



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Xavier Aguilar	Project Number S1801
Project Title Not All Sunscreens Are Created Equal	
Objectives/Goals To see if expensive sunscreens with high SPFS are better than inexpensive sunscreens with low SPFs.	
Abstract	
Methods/Materials Materials: Different brands of sunscreen, Saran wrap, 2 ring stands with a thermometer clamp, Vernier Labquest 2, Two UVB probes, Thermometer clamp, Desk, Outdoor access away from buildings and trees.	
Method <ol style="list-style-type: none">1. Set up the ring stand.2. Place the ring stand in direct sunlight.3. Cut out a 5x6in piece of saran wrap.4. Place the piece of saran wrap you cut out on the ring stand.5. Weigh out 1.2 grams of sunscreen on a scale and place it on the saran wrap.6. Spread the sunscreen out until you have a thin layer of sunscreen covering the saran wrap.7. Attach the UVB probe to the thermometer clamp.8. Place the UVB probe under the saran wrap.9. Connect the UVB probe to the Vernier Labquest 2.10. Set up your control by following steps 1-4 and 7-9.11. Press play on the Vernier Labquest 2 and start taking in data for 5 minutes with 1 second intervals.12. Save your data.13. Repeat steps 1-12 for each brand of sunscreen.	
Results Most sunscreens block the same amount of UVB rays;however, some cost less.	
Conclusions/Discussion My hypothesis that the more expensive sunscreens with higher SPF would outperform the inexpensive sunscreens with lower SPF was partially wrong. What I observed was that sunscreens with SPF 30-100 outperformed sunscreens with SPF 15 or lower. However, Anything past SPF 30 did not block more UVB rays than SPF 30. What did vary between these sunscreens was the price. Block UP 30 blocked 99.9% of the UVB rays, but only costs one cent per gram while This experiment applies to people everywhere because many people use sunscreen to try to protect themselves from sunburns and the more important disease, skin cancer. This also applies to people because everybody likes to save money and most people	
Summary Statement My project's main goal was to test the efficiency of different sunsceen brands and SPFs.	
Help Received Teacher helped proof read written material.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Anna Z. Baney	Project Number S1802
Project Title Investigating UVA Radiation on the Chemical Properties of Sunscreen	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this experiment was to investigate the new and developing studies of UVA radiation protection. The goal for this experiment is to promote educational study on radiation, chemicals in ingredients, and causes for skin cancer.</p> <p>Methods/Materials The apparatus required for this experiment included an aluminum tube, saran wrap, 60 watt black light bulb, light fixture, infrared camera, 3/4 teaspoon measurement, stopwatch, wooden stick, duct tape, and a rubber glove. The testing products are: (S1) OceanPotion SPORT XTREME Sunblock SPF 30, (S2) Pacific Sun Sport Sunscreen Lotion SPF 48, (3) Coppertone Sunscreen Lotion SPF 50, (4) Pacific Sun SPORT Sunscreen Spray SPF 30, and (5) CLINIQUE: even better SPF 20. To begin testing take first test sample by using rubber glove to evenly spread # of a teaspoon of sample on left side of the saran wrap. Next evenly spread # of a teaspoon of another sample, on the right. Place wooden divider in between the samples. Next turn on light fixture a after ten minutes turn off light fixture. Repeat this same process with different samples.</p> <p>Results Sunscreen products containing the ingredients Zinc Oxide and Avobenzone showed the best results in UVA radiation protection. Chemically absorbing ingredients had warmer temperatures than physically blocking chemicals. Zinc oxide, a physical blocker for UVA radiation was found the most reliable ingredient in all sunscreen products.</p> <p>Conclusions/Discussion This experiment concluded which ingredients affect the capability of the sunscreens performance to resisting UVA rays. Specific ingredients such as oxybenzone showed to have varying results that could have been altered by inactive ingredients in the product. Overall, my hypothesis was proved to be correct and temperatures dropped in sunscreens with chemical blocker ingredients. The ingredients of the sunscreen are an important role in determining the outcome of this experiment. This was shown through the results.</p>	
Summary Statement In order to prevent DNA damage caused by harmful UVA rays the chemical properties of UV protecting ingredients were examined	
Help Received Dennis Baney for aid in infrared camera use.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Carolyn Donohoe; Jonathan McDowell	Project Number S1803
Project Title Trampolines: Force and Compression	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective was to find the change in a trampoline's force when an object is dropped onto it off-center. Using this data, we tried to find the relationship between these two factors to see if there's a "spring constant."</p> <p>Methods/Materials First, a bowling ball was dropped onto a trampoline from a constant height, while changing the distance from the center. Trampoline compression was measured by placing a motion detector directly under the drop location. Results were inconclusive so the procedure was altered. The experiment was repeated with one person standing on a device that reduced surface area and the other measuring trampoline compression with string underneath the trampoline. Lastly, the string method was used on a smaller trampoline with varying weight to measure changes in compression in one location.</p> <p>Results We concluded that the distance from the center and trampoline compression have a quadratic relationship. At a constant position, mass and compression have a positive linear relationship. At a specific point on a trampoline there's a spring constant, though the spring constant varies with position. As the object's distance from the center of the trampoline changes, the amount the springs are pulled changes due to more force being put on either the material or the spring.</p> <p>Conclusions/Discussion From the results we created an equation, which eliminates the spring constant. $F = (mg \cdot \sqrt{dx^2 + dy^2}) / (dy \cdot (1 + dx / (D - dx)))$ We'd like to further simplify this, but the trampoline is an extremely complicated situation. Ideally, we would be able to find the way to make the most efficient trampoline with such an equation.</p>	
Summary Statement We analyzed the changes in a trampoline's force when objects hit it off-center, and created an equation for a trampoline's force according to our results.	
Help Received Discussed concepts with physics teacher	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Kishan M. Ghadiya	Project Number S1804
Project Title Sunspot Cycles	
Abstract Objectives/Goals Using a statistical significance test, the objective of the experiment is to determine the type of time trend sunspot cycles make over a period of almost 300 years. The goal is to find the probability of the fact that onset times and decay times are the same in value. Methods/Materials Some materials involved in the project include a computer, internet access, spreadsheet Program (Excel), and a graphing calculator. To begin, cross-referenced data was gathered from multiple sources. From the data, onset time and decay time was found from each of the 22 cycles. The hypothesis was tested through a Significance Test. Two statistical hypotheses were made to test the experimental hypothesis. The Null Hypothesis says that the average rise times and decay times are the same and that if there were any differences, they would happen by chance ($\mu O - \mu D = 0$). The Alternative Hypothesis says that average onset times occur faster than decay times ($\mu O < \mu D$). Significance Levels decided which statistical hypothesis is correct. In my case, my significance level is $\alpha = .01$ or 1%. The statistical formula was used to find the test statistic, and using the test statistic value, the probability of the null hypothesis was found. Results Using the formula of a 2-Sample T-Test, the test statistic value was -5.38 standard deviations from the mean of the samples. Graphing the test statistic value on a normal distribution curve, the probability of the null hypothesis was 1.699×10^{-6} . Conclusions/Discussion According to the P-Value, the null hypothesis was rejected and the alternative hypothesis was accepted at $\alpha = .01$. The probability value we have reached provides powerful evidence to show that onset times occur faster than decay times, proving my experimental hypothesis as correct, because they both represent the same statement. Astronomers are allowed use this information to determine an overall sunspot activity trend. Sunspots give out billions of radioactive ions, and this radiation only takes days to reach Earth's Ozone Layer, causing imbalances in Earth's magnetic fields, geomagnetic storms, and even communication satellites. Astronauts in space are greatly harmed from this radiation. Sunspots are also affecting farmers' crops, so this information can be used to predict solar activity. This project is a foundation for many projects to come, and its results can serve as a basis for different types of astronomical research projects.	
Summary Statement My project's goal is to determine is sunspot cycles undergo faster onset times and slower decay times.	
Help Received General help received from father such as arranging board.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Kyle A. Groves	Project Number S1805
Project Title The Consequences of Light Pollution and How Filters Can Limit Its Effects in Astronomy	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals To analyze the background light in the sky known as light pollution, observe its affects on observations in the night sky, and test filters to evaluate their effectiveness.</p> <p>Methods/Materials Meade LX 200 reflecting telescope; Canon camera; Celestron UHC/LPR filter 2 inch; Orion SkyGlow filter 1.5 inch; Laptop computer; Spectrograph using a prism and Meade DSI CCD Imager camera; Mercury, hydrogen, and helium spectrum tubes; Bushnell reflecting telescope; Green and red laser pointers. Procedure: Set up the spectrograph, connected to a computer. Adjust the mount and prism to so that bands are in optimum position. Adjust so that the bands are narrow and cleanly separated. Photograph the spectrum of mercury, hydrogen, and helium spectrum tubes. Place fiber optic cable of the spectrograph in place of the eyepiece on a telescope and photograph the spectrum of the night sky. Photograph the night sky with filters on the spectrograph. Photograph mercury light with the range of filters attached. Adjust exposure for each of the filters for each of the wavelengths so that they are the same intensity as unfiltered. For Telescope: Point telescope at the Orion Nebula, M42. Photograph it unfiltered, then filtered with both the Orion SkyGlow and the Celestron filter. Travel to a place without light pollution (in this case the pinnacles) and photograph the Orion Nebula.</p> <p>Results The spectrograph readings of the night sky show that both filters block mercury light. The night sky's spectrum reveals that the primary light is mercury. The testing of the spectrum tube with different filters attached to it shows that the Celestron filter blocks mercury's spectrum of light more effectively than the Orion SkyGlow, but the Orion allows the most frequency 630 light through. This is important as it is closest to the frequency of H-Alpha, one of the most prominent types of light in nebulae like M42. Pictures through the telescope reveal that the Orion SkyGlow filter yields the best image of M42, though it is still not as sharp or detailed as without light pollution, as represented by a picture taken from the Pinnacles.</p> <p>Conclusions/Discussion Filters do not replicate conditions with no light pollution, but they can get fairly close, and they block out a wide spectrum of mercury light effectively. This is important to the Salinas Observatory as it is heavily effected by light pollution, and these filters can help limit its effects.</p>	
Summary Statement My project is about how light pollution interferes with viewing celestial bodies through telescopes in urban areas and how different filters can lower its negative effects.	
Help Received Mr. Philip Deutsche provided me with help, advice, and equipment.	



CALIFORNIA STATE SCIENCE FAIR 2013 PROJECT SUMMARY

Name(s) Michelle Guo; Andrew Zhang	Project Number S1806
Project Title The Distribution of [C/Fe] Ratios in Milky Way Dwarf Spheroidal Satellites from Medium-Resolution Spectroscopy	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The main objective of this project is to measure carbon abundances, using the medium-resolution spectroscopy (MRS) technique, for stars in the Milky Way's dwarf satellites. The carbon abundances for these stars have not yet been reliably measured before, and this is the first time anyone has calculated carbon abundances with the MRS technique for such a large sample of stars. The direct results of this project will be used to determine if the MRS technique is better than the more commonly used high-resolution spectroscopy (HRS) technique in terms of precision and accuracy. To further examine the role of dwarf galaxies in building the halo, the degrees of carbon enhancement will be compared to the dwarf spheroidal galaxies (dSph) and the halo field population</p> <p>Methods/Materials A grid of high-resolution synthetic spectra for hypothetical stars of specific effective temperature, surface gravity, metallicity, alpha element abundance, and carbon abundance was generated for comparison with medium-resolution observed spectra of dSph stars of unmeasured [C/Fe] but otherwise known properties. After smoothing, rebinning, and normalizing the two data sets, carbon abundance was varied to find the best carbon abundance by determining the synthetic spectrum that gave the minimal deviation.</p> <p>Results A lower Carbon-Enhanced Metal-Poor (CEMP) fraction was found: 1%±1% in the dSph galaxies compared to the 21% ± 2% in the halo. In particular, Sculptor did not have any CEMP stars. The [C/Fe] values calculated for stars 598482 and 604526 in Draco are -0.08 ± 0.08 and -0.67 ± 0.22, respectively. The corresponding HRS measurements were found to be -0.48 ± 0.26 (star 598482) and -0.57 ± 0.30 (star 604526).</p> <p>Conclusions/Discussion A lower margin of error was discovered in the MRS measurements than in those from HRS, which shows that using the MRS technique to calculating abundances is in fact more precise than measurements through HRS. The difference in CEMP frequencies between the dSphs and the halo suggests that the dwarf galaxies have evolved over time. The lack of CEMP stars in Sculptor suggests that other galaxies similar to Sculptor in mass were not dominant contributors of the halo field population. The variation in carbon abundances supports prior knowledge of dSph stars and provides a deeper understanding of the formation of stars such as those of the Milky Way halo.</p>	
Summary Statement By using MRS, calculating 600+ carbon abundances proves MRS is more precise and more widely applicable than the traditional HRS, ushering a new era of data analysis for distant galaxies that were previously difficult to measure.	
Help Received Dr. Evan Kirby (UCI) provided guidance for our project. Dr. PuragraGuhathakurta (UCSC) provided the facility at UCSC for conducting our research project.	



CALIFORNIA STATE SCIENCE FAIR 2013 PROJECT SUMMARY

Name(s) Rahul Joshi; Harika Kalluri	Project Number S1807
Project Title Car Seats and Damage Control: Finding the Optimal Distance that a Car Seat Should Be Placed from a Crumple Zone	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals In our project, we are trying to understand how the distance away from the crumple zone can affect the acceleration of a child's head, and how this acceleration is similar to the acceleration of a child's head when experiencing whiplash in a car crash. Our hypothesis was that pulling back the car seat 1 meter from the crumple zone would lead to an increased acceleration when compared to shorter distances. This hypothesis was reached due to our understanding of the Law of Conservation of Energy.</p> <p>Methods/Materials To conduct this experiment, we made a mannequin that was the average height and weight of a child suited for a car seat. We tied the car seat with the mannequin to the top of a fence and pulled it back in an arc (imagine a pendulum). We measured horizontal distances away from the fence in increments of 10 cm, then proceeding to drop the car seat, which would then swing towards the fence (again, refer to a pendulum). We measured the acceleration of the child's head just as it hits a crumple zone using an accelerometer app for iOS, called Sensor Monitor.</p> <p>Results Our results show a direct relationship between the change in acceleration of the child's head and the distance at which the car seat is pulled. With each additional increment of 10 centimeters, the acceleration increased.</p> <p>Conclusions/Discussion Our results explain that even when we pulled the car seat only 10 centimeters horizontally from the wall, the child's head experienced enough change in acceleration to cause whiplash and potential brain damage to a child. By studying this, we learned that car seats like the one we used are very unsafe and can cause serious brain damage and even death for children who experience car crashes. This is especially important when considering that car crashes are the number one killer of children from ages 3 to 14. Also, we learned that 3 out of every 4 parents incorrectly use child restraints to keep children safe in potential car crashes. Simple solutions to this significant problem can save many children from damage like Shaken Baby Syndrome and whiplash, especially when they have immature skeletal and muscular structures in their necks and heads. Through this experiment, we discovered that car seats require a much safer design in order to keep children safe. A possible design we concocted was a small strap around the head of the child to ensure head safety.</p>	
Summary Statement Our project studies how the horizontal distance a car seat is from a crumple zone affects the acceleration of a child's head as if in a real car crash and how the problem must be solved to prevent child deaths.	
Help Received We worked in teacher's classroom and used school fence for method.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Jay Kamat; Alex Nagase	Project Number S1808
Project Title Exploring the Effect of Water Hardness on the Mpemba Effect	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This experiment was designed to test whether water hardness would enhance the Mpemba Effect, a phenomenon where hot water freezes faster than cold water. Hypothetically, cold water would freeze before hot water due to Newton's Law of Cooling because it begins at a lower temperature. It is hypothesized that harder water would decrease the amount of time between the freezing times of hot and cold water samples of equal hardness. In other words, the hypothesis predicts that the Mpemba effect would be more evident in harder samples of water.</p> <p>Methods/Materials The hypothesis was tested by preparing test tubes with 10 ml water samples of 3 different hardnesses, 1 ppm, 200 ppm, and 400 ppm. One sample of each hardness was heated to 50°C. A second set of samples was heated to 35°C. All 6 test tubes were placed in a freezer and the temperature was monitored using a data collection device with stainless steel temperature probes. By analyzing the graphs of temperature vs. time, the freezing point of each pair of samples was determined.</p> <p>Results Once a list of freezing times was compiled, the difference in the freezing time between that of the hot and cold samples of each hardness was calculated. The freezing time for the hot sample (in minutes after freezing started) was subtracted from the time it took for the cold sample to freeze. If the temperature difference was negative, the presence of the Mpemba effect was confirmed. The graphs consistently showed that the harder samples tended to have a lower difference in freezing time between hot and cold samples. In some cases, the harder samples of water showed the Mpemba effect while their softer counterparts did not. There was a direct correlation between water hardness and the difference in time that it took the hot and cold samples to freeze.</p> <p>Conclusions/Discussion Through the data obtained in the experiment, it can be concluded that water hardness had an effect on the difference in freezing times of hot and cold water. The harder water produced a smaller time difference between the freezing times of hot and cold samples, while the softer water resulted in a larger time difference. However, further testing with a more optimal control over freezing conditions will be required to decide whether water hardness directly or indirectly causes the Mpemba Effect to occur.</p>	
Summary Statement This projects examined whether water hardness was a contributing factor of the Mpemba Effect.	
Help Received Dr. Plano (Teacher) allowed us to use the high school laboratory equipment and a refrigerator and supervised us; Other science and math teachers in school helped to peer review our project	



CALIFORNIA STATE SCIENCE FAIR 2013 PROJECT SUMMARY

Name(s) Justin G. Lee	Project Number S1809
Project Title Sound Resonance: How Wood Properties Affect Sound	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals I want to understand how hardness and density of different types of wood affect the amplitude and power of sound propagation. What type of wood resonates sound the best and would be best for constructing a string bass.</p> <p>Methods/Materials Sound, density, and hardness measurements were collected on 8 types of wood boards - birch, Cambara mahogany, maple, MDP (Medium Density Fiberboard), poplar, red balau, red oak, and redwood. Sound from a music box mechanism placed on top of the wood was recorded and analyzed with Raven Lite 1.0 software. Weight and dimension of each wood board were measured to calculate the density. The amount of force needed to penetrate a wood screw tip 3/16" into each wood was measured using a load cell to determine the hardness of the wood. Correlations were made between the amplitude and loudness of the sound from each type of wood and the corresponding hardness and density of the wood. The melody recorded on each wood was listened to carefully to evaluate the sound quality from each wood.</p> <p>Results The hardness of the wood in the order of hardest to softest was red balau, maple, birch, red oak, MDF, mahogany, poplar, and redwood. The density of the wood followed the same order as the hardness except for MDF. Red balau, the hardest wood, had the largest amplitude of 8930MU and resonated the loudest at 109.5dB at 2220Hz frequency. Redwood, the softest wood, had the lowest amplitude of 3580MU and resonated at a lower level of 87.0dB on loudness at 1480Hz.</p> <p>Conclusions/Discussion My experimental results showed that denser and harder wood such as red balau, birch, maple and red oak produced larger amplitude and higher power sound. This supported my hypothesis that denser and harder wood had less room for the sound to get absorbed; instead allowed sound to vibrate more on the surface of the wood. However, the density and hardness of the wood affected the tone quality of sound as well as the volume, pitch and other properties of sound. The red balau and other harder wood though produced a louder sound for the melody, but the sound of the notes were not evenly distributed. Softer and less dense woods like poplar emitted sounds that was very soft, muffled, almost muted and the resonance that rang from the wood was very rich and subtle. I would prefer using poplar to build my next bass.</p>	
Summary Statement My project examines how wood properties affect sound resonance and what type of wood would be best for constructing a string bass.	
Help Received My mom's work loaned me the load cell. My dad assisted with constructing the load cell platform.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Jamie R. Lesser	Project Number S1810
Project Title Kinetic Monte Carlo Simulation on Atomic Diffusion on a Cu-Sn Surface	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Under applied electric current, interconnects in integrated circuits are known to fail when lack of resistance to electromigration causes directional diffusion and the formation of voids as a consequence. The goal of this project is to study the influence of alloyed Sn atoms on resistance of Cu to electromigration by focusing on the migration paths of a single Cu atom (adatom) as it moves along the surface.</p> <p>Methods/Materials We model the diffusion of an adatom on the Cu (111) surface in the presence of Sn impurities using a computational simulation. The Sn impurities deform the potential energy surface and create obstacles that block the adatom migration. The Kinetic Monte Carlo method (KMC) is employed as a randomization technique to generate the migration paths of the adatom.</p> <p>Results The results confirm that the Sn impurities create areas to which the adatom cannot migrate and that these areas change in size with temperature.</p> <p>Conclusions/Discussion Since the Sn impurities significantly affect the potential migration paths of the adatom, it can be concluded that the Sn impurities would increase resistance of copper to electromigration. This supports a future improvement of interconnects by coating them with a Cu-Sn alloy surface, therefore allowing the material to last longer under applied electric current. A stronger interconnect would also allow for the production of smaller integrated circuits.</p>	
Summary Statement Studying a Cu-Sn alloy surface's effect on the physical property of copper's resistance to electromigration.	
Help Received Parents edited report; Dr. Cheng, Dr. Po, and Professor Ghoniem supervised and mentored me in the building of my computational simulation; Mr. Starodub guided me in the research formalities.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Vinson Luo	Project Number S1811
Project Title Relativistic Ray Tracing: Using Ray Tracing to Simulate the Appearance of Objects in Relativistic Situations	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of the project was to determine whether ray tracing is an effective method of visualizing relativistic physics.</p> <p>Methods/Materials A basic Java ray tracer was written using the Eclipse IDE on an Intel quad core i7 laptop, upon which relativistic transformations for both special and general relativity were applied. The resulting program was then run on a variety of test scenes, and the resulting images were analyzed. Computation times for the multithreaded ray tracer were compared with those of a single threaded approach, and were anti-aliased and aliased versions of the ray tracer were compared as well.</p> <p>Results Implementing multithreading and antialiasing into the ray tracer cut computation times by approximately 50% while increasing overall image quality, particularly around the edges of objects. The images produced under both special and general relativistic conditions demonstrated a wide range of relativistic effects, including the Lorentz transformation, relativistic aberration, and gravitational lensing. Moving towards scenes at relativistic speeds typically resulted in an increasing field of view accompanied by the shrinking of objects, whereas moving away from scenes at relativistic speeds resulted in a decreasing field of view and the enlargement of objects. The addition of gravitational lenses into scenes allowed for the visualization of various optical effects caused by gravity.</p> <p>Conclusions/Discussion Ray tracing demonstrated great success at providing a means to visualize scenes under relativistic conditions. A ray tracer built from scratch in Java and run on a home laptop was capable of rendering a diverse variety of scenes implementing both special and general relativistic effects. Images produced by the ray tracer were physically accurate, excluding inaccuracies caused by the use of the gravitational lens approximation, and rendered within relatively short amounts of time with the addition of multithreading. In conclusion, the ray tracing proved to be an efficient, capable, and accurate method of visualizing relativistic physics.</p>	
Summary Statement This project applies the computer graphics technique of ray tracing to visualize the appearance of objects under special and general relativistic conditions.	
Help Received Dr. James Li served as a mentor for the project and provided guidance on the general direction of the project, including the extension into general relativity after special relativity. Mr. Tim Smay also helped structure the final research paper and edited some parts of this report.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Marc J. Matossian	Project Number S1812
Project Title The Physics of Operating a Negative Corona Discharge	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of my science project was to study the physics of operating a negative corona discharge; specifically the radial and angular flow field of ions exiting a corona discharge, as well as the type of gas species produced. My hypothesis was that only electronegative ions could exit a negative corona discharge and that the intensity of negative ions would decrease with radial distance and angle from the exit plane of the discharge. In addition, I expected the gas species produced to depend on the gas type used to operate the corona discharge.</p> <p>Methods/Materials A negative corona discharge source was assembled and consisted of a small high voltage DC power supply providing -7.5 kV to an array of 7 sharp nails (serving as cathodes) that were concentric with 7 copper cylinders (serving as anodes). The source was placed inside a plastic enclosure which could be pressurized with electronegative gases such as CO₂, N₂, and Air, as well as an inert gas such as Ar. Ions and neutral species exited the plastic enclosure through small holes at one end. An ion counter was used to measure the ion polarity (+ or -) as a function of radial distance and angle from the source. Colorimetric gas detection tubes were used to measure various gas species produced by the corona discharge (NO_x, CO₂, CO, HC, and O₃).</p> <p>Results</p> <ol style="list-style-type: none">1. Positive ions are unable to exit a negative corona discharge2. Only negative ions are emitted from a negative corona discharge<ol style="list-style-type: none">a. The negative ion count decreases exponentially with radial distanceb. The negative ions are contained within + 15 degrees of the centerlinec. The negative ion count is independent of the discharge voltaged. The exact type of negative ions exiting the source was not determined3. The dominant gas species produced were ozone (O₃) and CO₂<ol style="list-style-type: none">a. CO₂, N₂, and Argon gases produced more ozone compared to airb. CO₂ production increased during corona discharge operation <p>Conclusions/Discussion The negative ion density from a negative corona discharge decreases exponentially with distance from the source and is constrained to a +/- 15 degree region from the exit plane. Ozone and CO₂ were the dominant gas specie produced for all gas types.</p>	
Summary Statement My project studies the radial and angular flow field of negative ions and gas species exiting a negative corona discharge.	
Help Received Father helped with some of the assembly, helpful discussions with Professor John Williams of Colorado State University to discuss the results.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Rayna M. Rampalli	Project Number S1814
Project Title Looking for Another World? Rapid Inference Model for Exoplanets as Super Earths or Hot Jupiters	
Objectives/Goals To create a rapid inference classification system by correlating transit curvature to mass and orbital radius of exoplanets. The rapid inference classification system provides astronomers with a more cost- and time-effective method of classifying exoplanets. Goal is to reduce costs of expensive instrumentation and improve efficiency of classification methodology.	
Abstract Methods/Materials a. Obtain raw transit data from the Kepler Public Survey Data b. Select a sample of exoplanets corresponding to planet mass and size of Jupiter, Neptune and Earth. c. Clean up data by filtering noise and outliers from the sample obtained from the Kepler Public Survey Data. d. Plot clean data into transit graphs using MATLAB. e. Establish curvature equations of the 6 transit flux graphs in a generalized model. Establish the goodness of fit or correlation co-efficient. f. Deduce a family of transit curvature models from mapping transits. Verify correlation to exoplanets in the Kepler Public Survey Data and plot an inference model or classification.	
Results The following show the best fit curvature equations from each plot for classification of exoplanets. Type 1 Hot Jupiter: close correlation between flux in/out versus time transit curves. Type 2 Super Earth: close correlation between flux in/out versus time transit curves.	
Conclusions/Discussion The transit curve equations determined through MATLAB conclusively point to the possibility of creating a taxonomy of transit curves. The high degree of fit/correlation (R-squared) allows the use of these equations to be a reliable predictor of the nature of exoplanets in the currently categorized in the Kepler Public Survey Data and any other yet-to-be discovered exoplanets. The use of this mathematical estimation through the use of MATLAB makes it possible to eliminate the use of cumbersome instrumentation and mathematical analysis to compute the mass and exoplanet type used by contemporary astronomers and astrophysicists. While this method is not a substitute for precise measurement, it provides a rapid, first order inference model for the nature of a newly discovered exoplanet in the first step of an expanded study. In closing my analysis confirms the hypothesis that the shape of the transit curve trough varies predictably in proportion to the mass and temperature (gaseous, cold) of the planet.	
Summary Statement This project is a rapid inference model for characterizing extrasolarplanets.	
Help Received Poster layout and printing by Hal Hammond	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Sara K. Simpson	Project Number S1815
Project Title Modeling Parameter Sensitivity of Nonlinear Oscillators with Fitzhugh Nagumo Equations	
Abstract Objectives/Goals The Fitzhugh Nagumo Model is widely used to understand the behavior of neurons and other excitable systems, which are nonlinear oscillators with a distinct threshold and dynamics. An important physical parameter is the oscillation frequency, or firing rate, as a function of an external stimulus or another model parameter. This project investigated whether this frequency is always sensitive to changes in the stimulus and other model parameters. Methods/Materials First, the model was formulated with the minimum number of free parameters that gave the full range of physically relevant variations. Numerical experiments then were performed to integrate the nonlinear differential equations, and calculate the Fourier spectrum that determines the oscillation frequency. The adjustable parameters were varied to measure the level of sensitivity of the oscillation frequency to these changes. Results These experiments confirmed that the frequency of excitable systems was sometimes insensitive to changes in the stimulus and/or other model parameters, even when multiple parameters were changed simultaneously. This insensitivity could be useful for an oscillator, for example as a steady frequency reference in an electrical circuit used in sensing or communications. Additionally, when two oscillators were modeled in a coupled system based off the basic neural circuitry in the brain during Parkinson's disease, these operating points of insensitivity were still observed. However, the Fourier Spectra differed greatly between neurons at these points, with some of the points having multiple low frequency components along with a dominant frequency. Conclusions/Discussion These components are indicative of Parkinson's-like neural behavior in the brain, and so there may be a relationship between these special points and firing patterns during Parkinson's Disease. Therefore, the results of this project have potentially wide ranging implications in physics, engineering, and biology/neuroscience.	
Summary Statement This project demonstrated through the Fitzhugh Nagumo Model that the fundamental frequency of individual or coupled nonlinear oscillators can be insensitive to parameter variations with potentially wide applications, including neurophysics.	
Help Received	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Adam C. Stephens	Project Number S1816
Project Title It Is a Bird! It Is a Plane! No, It Is a Film Canister Rocket	
Abstract Objectives/Goals To determine the effect of air temperature on the flight distance of a fueled film canister. Methods/Materials Two blocks of wood were screwed together with one cut at a 45 degree angle to form a launch pad. The film canister lid was screwed to the launch pad. A hole was drilled through the launch pad and lid to allow two wires to run from an electronic ignitor through the hole to form a spark gap for the ignition source. The film canister was sprayed with hair spray, and the canister was attached to the cap. The electronic ignitor was activated which caused the canister to be launched into the air. Results As the air temperature dropped, the average flight distance of the canister increased. Conclusions/Discussion The fuel (hairspray) contains alcohol. The reason the canister flew further as the air temperature dropped is because more of the fuel was contained in the canister at lower air temperatures due to lack of lift and evaporation of the hairspray in the container.	
Summary Statement To see how far a fueled film canister will fly depending on air temperature.	
Help Received Father recorded results of each launch. Mother helped tape pieces of paper together.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Caitlin E. Thompson	Project Number S1817
Project Title Bio-Inspired Design of a Dew Catcher Based on Nanotechnology	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Inspired by the fog catching beetle of the Namib Desert, I am testing prototype designs for a dew capturing surface, using nanotechnology and recycled materials, that is capable of collecting drinkable water for humid air.</p> <p>Methods/Materials MATERIALS Hydrophobic nanoparticle spray, Hydrophilic spray, Rainex spray, CDs , Metal disks, Pipettes, Tissues, Scale, Instrument to measure dew point.</p> <p>METHODS CDs or metal disks were coated with either hydrophobic, hydrophilic or Rainex sprays or half coated in hydrophobic and half in hydrophilic. The CDs and disks were placed out at night and the dew point was measured. In the morning, water collected on the CDs or disks was removed with a tissue and the tissue was weighed to see how much water collected. Pictures were also taken of water drops on all substances.</p> <p>Results The contact angle on hydrophile was 9 degrees, while on glass it was 11 degrees. Water did not form drops or roll off either the hydrophilic surface or plain glass. The hydrophobic spray from Nanobead did result in a superhydrophobic surface with a contact angle of > 150 degrees. Microscopic examination of that surface showed that it consists of particles ranging from <100 nm to microns in diameter. Rainex did not reach the status of a hydrophobe. For the metal disc, half of which coated with superhydrophobe and other half with hydrophil, we were able to collect 0,3 grams of water overnight. This is equal to 143 mL/m2.</p> <p>Conclusions/Discussion In my experiment, I found that hydrophilic coating enhance attraction while hydrophobic coatings decrease attraction. The variety of hydrophobic substances that was used lead to several new findings. Both Rainex and Teflon were surprisingly effective hydrophobes, although neither reached the level of a superhydrophobe. The hydrophobic spray from Nanobead did result in a superhydrophobic surface. The hydrophilic coating was only slightly more effective than uncoated glass. In testing prototypic fog catchers outdoors, I found that surface coatings increased the ability to capture water from air, relative to uncoated control surfaces. The most effective method for collecting water was a metal disk coated half with hydrophobic, half hydrophilic.</p>	
Summary Statement Inspired by the fog catching beetle of the Namib Desert, I am testing prototype designs for a dew capturing surface, using nanotechnology and recycled materials, that is capable of collecting drinkable water for humid air.	
Help Received Used lab equipment of Hopkins Marine Station	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Elizabeth Thomson; Allyn Tolosa	Project Number S1894
Project Title Extinguishing Fire Using Sound Energy	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective is to duplicate the results achieved by DARPA in their developmental experiment to extinguish fire using sound energy. Our goal for this experiment is to further develop an environmentally friendly and safe method to extinguish fire in closed volumes such as aircraft's, and ships</p> <p>Methods/Materials A pair of speakers capable of producing below 40 Hz with a lot of power 12# Subwoofers for desired range of 20-80 Hz. Subwoofer amplifier capable of powering 12# speakers with a lot of power, Wiring and various plugs, Sound spectrum analyzer and microphone, Flame source (We used an oil candle for consistency), Earplugs, computer, sine wave test-tone generator app for iPhone, camera, tape measure, lighter, candle stand to elevate flames to the speaker height, paper & pencil. Set sound system up in various locations and analyze room response before beginning experiment. Record spectral data at the point when the fire extinguishes, analyze and compare. calculate the optimum frequency at each various distance and location.</p> <p>Results Results demonstrate that fire may be extinguished with sound but, the performance is dictated by the acoustic environment such as the way the various rooms respond to a range of frequencies(the acoustics). The overall performance of this experiment relies on the power and frequency of the sonic source. One of the major, unexpected complications of this experiment were overtones created as a result of the acoustic environment in which the test was performed. We were able to identify an optimal range of frequencies in which to achieve the minimum sound energy when extinguishing fire.</p> <p>Conclusions/Discussion The experiment was successful in duplicating the DARPA results on a smaller scale. However, the DARPA results were based on a single set up and a single frequency. my results demonstrated that the results vary based on the set up, the variables include: the distance between sound sources, the frequency, and the power available, as well as the natural acoustics of the room.</p>	
Summary Statement To expand upon DARPA's research on extinguishing fire with sound energy, by including additional variables that may influence the results.	
Help Received Interviewed sound system professionals who generously loaned 12-in low frequency speakers(Subwoofers), My Father helped me with wiring the sound system to different amplifiers. Borrowed sound pressure spectrum analyzer from father.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Diego Kress; Sean Williams	Project Number S1895
Project Title Quantum Levitation	
Objectives/Goals The objective of our experiment was to figure out how long it takes for a neodymium magnet to seize levitating over a Yttrium Barium Copper Oxide compound cooled with liquid nitrogen. We also tried to figure out the temperature at which the magnet seizes to levitate. Our experiment is based upon the Meissner effect otherwise known as Quantum Levitation. We believed that if the temperature of the magnet reached above -50 degrees centigrade, then the magnet would fail to continue to levitate. We also hypothesized that it will take at least two minutes and thirty one seconds for the magnet to stop levitating once all the liquid nitrogen in the dish had evaporated.	
Abstract Methods/Materials Our experiment is based upon the Meissner effect otherwise known as Quantum Levitation. During our experiment we measured the time and temperature once all the liquid nitrogen had evaporated from a Petri dish that the experiment occurred in. We tested this same procedure ten consecutive times. During our experiment we used: 10 liters Liquid Nitrogen, 1 Petri Dish, 1 Supper Conductive Rectangle of Yttrium Barium Copper Oxide (1# Diameter x 1/8), 1 Pair of Plastic Forceps, 1 Pair of Cryo Gloves, 1 500 ml Beaker, 1 Thermometer, 1 Stopwatch, 1 Neodymium Rare Earth Magnet. Our procedure consisted of 11 steps: 1. Prepare Petri dish and place the rectangular superconductor in it. 2. Pour the liquid nitrogen into a 500 ml beaker. 3. Slowly pour the liquid nitrogen so that it covers the top of the rectangle. 4. Use the forceps to pick up the magnet and place it gently over the cooled disc. 5. Continuously measure the temperature of the superconductor. 6. When all the liquid nitrogen evaporates start the timer. 7. Stop the timer when the magnet stops levitating and record it. 8. Measure the temperature when the magnet stops levitating and record. 9. Take the magnet out of the Petri dish. 10. Pour more liquid nitrogen inside until covered. 11. Repeat steps 4-10 until experiment has been preformed 10 times.	
Results The magnet took an overall time varying from 9.2-22.3 seconds to fall. The temperature of the compound however varied from -65.5 to -65.8 degrees Celsius when the magnet dropped.	
Conclusions/Discussion Overall our science experiment was a success and we succeeded in managing to make the magnet levitate, and testing the temperature and time while successfully demonstrating the Meissner effect.	
Summary Statement To test how long it takes, and at what temperature a cooled superconductor stops supporting a magnet through its changes in its magnetic field levitation.	
Help Received Don Kress helped by supplying safety gloves and taking photos; Ms. Reynosa let us use her classroom to preform the experiment, and use of her thermometer; and Praxair supplied the liquid nitrogen	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Blake A. Bergstrom	Project Number S1896
Project Title Visual and Photometric Classification of a Sample of Low to Intermediate Redshift Galaxies in the COSMOS Field	
Abstract Objectives/Goals Morphological types of galaxies are one of the most fundamental properties of galaxies, and yet it is still not completely understood why such diversity exists. This experiment is designed to classify 1,000 galaxies from the COSMOS survey, done by the Hubble Space Telescope, by their visual appearance and color, seeing what redshift each type of galaxy is located in. This will tell us which galaxies are older and newer, helping support theories about the evolution of such shapes. The hypothesis is if late-type galaxies (spiral and irregular) are young and contain star-forming gas, then they will be blue and will be found at higher redshifts. If early type galaxies (elliptical and lenticular) contain older stars with less forming gas, then they will be red and found at lower redshifts. Methods/Materials The 1,000 galaxies were divided into 500 bright and 500 faint galaxies. Both groups had ten categories of redshift, with 50 galaxies in each category. Using DS9, all galaxies were classified (elliptical, lenticular, spiral, or irregular). Data about frequency length was given by the grad student, and each galaxy was classified by color also. Results Early-Type galaxies (elliptical and lenticular) proved to have a trend of increasing numbers with higher redshifts, meaning they appear later in the universe. Late-Type galaxies (spiral and irregular) had an increasing trend with decreasing redshift, meaning they appeared more in the early universe. Conclusions/Discussion As a result, the hypothesis was confirmed in the visual classification aspect. This backs up the hierarchical theory and Cold Dark Matter theory of how the universe was formed, and also supports the evolutionary theory of spiral galaxies first colliding and forming ellipticals as a result, making irregulars as an intermediate stage. Color did not show such trends, since look back time is not the only thing that affects color, as composition does too. These results help to fill in the gap of one of the most highly debated topics in modern astronomy.	
Summary Statement This project has many different aspects, but the central purpose of it is to answer why there are different types of galaxies and how they formed into the types they are today through visual and photometric analysis.	
Help Received Dr. Bahram Mobasher of UCR and grad-student Behnam Darvishi provided guidance and consultation on analysis of the COSMOS Field.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Ezra B. Creighton	Project Number S1897
Project Title Making a Four Stroke Engine Run on Water, Instead of Gasoline	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Today four stroke gasoline engines control our transportation. These engines are polluting the environment and run on a limited fuel. I've proved before that HHO added to the air-fuel mixture can improve fuel efficiency of a engine. This because HHO is an explosive gas made of hydrogen and oxygen. If HHO can supplement gasoline, maybe I can build a HHO generator to safely power an engine with no gasoline at all. I produced the HHO by using electrolysis to split water molecules into separate gases. Due to HHO being a very flammable gas I hope when I put it into the engine it will take gasoline's place in running the engine. If I can run an engine it will prove that HHO can be safely made at home to replace gasoline. When HHO is combusted in the engine, it turns back into water. If HHO was used to run engines we would have an abundant amount of free fuel that is environmentally friendly. My design has to run the engine and be safe.</p> <p>Methods/Materials My first HHO generator prototype did not fulfill the design criteria so I remodeled it before starting my testing. First I made sure the four stroke engine could run on gasoline. After making sure the engine was out of gasoline, I put the HHO tube into the air intake of the carburetor. I let pressure build up in the generator. Next I pull started the engine as I released the pressure to allow the HHO to surge into the engine's intake. The engine backfired on a test and cracked my generator, so I remodeled with a different safety.</p> <p>Results Prototype 1 didn't work because the safety was not working properly. I remodeled the generator (prototype 2) to have a working safety so it would not be dangerous in case of a backfire. Prototype 2 successfully started the engine. But prototype 2 broke after a backfire. Prototype 3 was able to successfully run the engine 18 times without fail. The run times varying with the amount of HHO in the system. Prototype 3 was successful in fulfilling the design criteria.</p> <p>Conclusions/Discussion My tests show that an engine can run on HHO! The engine would run when the HHO surged into the engine but not run without it. This proves that HHO can be easily manufactured to run an engine. Since HHO can replace gasoline if we used it in our engines we would save money, fuel and have emissions that will help save the environment. HHO can be produced for free if solar panels are used to provide the electricity to run the HHO generator.</p>	
Summary Statement This project proves that a four stroke, 13.0 horsepower engine can be made to run on a safe, homemade HHO generator.	
Help Received I would like to thank Mike Bell for his help in fixing the problems with the HHO Generator and the engine, as well as for proofreading. I would also like to thank my dad for getting the pieces to make the generator and the use of his engines and tools. Also Audrey Bell for proofreading.	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Roshan J. Plamthottam	Project Number S1898
Project Title The Self-Assembly of Diamagnetic Materials Using a Magnetic Field	
Abstract Objectives/Goals My project was to determine if macro, micro, and nano scale diamagnetic materials can be self-assembled into three-dimensional structures using a magnetic field in a superparamagnetic medium. I believe that the nano-scale and macro-scale beads will not self-assemble due to issues arising from the size of the beads relative to the size of the particles in the medium. Methods/Materials After synthesizing super-paramagnetic nano-particles, 1 μ m, 2 μ m, 15 μ m, 25 μ m, and 1/16" polystyrene and acrylic beads were placed in microscope filter holders by size along with a diluted solution of the nano-particles. Each sample was placed under a strong magnetic field for at least two hours before being observed under a microscope, in order to visually examine any structures that may have formed. The procedure was carried out three times to ensure accuracy and to obtain reliable and sufficient data. Results The 1 μ m, 2 μ m, and 1/16" beads did not self-assemble into structures when examined under an optical microscope. However, the 15 μ m and 25 μ m polystyrene beads did self-assemble into various ordered structures. Conclusions/Discussion It was determined that the 15 μ m and the 25 μ m polystyrene beads can be self-assembled using a magnetic field in a superparamagnetic medium, despite the bead's diamagnetic properties. Similar processes can be employed for applications in fields such as chemistry, medicine, and photonics as well as others. Conditions must be met before self-assembly can occur, and the superparamagnetic medium allows certain sized diamagnetic materials to self assemble.	
Summary Statement My project was to determine if macro, micro and nano scale polystyrene and acrylic beads will self-assemble under a magnetic field when placed in a superparamagnetic medium.	
Help Received Used lab equipment at Sebastian Scientific Corporation under the supervision of Dr. Plamthottam	



**CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY**

Name(s) Jessica Cao; Austin Ha; Cameron Khansarinia	Project Number S1899
Project Title The RC Time Constant: Developing and Optimizing a Three-Dimensional Tracking Interface	
Abstract Objectives/Goals The purpose of this project was to develop and optimize a three-dimensional tracking device. Our hypothesis was that higher resistances would decrease the RC time constant, therefore increasing the overall speed of the system's response to movement. Methods/Materials Different resistors were hooked up via shielded cables to an X, Y, Z coordinate cube, built of cardboard and aluminum foil. The cables were connected to an Arduino Uno and a computer. Placing a hand inside the apparatus created disturbances in the electrostatic fields of the capacitive sensors. Comparing the movement time to the response time in the software revealed the correlation between resistance and latency. Results In the resulting averages, it was observed that the system built with 220K ohm resistors was the most efficient with regards to real-time response. Conclusions/Discussion The main hypothesis was that higher resistances would produce a lower RC time constant and thus less latency. The results of this experiment proved our hypothesis to be incorrect. There is a curve in the relationship between resistance and latency, with the tested resistance of 220K ohm performing best overall. Our experiment provides a simple prototype of capacitive sensing, which can be optimized to provide real-time interaction in three dimensions.	
Summary Statement The purpose of this experiment was to determine how resistance changes the latency within a three dimensional tracking interface.	
Help Received Parent helped to finance the project; Mr. Lum taught us the basic concepts behind the physics of the experiment.	