirable feature for superparamagnetic MTJs.

MTJs in which magnetic material is evaporated as a granular layer at the electrode/insulator interface may have application as a magnetic field sensor due to the reliable dependence of resistance on applied magnetic field up to relatively high magnetic fields.

Summary Statement

The magnetoresistance in magnetic tunnel junctions fabricated with a layer of magnetic material evaporated as a granular layer at the electrode/insulator interface was investigated.

Help Received

Participant in Boston University High School Honors Research Internship Program; conducted research under the direction of Dr. Moodera and staff at the Francis Bitter Magnet Laboratory, MIT.