



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Katherine S. Anderson</b>	<b>Project Number</b> <b>S0601</b>
<b>Project Title</b> <b>The Effect of Surfactant Head Charge and Water Composition on the Degradation of Oil</b>	
<b>Abstract</b> <b>Objectives/Goals</b> My objective was to identify the effect surfactant head charge on the breakdown of oil in freshwater and bay water. <b>Methods/Materials</b> Three cleaning products were obtained, one with an active anionic surfactant, one with a cationic surfactant, and one with a nonionic surfactant. Each of these were added to standard motor oil in samples of fresh and bay water. After being mixed, the resulting suspensions were observed tested for light transmittance with a colorimeter/spectrophotometer. <b>Results</b> The cationic surfactant showed consistently higher transmittance than both the anionic or nonionic surfactants in both types of water, demonstrating a more efficient degradation of oil. The bay water samples also showed greater transmittance by a margin of at least 5% for all surfactant types. <b>Conclusions/Discussion</b> The results indicate that cationic surfactants are most effective in breaking down oil, and that all surfactants are more efficient in bay water than in freshwater. This conclusion is supported by the fact that anionic surfactants in particular are sensitive to water hardness, unlike cationic surfactants, and suggests that the abundance of minerals present in bay water versus inland freshwater increases the efficiency of surfactants.	
<b>Summary Statement</b> This project explored the effect of anionic, cationic, and nonionic surfactants on the breakdown oil in fresh and bay water.	
<b>Help Received</b> Used basic lab equipment from my high school science department; was accompanied by my mom to pick up some materials.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Rohith M. Bhethanabotla</b>	<b>Project Number</b> <b>S0602</b>
<b>Project Title</b> <b>Achiral GC Analysis Using Alpha- and Beta-cyclodextrins as Chiral Selectors to Separate Diastereomers of Cypermethrin</b>	
<b>Abstract</b> <b>Objectives/Goals</b> Cypermethrin is a highly chiral synthetic pyrethroid pesticide. Despite having desired insecticidal effects, it is harmful to the environment because certain stereoisomers induce sharp levels of toxicity in aquatic wildlife and cause hyperactivity in voltage-sensitive sodium channels in the animal nervous system. In this study, cypermethrin was used in spiked water samples to determine whether chiral selectors, alpha- and beta-cyclodextrin would assist in isolation of insecticidal cis-cypermethrin diastereomers to prevent this environmental stress. Because of its larger cavity, beta-cyclodextrin should show greater resolution. <b>Methods/Materials</b> Emulsifiable CP-concentrate (100 mg) was immersed in 100mL hexane/acetone (1:1 v/v) stock solution with cyclodextrin to create spiked solutions with 1:1 guest-to-host molar ratios. Magnetic stirrers mechanically included analyte in cyclodextrin buckets; the hydrophobic guest binds to CD's chiral cavity through lateral interactions with hydroxyl groups. Unselected isomer formed in top layer, selected in the bottom, which was extracted using hexane/acetone to "pull" analyte from cavity. Using Thermo-Fisher's TR-5MS, each sample was injected in Autosystem XL GC at 2 microliters for 50 min at 260 C inlet temperature and FID detector at 290 C. <b>Results</b> Four peaks were resolved at the baseline with retention times similar to those in previous research journals. Two peaks represented two cis-diastereomer pairs, while two peaks represented two trans-diastereomer pairs. In cross-comparison with samples, little visible effect of cyclodextrin-assisted separation occurred. However, elution order marked visible separation of diastereomers. <b>Conclusions/Discussion</b> Chemical reasoning seems to show that the H on the cyano-carbon H-bonded with carbonyl oxygen at one chiral center which created a 5-member ring structure reducing rotatability of the cyanocarbon. Rigidity increased, decreasing vapor pressure as retention time increases, such that molecules with greater linear stability adsorb onto stationary phase due to stronger IMFs while other more volatile diastereomers pass through mobile phase. Modifications with procedure like increasing host to guest ratio, using stronger non-polar extraction solvent like ethyl acetate, concentrating solution to near dryness, will help for future experimentation to ensure cyclodextrin participation in chiral separation.	
<b>Summary Statement</b> With the intent of creating more potent and less toxic pesticide, cis-cypermethrin diastereomers with insecticidal properties were separated from environmentally harmful trans-cypermethrin using different cyclodextrins as chiral selectors.	
<b>Help Received</b> Used Autosystem XL Gas Chromatograph and TR-5MS Column at Thermo-Fisher Inc. under the supervision of Mr. Jinhua Chen and Dr. Chris Pohl	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Joseph Brooks; Erone Cao</b>	<b>Project Number</b> <b>S0603</b>
<b>Project Title</b> <b>Greasy Pizza: To Dab or Not to Dab?</b>	
<b>Abstract</b> <b>Objectives/Goals</b> The objective is to determine if there are any major health benefits from dabbing the grease off of pizza slices. Specifically, if dabbing the grease off leads to a significant reduction of calories. <b>Methods/Materials</b> The experiment was conducted by making a calorimeter. Water was placed in a small tin can and suspended using a ring stand. For each trial a napkin (either clean or greasy) was placed directly under the can and set on fire. A thermometer measured the temperature before and after the burn. Using this information the amount of energy released by the grease can be calculated. <b>Results</b> Of the small pizzas tested, the energy released by greased ranged from about 400 calories to about 800 calories. This amount of calorie reduction is insignificant in an average daily consumption of 2000-2500 Calories. <b>Conclusions/Discussion</b> The results support the hypothesis that dabbing grease off of pizza does not lead to significant health benefits.	
<b>Summary Statement</b> The purpose of the project was to determine if there were any significant health benefits from dabbing greasy pizza with napkins.	
<b>Help Received</b>	



CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY

<b>Name(s)</b> Nikhil Buduma	<b>Project Number</b> <b>S0604</b>
<b>Project Title</b> <b>A Computational Investigation of the Structures, Energies, and Formation Pathways of Interstellar Anions</b>	
<b>Objectives/Goals</b> About 130 neutral and about a dozen positively-charged molecules have been discovered in space (the most abundant of which include H <sub>3</sub> <sup>+</sup> , CO <sup>+</sup> , N <sub>2</sub> H <sup>+</sup> , CH <sub>5</sub> <sup>+</sup> , etc). However, only recently did National radio Astronomy Observatory (NRAO) discover the butetraynyl (C <sub>4</sub> H <sup>-</sup> ), hexatetraynyl (C <sub>6</sub> H <sup>-</sup> ), and octatetraynyl (C <sub>8</sub> H <sup>-</sup> ) anions in interstellar space. The presence of these molecules has been paradoxical to astronomers because it has long been thought that large negatively charged molecules would not be able to exist in the interstellar space. To explore this novel area of astrochemistry, we aimed to study the structures, energies, and formation pathways of these carbon chain anions in order to develop a deeper understanding of astrochemical processes.	
<b>Abstract</b>	
<b>Methods/Materials</b> In this study, we use computational techniques using density functional theory. All geometry geometry optimizations were performed at the B3LYP DFT level with the 6-31G* and the 6-311+G** basis sets. Optimization of minima and transition structures (states) was performed within the Gaussian 09 environment. We ran Intrinsic reaction coordinate (IRC) analyses on the transition states of the minimum-energy pathways to investigate formation and isomerization pathways. All of the relative energies were corrected using a zero point vibrational energy correction.	
<b>Results</b> First, we were successful in optimizing the structures of a number of nonlinear isomers of carbon chain anions, contradicting previous assumptions that C <sub>4</sub> H <sup>-</sup> , C <sub>6</sub> H <sup>-</sup> , and C <sub>8</sub> H <sup>-</sup> exist exclusively as linear molecules. Second, our computations posit that these isomers occupy energetic minima of reasonable electronic energy compared to the linear isomers, thus confirming that these nonlinear isomers may exist in appreciable quantities in interstellar space. And finally, our IRC computations enable us to account for the isomerization between the linear and 3-membered-ring conformations of the C <sub>4</sub> H <sup>-</sup> isomers.	
<b>Conclusions/Discussion</b> These results posit the existence of complex carbon chain isomers, especially ring and branched chains that are reminiscent of biologically relevant molecules such as amino acids and nucleotides. Consequently, our study challenges current assumptions regarding astrochemistry and fundamentally argues that the composition of interstellar space is much more complex than ever before imagined.	
<b>Summary Statement</b> We computationally studied the structures, energies, and formation pathways of interstellar carbon chain anions.	
<b>Help Received</b> Received background material from Dr. Debjani Roy (teacher), computational resources from Mr. Chris Carey (School IT), complimentary license to Gaussian 09 from Dr. Michael Frisch (President of Gaussian), and Gaussian 09 tech support from Dr. Fernando Clemens (from Gaussian)	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> Seung Hye Choi	<b>Project Number</b> <b>S0605</b>
<b>Project Title</b> <b>Simple and Cost-Effective Detection of Cadmium Using an Electrochemical Sensor Made with Gold Nanoparticles</b>	
<b>Abstract</b> <b>Objectives/Goals</b> The main objectives of my project are (1) to develop a simple and cost-effective detection method using an electrochemical sensor made with gold nanoparticles and (2) to evaluate its sensing potential. <b>Methods/Materials</b> Gold nanoparticles of ~1.6 nm diameter were synthesized by Brust's method. Briefly gold salts (HAuCl <sub>4</sub> ) reacted with various hexanethiols to form gold-thiolate polymers which were further reduced to gold nanoparticles. The surface of gold nanoparticles was functionalized with mercaptoundecanoic acid (MUA) and 18-crown-6-undecanethiol (CW) by ligand exchange reactions. After purification, gold nanoparticle films were prepared on interdigitated array electrodes by drop cast. Then conductance of a gold nanoparticle film was measured in various standard solutions of cadmium ions. To evaluate sensing potential, figures of merit (e.g. detection limit, sensitivity, selectivity) were determined. <b>Results</b> Three different prototypes of electrochemical sensors were prepared and tested for the detection of metal ions (sodium, magnesium, and cadmium). The sensor made with CW-functionalized gold nanoparticles showed best performance for cadmium detection (lowest 0.43 nM detection limit, highest 0.029 S/M sensitivity, and highest selectivity), whereas non-functionalized gold nanoparticle sensor displayed worst performance. It was possible to prepare at least 15 drop cast films with 10 mg of gold nanoparticles. <b>Conclusions/Discussion</b> Conductance of a gold nanoparticle film was significantly affected by metal ions bound on the film and correlated to the concentration of metal ions (sensitivity & detection limit). Selectivity was controlled by regulating the binding of metal ions on functionalized gold nanoparticles. My prototype sensors are simple, portable, and convenient to measure cadmium ions. They can be operated with a small 1.5 V battery (low power consumption) and prepared with a cost less than \$5.	
<b>Summary Statement</b> My project describes a simple, cost effective method to detect cadmium ions in contaminated water and has a possibility to detect cadmium ions in contaminated soil samples.	
<b>Help Received</b> Chemistry department at Fresno State University allowed me to conduct all experimental works (synthesis of gold nanoparticles, and measurement of conductance)	



CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY

<b>Name(s)</b> Forrest D. Csulak	<b>Project Number</b> <b>S0606</b>
<b>Project Title</b> <b>Catalytic Conundrum 3: Effect of Cluster Size and Isomers on Activation of H<sub>2</sub> on Pt Particles in PEM Fuel Cell Reaction</b>	
<b>Abstract</b> <b>Objectives/Goals</b> Fuel cell technology is about 60% efficient but costs around \$1500/kW. Optimizing the energy output of the platinum catalyst by altering the individual structures could lower the cost. My experiment observes the effect of cluster size and isomers on the activation of hydrogen on platinum clusters in a fuel cell reaction. Based on the instability of more complex structures in a chemical reaction, I hypothesized that smaller and simpler platinum structures would have higher catalytic properties and yield higher energies. <b>Methods/Materials</b> My experiment was conducted using density functional theory calculations in Gaussian 09. I utilized the Becke, 3-parameter, Lee-Yang-Parr functional with the Los Alamos National Laboratory 2-double-z basis set for platinum and the polarized and diffused 6-31G basis set for hydrogen and oxygen. Monomers and dimers of platinum and several alternate spin states and transition states were tested. Testing for trimers and tetramers are currently ongoing. Each configuration was recorded along with its energy and placed into an estimated reaction pathway for both the anode and cathode side of the reaction. <b>Results</b> The catalysis of hydrogen on the anode on single platinum atoms was endothermic. Along the reaction pathway it switches between the singlet and triplet spin states and requires 817.63 kcal/mol. Along the cathode, the reaction is exothermic, yielding 1180.29 kcal/mol. The overall fuel cell reaction on single platinum atoms is exothermic, producing 362.66 kcal/mol. For dimers, the reaction at the anode is endothermic with a comparative molecular energy of 768.93 kcal/mol. The reaction at the cathode was exothermic with a comparative molecular energy of -1055.42 kcal/mol. Overall, the reaction on the dimer configuration is exothermic with a yield of 266.38 kcal/mol. <b>Conclusions/Discussion</b> I initially hypothesized that smaller and simpler compounds would be more effective at the activation of hydrogen on platinum in a fuel cell system. As of now, my data supports my hypothesis. The reaction on a single atom produced 96.28 kcal/mol more than the reaction on two platinum atoms. In order to effectively confirm my hypothesis, trimers and tetramers, along with their isomers, need to be tested and compared to my other results. Further calculations will be made to compare my results with experimental data from actual fuel cells. There will be a updated abstract with my project.	
<b>Summary Statement</b> My experiment uses computational chemistry to study the effect of cluster size and isomers on the activation of hydrogen on platinum clusters in a proton exchange membrane fuel cell reaction.	
<b>Help Received</b> Dr. Tiffany Pawluk of CSU Bakersfield provided access to Gaussian 09; My mom provided transportation.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> Sara N. D'Souza	<b>Project Number</b> <b>S0607</b>
<b>Project Title</b> <b>Iron Based Catalytic Biosensor for Reactive Oxygen Species: Detection to Fighting Chemical Terrorism</b>	
<b>Objectives/Goals</b> My research is to study the effects of Reactive Oxygen Species(ROS) and Oxidative Stress that affect our environment and everyday life. I harnessed the power of the natural occurring enzyme- horseradish peroxidase(HRP) by extraction and chemical modifications and developed a novel biosensor to detect peroxide type ROS in aquatic as well as from chemical explosives.	
<b>Abstract</b> <b>Methods/Materials</b> I extracted HRP-Enzyme from the roots of the horseradish and modified it by chemical conjugation to a chromogenic substrate (Fluorescein) by NHS ester to promote the cell permeation in zebra fish cells (ZFL). I cultured ZFL cells for 3-4 days in media and treated with various amounts of copper and phenol (water contaminants) to investigate if they produce intracellular ROS, which can be measured by known H2DCF-DA substrate. I used HRP-Fluorescein as a detection reagent to detect intracellular ROS spectrometrically. I planned to detect peroxide type ROS that are byproducts of the decomposition of chemical explosives such as TATP (Triacetone Triperoxide). I adsorbed HRP and ABTS dye onto silica beads (H-A-S) and determined the structural morphology by Scanning Electron Microscope (SEM). Using solid acids such as Amberlyst 15, Nafion, and Citric acid to decompose TATP into peroxide, I developed a colorimetric sensitive test method to detect explosives. Then, I developed a prototype pen device using my silica- HRP as biosensor to detect harmful peroxide-based explosives analogous to TATP.	
<b>Results</b> I discovered that copper (20mg/ml) and phenol(5mg/ml) produce concentration dependent intracellular ROS. My HRP-Fluorescein conjugate permeates ZFL cells and acts as an intracellular ROS detection reagent, while native HRP did not. Using my Silica adsorbed HRP (H-A-S), I optimized conditions between solid acids and TATP and designed several prototype pen models to deliver a most effective one step device for chemical explosive detection.	
<b>Conclusions/Discussion</b> I have shown that a natural enzyme can perform multiple functions by chemical modifications which is shown by my HRP-Fluorescein and H-A-S. I conclude that my HRP-Fluorescein is very efficient in detecting intracellular ROS using native HRP as control. My modified HRP had useful and unique properties that enabled to act as a biosensor for intracellular ROS. My novel prototype pen device using HRP-ABTS-Silica that detects these peroxide based explosives has	
<b>Summary Statement</b> The purpose of this project is to devise a sensitive biosensor to detect Reactive Oxygen Species (ROS) from chemical explosives like TATP and by industrial wastes in our aquatic ecosystems by chemically modifying the natural enzyme HRP	
<b>Help Received</b> I worked in the department of chemistry at Amylin Pharmaceuticals under the supervision of Dr. Lawrence D'Souza-Sr. Scientific Investigator.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Parsa Derakhshan</b>	<b>Project Number</b> <b>S0608</b>
<b>Project Title</b> <b>Sunlight Assisted Water Remedial: The Photocatalytic Removal of the Toxic Organic Dye Rhodamine B from Wastewater</b>	
<b>Objectives/Goals</b> My objective was to understand the role of TiO(2) content, reaction time and temperature on photocatalytic removal of Rhodamine B (RhB). This project could be used to help the environment by creating a more efficient way to decontaminate industrial wastewater.	
<b>Abstract</b> <b>Methods/Materials</b> Method: In a specially designed reactor, the pink solution of RhB (7.92 micro M) was mixed with a corresponding amount of TiO(2) and was stirred continuously by a magnetic stir bar. The reactor was equipped to a light source, which resembled sunlight (Solar Simulator). The reaction temperature was controlled by an external water bath, which was circulating water around the reactor. As soon as the target temperature was reached, the light source was turned on. Once the reaction time completed, the power source was turned off. The samples were transferred by a pipette into small vials, which were kept in dark to allow the settlement of TiO(2). The concentrations of the dye in transparent solutions were monitored by UV-VIS absorption spectroscopy. RhB has a large absorbance in visible range (maximum wavelength = 552 nm). According to the Beer-Lambert law the absorbance is directly proportional to the concentration of the absorbing substance. Accordingly, one could relate the recorded absorbance to the concentration of remaining RhB. Materials: TiO(2), Rhodamine 610 Perchlorate (RhB), MilliQ water, analytical balance, sonicator, para film, UV-VIS spectrophotometer, specially designed reactor, solar simulator, computer (with Microsoft Excel and Overture Spectroscopy), glass pipettes and bulbs, 1.5 mL vials, UV protection goggles, UV-VIS 1cm cells (cuvettes), nitrile gloves, lab-coats, 1 and 2 L volumetric flasks, 100 mL Beakers, Water Bath, magnetic stir bar.	
<b>Results</b> The absorbance decays exponentially over a period of time. Reaction rate initially increases as a function of TiO(2) content and then remains unchanged. Absorbance decays faster while the temperature increases.	
<b>Conclusions/Discussion</b> 1) Time dependence study: The observation is consistent with a first order chemical reaction. 2) TiO(2) content dependence study: As the amount of TiO(2) increased, absorbance decrease faster until a saturation point. Beyond it, absorbance was not dependent of concentration. 3) Temperature dependence study: As temperature increased, the reaction rate increased.	
<b>Summary Statement</b> The ultimate goal is to find the optimized reaction condition for the photocatalytic removal of Rhodamine B from industrial waste-water.	
<b>Help Received</b> Mr. Daniel Tran an undergraduate research student in Professor Mezyk's lab at CSULB showed me how to work with the solar simulator and the spectrophotometer.	





# CALIFORNIA STATE SCIENCE FAIR 2013 PROJECT SUMMARY

<b>Name(s)</b> Armine I. Dingilian	<b>Project Number</b> <b>S0609</b>
<b>Project Title</b> <b>Predicting Acid Rain Initiated Corrosion Resistance of Zinc-Plated and Stainless Steel Screws in Variant Environments</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The objective of this experiment was to compare the acid rain corrosion resistance of zinc-plated and stainless steel "wood" screws in manipulated temperature and humidity.</p> <p><b>Methods/Materials</b> Materials used were stainless steel wood screws, zinc-plated wood screws, swimming pool acid, analytical balance, cupcake holders, 180 mL jars with caps, weighing dish, and water. Zinc-plated and stainless steel screws were dipped in a pH 4 sulfuric acid solution for 5 minutes, then rinsed in water for 5 minutes, and allowed to dry. To simulate environments, some screws were dried at an ambient temperature of 17-30°C and no humidity, while others were dried in a closed container at 93°C and 100% humidity. After drying for one week the screws were removed and their masses recorded. The screws were again dipped in the acid solution, rinsed and placed in their environments for another week, for a total of 5 weeks. During weeks 3-5, the screws were massed before and after wiping them with a paper towel.</p> <p><b>Results</b> The data showed that zinc-plated screws corroded and lost mass significantly more than stainless steel ones. For example, in the environment where the most corrosion occurred, the zinc-plated screws lost about 3.16% mass, while the stainless steel ones lost about 0.03% mass. The results showed that corrosion was highest and mass loss the most when the drying environment was high in temperature and humidity. The exposed zinc-plated screws dried at 17-30°C showed a loss of about 0.68%, while those in high temperature and humidity showed loss of about 3.16%. It was observed that as corrosion started in the zinc-plated screws, the mass increased slightly, but later the screw lost more mass.</p> <p><b>Conclusions/Discussion</b> The purpose of this experiment was to evaluate the effect of acid rain on zinc-plated and stainless steel screws in manipulated temperature and humidity. It was hypothesized that zinc-plated screws in high temperature and a moisture environment would be most affected by the acid rain simulation solution, and the data from this experiment supported the hypothesis. Through this experiment it was also found that acid rain in the environment would first attack the coating on a screw, in this case the zinc plating, and cause it to corrode first. These data can be used by architects and engineers when designing houses or buildings as another step in assuring the safety and durability of infrastructures.</p>	
<b>Summary Statement</b> This project analyzed the effect of acid rain on zinc-plated and stainless steel screws in manipulated temperature and humidity.	
<b>Help Received</b> Both Mr. Antrim and Father provided materials for the project.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> Arteen Galstyan; Farah Kandah	<b>Project Number</b> <b>S0610</b>
<b>Project Title</b> <b>The Effects of a Cobalt-Phosphate Catalyst on the Efficiency of an Electrochemical Cell</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The goal of our experiment was to test the effects of a Cobalt-Phosphate catalyst on an electrochemical cell.</p> <p><b>Methods/Materials</b> We first used copper wiring, alligator clips, 9V batteries, and a breadboard to create a circuit. The electrochemical cell was created using metal plates as electrodes secured in a Styrofoam block where about 1/3 of the electrode was submerged in the beaker filled with Phosphate buffer. We then connected the electrochemical cell to the circuit in order to stabilize the electric current and measure the voltage of the cell. We then measured the change of voltage after adding the cobalt nitrate and determined the efficiency of the electrochemical cell.</p> <p><b>Results</b> The average energy efficiency of the electrochemical cell increased by about 15% when cobalt nitrate was introduced to the cell. The overall highest energy efficiency of the electrochemical cell was 72.4%, 70.3%, and 72.4% for trials 1, 2, and 3 respectively.</p> <p><b>Conclusions/Discussion</b> Our conclusion was that the cobalt-phosphate compound served as a catalyst which electroplated to the electrodes of our electrochemical cell. The catalyst dropped the required voltage to keep the same amount of current running through the circuit, thus making it more efficient.</p>	
<b>Summary Statement</b> The effects of cobalt nitrate and phosphate buffer on an electrochemical cell.	
<b>Help Received</b>	



CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY

<b>Name(s)</b> George D. Geng	<b>Project Number</b> <b>S0611</b>
<b>Project Title</b> <b>From Waste Heat to Electricity: Synthesis and Analysis of a New Zintl Phase Compound for Thermoelectric Power Generation</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Thermoelectric materials can turn a temperature gradient to electricity. However, to be efficient they need high electrical conductivity and low thermal conductivity. A class of Zintl phases called type-I clathrates have a Si/Ge/Sn framework and extremely low thermal conductivities because of atoms that loosely oscillate in framework voids, disrupting phonons. Their efficiency is low because their electrical conductivity is not too high; however certain d-metals have electrical conductivities orders of magnitude higher than Si, Ge, Sn. The goal of this project is to make a new Zintl phase compound with transition metals incorporated into the framework instead and the same rattling action.</p> <p><b>Methods/Materials</b> Formulas of possible phases with a framework containing Cu/Ni and rattling Cs/Rb atoms were predicted from charge-balance requirements (each framework atom must be tetra-coordinated) in accordance with the Zintl-Klemm bonding concept (relying on the hypothesis that certain transition metals obey the Zintl-Klemm rule). Elements and flux were loaded in the proper ratio into carbonized quartz ampoules, the vessels were vacuum-sealed, and the samples were baked at 850C for 140 hours and then washed to dissolve salts. Powder X-ray diffraction (XRD) data was analyzed. If the analysis indicates a new compound, single crystal XRD data was obtained.</p> <p><b>Results</b> <math>Cs(3x)Si(1-x)Cu(x)As(2)</math> and the Rb analog <math>Rb(3x)Si(1-x)Cu(x)As(2)</math> were made in 2 samples; both are new Zintl phase compounds with high electrical conductivity transition metals in the framework. Both contained impurities; however, further syntheses were done until an instance of <math>Cs(3x)Si(1-x)Cu(x)As(2)</math> was created in the pure phase (i.e. alone without other trace compounds). Analysis of the crystal structure and comparison with the traditional clathrate <math>Cs(8)Si(46)</math> revealed a new framework with high concentrations of Cu and As and a similar vibrational structure with Cs atoms in the new compound.</p> <p><b>Conclusions/Discussion</b> <math>Cs(3x)Si(1-x)Cu(x)As(2)</math>, a new compound with potential for thermoelectric power generation, was synthesized in the pure phase. Additionally, this project demonstrates that the Zintl-Klemm concept holds for certain transition metals, indicating that there may be a class of promising thermoelectric materials with framework-incorporated transition metals and rattling action. Future research will characterize the thermoelectric-figure-of-merit.</p>	
<b>Summary Statement</b> This project created a new Zintl phase compound with potential for thermoelectric power generation and demonstrates through the unorthodox application of the Zintl Klemm bonding concept to Cu/Ni that certain transition metals obey the rule.	
<b>Help Received</b> Mother helped with the board and printing, used lab equipment at UC Davis under graduate student Juli-Anna Dolyniuk and with guidance of Professor Kirril Kovnir	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Irfan S. Habib</b>	<b>Project Number</b> <b>S0612</b>
<b>Project Title</b> <b>Investigation of the Corrosion Performance of Electrodes Used for Effective and Safe Electrical Grounding</b>	
<b>Abstract</b>	
<b>Objectives/Goals</b> Are copper-bonded or galvanized rods more resistant to corrosion? Do installation damages accelerate corrosion?	
<b>Methods/Materials</b> The procedure was a realistic simulation of the corrosion of a range of ground rod samples in soil using a controlled laboratory-based accelerated corrosion test according to the European Standard EN50164-2. All testing was carried out using a worst-case approach. There were four main steps in the procedure (i) In order to simulate realistic but relatively harsh installation conditions, ground rods were driven a distance of approximately 1m into rocky ground. The samples were then carefully excavated and observed for any damages. (ii) A batch of ground rods were prepared with two of each type of damage observed above from the installation trials. All rods were weighed and diameter, length and resistance were recorded. (iii) Accelerated corrosion testing on the rods were carried out for 28 days. Each rod was inserted separately into a PVC test tube and totally immersed in a non-stirred purified water solution containing calcium chloride and sodium sulphate. (iv) Finally after 28 days all rods were removed, washed, dried carefully. Then mass, diameter, length, and resistance was again recorded.	
<b>Results</b> copper-bonded rods mean mass loss was 176.4mg, diameter loss 0.51mil, mean resistance increase 4.125microohms. galvanized rods mean mass loss was 210.5mg, mean diameter loss 0.75mil, mean resistance increase 5.25microohms	
<b>Conclusions/Discussion</b> 1. Galvanized ground rods corroded at a faster rate than the copper-bonded ground rods. 2. The zinc coating on galvanized rods corroded faster than the copper coating on copper-bonded rods. 3. Our results are in excellent agreement with the 50-year nation bureau of standards field study, which showed that galvanized and copper-bonded rods have a service life of ten to fifteen and thirty to forty years, respectively. 4. Also typical installation damage, such as scratches and dents, on the coating of ground rods did not affect the corrosion effect of rods.	
<b>Summary Statement</b> comparison of corrosion of copper-bonded and galvanized ground rods	
<b>Help Received</b> Mother gathered material and explained chemistry	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>James Haraguchi; Edward Vasquez</b>	<b>Project Number</b> <b>S0613</b>
<b>Project Title</b> <b>Determining an Optimum Water Temperature Range for Maximum Efficiency of a Hydrogen Fuel Cell</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The Hydrogen Fuel Cell has emerged as an alternative energy source to fossil fuels in vehicles. This project aims to determine the optimal water temperature range for maximum efficiency of a fuel cell.</p> <p><b>Methods/Materials</b> Reversible Fuel Cell Kit, Distilled Water, Insulated Containers tall enough to hold Cylinders, Weight, Electric Heating Pad, Alligator Clips, Resistor, Digital Multimeter, Electrodes/Thermocouple, Timer.</p> <p>Pre-Test H<sub>2</sub>O was heated/cooled to a pre-specified Temperature (3, 10, 20, 30, 40 degrees C). Assemble fuel cell/misc. tools. Place Cylinders in Bowl w/H<sub>2</sub>O @ respective Temperatures &amp; place Weight on Cylinders (leave room for gas escape). Follow #Electrolysis# directions, followed by #Creating Energy# for five trials of ten tests each.</p> <p>Hydrolysis Start timer/battery pack simultaneously. Take Voltage measurements at intervals of 10, 30, 60, and 90 seconds. Take time readings when the H<sub>2</sub> tank was bubbling (indicating max H<sub>2</sub>O displacement) and when O<sub>2</sub> bubbles (time elapsed). Shut off battery pack, Reset timer</p> <p>Creating Energy Attach motor/Start the timer. Measure voltage at start (0s), 120s, 300s, and 480s. Measure time elapsed upon the motor stopping. Flush cell with H<sub>2</sub>O and reset for hydrolysis.</p> <p><b>Results</b> Temperature (degrees C):Avg. Efficiency (%) 3: 19.122 10: 36.067 20:38.425 30:31.485 40:28.410</p> <p><b>Conclusions/Discussion</b> The fuel cell operated at max efficiency at 20OC and had an average efficiency of 38.425% with a Std. Dev. of 11.264. However, the average efficiency of a standard gasoline engine is 25-30%, and a diesel engine#s is 40-50%. Thus, this fuel cell is as efficient as its counterparts are. Though this cell too simple to provide much energy, it represents the future of the energy market.</p>	
<b>Summary Statement</b> This project aims to determine the optimal water temperature range for maximum efficiency of a fuel cell.	
<b>Help Received</b> Parents helped with supplies, design; Mr Mark Grubb helped with data interpretation.	



# CALIFORNIA STATE SCIENCE FAIR 2013 PROJECT SUMMARY

<b>Name(s)</b> <b>Anjini Karthik</b>	<b>Project Number</b> <b>S0614</b>
<b>Project Title</b> <b>Novel Environmentally Benign Synthesis of Metal Nanoparticles for Surface Enhanced Raman Spectroscopy</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Goal: To produce metal nanoparticles using plant material and test viability of the nanoparticles for Surface Enhanced Raman Spectroscopy (SERS). Challenge: Nanotechnology is a hot field of intensive research; one important application is SERS. SERS is an extensively used industrial method in applications like detection of pathogens, security threats, and medical diagnoses, as SERS gives a fingerprint of the molecule studied. SERS uses Au and Ag NPs as a substrate to enhance the Raman spectrum of a molecule. However, the conventional methods of producing these NPs use harsh chemicals that are toxic to the environment and body. It is critical that these NPs be produced in a safe green way. Proposed Solution: Plants contain naturally occurring, non-toxic phytochemicals. It was hypothesized that NPs produced in a green way using plant material could be harnessed for SERS; secondary hypothesis was that AgNPs would show greater Raman signal enhancement than AuNPs.</p> <p><b>Methods/Materials</b> Water was the solvent and plant material was the reducing/capping agent for NP production. Cinnamon was used for AuNPs and curry leaves for AgNPs. Both AuNPs and AgNPs were also conventionally produced with sodium citrate. After production, NP solutions were titrated with Rhodamine 6G, and SERS spectra were recorded. Negative control was the Raman spectrum of R6G (no enhancement from NPs); positive control was the ideal SERS spectrum of R6G (laboratory standard).</p> <p><b>Results</b> AuNPs and AgNPs were successfully produced with plant material. AuNPs made a viable SERS substrate, but AgNPs did not until aggregated with NaCl. Data is qualitative; enhancement of Raman signal is shown by matching peaks to positive control. Molecular fingerprint of R6G was clearly identified.</p> <p><b>Conclusions/Discussion</b> Metal NPs produced in a green way could be successfully harnessed for SERS; AuNPs gave a better Raman signal enhancement than AgNPs. The wavelength of the laser of the Raman spectrometer was compatible with the peak wavelength for AuNPs, but not compatible for AgNPs - therefore, electronic excitation was not induced in the AgNPs until aggregated. Hypotheses were partially supported. SERS has several applications in the real world, including detection of food and water-borne pathogens, terrorism threats, gemology/mineralogy, and non-invasive medical diagnoses. This project is a new approach for SERS with viable, environmentally-friendly metal nanoparticles.</p>	
<b>Summary Statement</b> The project investigated a novel green method to produce metal nanoparticles that could be successfully utilized for Surface Enhanced Raman Spectroscopy.	
<b>Help Received</b> I acknowledge my family and teacher for their support and Dr. Terrill from San Jose State University for guidance and for granting me access to lab equipment.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Hope Lee</b>	<b>Project Number</b> <b>S0615</b>
<b>Project Title</b> <b>Modeling of Liquid-Liquid Extraction Using Caffeine as the Model System</b>	
<b>Objectives/Goals</b> The liquid-liquid extraction process is an important process for chemical separation and purification. The purpose of this scientific research was to identify factors which affected the recovery percentage of the liquid-liquid extraction process and to create a mathematical model to characterize and optimize the process.	
<b>Abstract</b> <b>Methods/Materials</b> A caffeine solution and a non-toxic solvent, ethyl acetate, were chosen as the model chemical and extraction solvent for this study, respectively. Three parameters, solvent volume, extraction method, and salt concentration, were tested for impact on final extraction amounts. The study was divided into two separate phases: one focused upon the effect of increasing amounts of solvent and multiple extractions in comparison to single extractions, while the other phase focused upon the effect of the addition of salt to the aqueous solution.	
<b>Results</b> The control extraction was completed with 10 mL caffeine solution extracted by 10 mL ethyl acetate and yielded an average of 30%, with a variation of 5%. As the amount of solvent was increased to 40 mL in single extractions, the percentage of caffeine extracted increased to 74.5%. For the multiple extraction method, the percent of caffeine extracted increased to 79.5% by 10 mL solvent extractions repeated four times. In phase 2, the control extraction percentage increased from 30% to 39.5% when 0.5 g of salt was added into 10 mL of caffeine solution. The extraction percentage increased to 48.05% when 1 g of salt was added. When 2 g of salt was added, the extraction percentage decreased to 37%, and undissolvable white crystals were observed. Based on the results, a quadratic mathematical model was created to describe the extraction process.	
<b>Conclusions/Discussion</b> Multiple extraction method was more effective than singular extraction with the same amount of solvent. Salt addition was also able to increase extraction yields. However, a high salt concentration resulted in both caffeine and salt being unable to dissolve back into the aqueous phase as exemplified when 2 g of salt was added. The sudden decrease in caffeine extraction in result of the oversaturation of the aqueous solution was excluded from the final mathematical model fitting. In accordance to the mathematical model, the optimized caffeine extraction process is with multiple extractions and a controlled amount of salt.	
<b>Summary Statement</b> A Liquid-Liquid Extraction model was constructed based on three study factors, solvent volume, extraction method, and salt concentration, to calculate and optimize the extraction percentage for extraction process.	
<b>Help Received</b> My teacher lent me equipment for the experiment and helped me order chemicals, my father supervised me during the duration of the actual experiment itself.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Hailey C. Loehde-Woolard</b>	<b>Project Number</b> <b>S0616</b>
<b>Project Title</b> <b>Investigating Cellulosic Ethanol: Oxidation of Lignocellulosic Materials to Achieve High Conversion Yields of Cellulose</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The purpose of this experiment was to compare my previously developed treatment process with recent developments by others utilizing hydrogen peroxide to delignify wood pulp, and to adjust my methods in order to achieve the highest yield possible.</p> <p><b>Methods/Materials</b> I used unprinted newsprint as a model of waste stream paper and hardwood, as it has the same concentrations of lignocellulosic materials. I used my (patent-pending) process with a high alkaline, high temperature, high pressure, and microwave digestion process. I also used hydrogen peroxide to act as an oxidizer to delignify the paper in hopes of an increased conversion.</p> <p><b>Results</b> For the control alkaline tests (without H<sub>2</sub>O<sub>2</sub>) I achieved similar results compared to previous years experiments. A conversion of about 47.99% cellulose to glucose was achieved. In the H<sub>2</sub>O<sub>2</sub> experiment, I saw drastic changes. I achieved an average conversion yield of 95.36%, with my highest results being 99.89%. These results are higher than the scientific papers I consulted on the subject.</p> <p><b>Conclusions/Discussion</b> I believe the changes in the conversion yields were due to the liquification of the other lignocellulosic materials in combination with my method. In the overall purpose of my endeavors, I believe that I have successfully found an adequate, feasible and high yielding procedure for the production of cellulosic ethanol on a large scale. I am in the process of filing for a patent.</p>	
<b>Summary Statement</b> I have developed a novel method utilizing hydrogen peroxide and microwave digestion to increase conversion yields of cellulose to glucose for the purpose of producing cellulosic ethanol on a commercial scale.	
<b>Help Received</b> Mother ceded use of the kitchen and garage for three weeks for the duration of experiments, and bought necessary supplies. Genencor Co. donated samples of one of their commercial enzymes for use in this experiment. Father helped obtain chemicals.	





**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Dante Monaldo</b>	<b>Project Number</b> <b>S0617</b>
<b>Project Title</b> <b>Discovering the Most Cost-Effective Catalyst for Efficient Energy Storage through Electrolysis</b>	
<b>Objectives/Goals</b> The purpose of this experiment was to determine the most cost-effective catalyst for electrolysis. The null hypothesis states that the cost to produce one mL of hydrogen and oxygen gas will be the same for all the tests performed. The alternative hypothesis states that the cost to produce one mL of hydrogen and oxygen gas with zinc oxide plated electrodes will cost the least out of all other tests performed.	
<b>Abstract</b> <b>Methods/Materials</b> The metal compounds used in this experiment included cobalt oxide (C3O4), nickel oxide (NiO), zinc oxide (OZn) and copper oxide (CuO). Each metal compound was electroplated onto two pairs of platinum electrodes and placed in a graduated Hoffman apparatus with 1.16g of potassium phosphate monobasic (H2KO4P) as a buffer. Tests were run for 4 hours per electrode pair. Volumes of gases produced, ambient room temperature and water pH measurements were recorded.	
<b>Results</b> The results for each set of tests were averaged and the data was analyzed. The control tests with platinum electrodes produced 23.65mL and 10.70mL of hydrogen and oxygen gas, respectively. Cobalt oxide plated electrodes generated 23.05mL/10.32mL and nickel oxide produced 22.50mL/10.05mL. Zinc oxide produced 20.15mL/9.05mL and copper oxide produced 20.05mL/9.00mL. The zinc oxide and copper oxide catalysts corroded the quickest and produced less gases. Nickel oxide costs less than 29% the price of cobalt oxide, and less than 1% the price of platinum. While cobalt oxide was the most efficient catalyst, nickel oxide cost the least per mL of hydrogen and oxygen gas produced.	
<b>Conclusions/Discussion</b> The data showed that neither hypotheses were supported, but also allowed for the discovery of nickel oxide as a more cost-effective catalyst. These results can be used in further research to continue to isolate cost-effective catalysts for electrolysis while maintaining the overall system efficiency. This knowledge can also be applied to future electrolysis systems in which hydrogen and oxygen gases are later recombined in PEM (proton exchange membrane) fuel cells to release electrical energy.	
<b>Summary Statement</b> Tested the effects of certain metal compounds to discover a more cost-effective catalyst to replace the expensive platinum electrodes currently used in electrolysis.	
<b>Help Received</b> I borrowed a lab power supply from De La Salle High School.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Bryden D. Pearson</b>	<b>Project Number</b> <b>S0618</b>
<b>Project Title</b> <b>The Effect of Electrolyte Conductivity on Gas Production during Electrolysis</b>	
<b>Abstract</b> <b>Objectives/Goals</b> Hydrogen is most commonly obtained through a process of decomposing water in a process known as electrolysis. Hydrogen can be used to store electrical energy for use in hydrogen fuel cells and it is key to know what factors effect gas production during electrolysis in order to better improve the efficiency of the process. I tested how varying the conductivity of the electrolyte effects the amount of hydrogen produced at the cathode and gas produced at the anode during electrolysis. My hypothosis was that if differing levels of molar solutions of hydrochloric acid, Sulfuric acid, and ammonium chloride are used as an electrolyte in electrolysis then conductivity will be the only major factor effecting gas production. <b>Methods/Materials</b> I used a electrolysis apparatus to measure the amount of hydrogen produced at the cathode and gas produced at the anode during electrolysis. I ran trials of hydrochloric acid, sulfuric acid, and ammonium chloride, at three different molarity, and three trials were run for each of these nine solutions. I also measure the conductivity of each of these solutions and use this data to a eliminate conductivity as a variable and thereby show if any other factor was having a significant effect and gas production. <b>Conclusions/Discussion</b> My data supported my hypothesis. When conductivity was removed as a factor the amount of hydrogen produced remained approximately the same at about 7.76 mL per .1A every ten minutes. The standard deviation of the data was at average around the .3 mL and a two-way ANOVA test showed that for molarity 96% of the variation in the data was due to chance and for solution type 50% of variation was due to chance. This showed that neither solution type nor molarity had a significant effect on electrolysis and therefore conductivity was the only major factor in hydrogen production.	
<b>Summary Statement</b> I tested the effect of electrolyte conductivity on gas production during electrolysis.	
<b>Help Received</b> I borrowed an electrolysis apparatus from the chemistry department.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Cristian G. Placencia Mata</b>	<b>Project Number</b> <b>S0619</b>
<b>Project Title</b> <b>Testing the Accuracy of Food Calories by Using a Calorimeter and Calorimetry</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> This project tests the amount of calories on various products by using a homemade Calorimeter. The objective of this project is to find out if the Calories stated on the nutritional labels are correct or incorrect.</p> <p><b>Methods/Materials</b> First thing one must do is create the calorimeter I designed. You will need a foam container that is capable of storing 24 cans and wrap the interior with aluminum foil and secure the foil with duck tape. Place a stance in the center of the foam container and cover three of its walls with styrafoam. Make a hole in the foam container so that you can the ignite the product and see what is occurring. Fill the aluminum can with water and weigh the mass of the water in grams as well as its temperature in Celcius. Place either Doritos, Skittles, M&amp;M's, Goldfish(cheddar), Tostitos, Danish Butter Cookies, Ritz Cheese Sandwiches, Barritas Fresas, Almonds, dried banana, dried pineapple, or Bibinuelos in the bottom of the aluminum can. But first, measure the weight of the product being tested in grams, close the container, and ignite the product through the hole you created. Measure the temperature of the water after the product finishes burning. Use the information you received in the trail and plug it in to the equation <math>Q=mc(\Delta)t</math> to solve for calories. Then divide that answer by 1000 and you got the amount of Calories for that certain weight. Divide that answer by the weight you noted earlier and you got the Calories per gram. The last thing you must do is multiply that amount by the grams per serving on the nutritional label and you have the calories per serving, according to what to you tested.</p> <p><b>Results</b> The results I got were off from the amount of calories on the nutritional labels. I got a 13% error overall. That means that my experiments were lower by 13% from the amount of calories on nutritional labels.</p> <p><b>Conclusions/Discussion</b> I found out that the calorimeter design wasn't very efficient because of the fact that there is still heat escaping. Also there is not enough oxygen being supplied into the Calorimeter. Both of these factors lead to error. Companies spend lots of money making sure that their products are true, which leads to my final thought. The calories on nutritional labels are correct, and one can only verify this by using a high-end bomb calorimeter.</p>	
<b>Summary Statement</b> My porject is about me testing the accuracy of food calories found on nutrtrional labels by using a homemade calorimeter and Calorimetry.	
<b>Help Received</b> Dr. Immel helped me by bring my project to life and provided me with a thermometer; Mr. Kempiak gave me a brief lecture on Calorimetry and provided me with a stance and an aluminum can.	



CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY

<b>Name(s)</b> Shreya S. Ramayya	<b>Project Number</b> <b>S0620</b>
<b>Project Title</b> <b>Increasing the Bioefficacy of Artemisinin through Trifluoromethylation</b>	
<b>Abstract</b> <b>Objectives/Goals</b> The application of fluorine in pharmaceuticals has been widely recognized. Due to its structural similarity to hydrogen and high electronegativity, fluorine has been extensively employed to modulate such biological properties of drug molecules as acidity, basicity, protein binding affinity, and lipophilicity. There is an urgent need for capable protocols to efficiently incorporate fluorine into complex organic molecules. This study has specifically focused building the process to trifluoromethylate artemisinin to increase its bioefficacy and make the currently available drugs for malaria even more potent and cost effective. <b>Methods/Materials</b> TMS-CF <sub>3</sub> , the Ruppert- Prakash reagent, has become very popular for nucleophilic trifluoromethylation of carbonyl compounds. Before attempting trifluoromethylation of a complex molecule like artemisinin, aldehydes, esters, and ketones were used as substrates to devise a possible reaction mechanism for the process. The reactions required a simple catalyst, such as potassium carbonate to achieve the maximum yield. <b>Results</b> Using NMR (Nuclear Magnetic Resonance) analysis, the results show that the trifluoromethylation of the substrates produced high yields of the desired products with the Ruppert- Prakash reagent. With yields of products ranging from 80-94%, the method of trifluoromethylation proved successful. <b>Conclusions/Discussion</b> The results of this study suggest that it is possible to include fluorine and the trifluoromethyl group into substrates with structures similar to that of artemisinin by using the Ruppert-Prakash reagent. Therefore, it is possible that trifluoromethylation may increase the bioefficacy of artemisinin to treat a variety of diseases, including malaria and cancer, in the future.	
<b>Summary Statement</b> This main goal of my experiments was to create a practical reaction procedure that could be followed for the trifluoromethylation of artemisinin.	
<b>Help Received</b> I worked at Loker Hydrocarbon Research Institute at USC and was supervised by Drs. Surya Prakash, Parag Jog, and Hema Krishnan. My parents took me to and from the lab.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> Shawn T. Schwartz	<b>Project Number</b> <b>S0621</b>
<b>Project Title</b> <b>Computational Simulation of Multidimensional H(2)O Molecule Interactions</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> This experiment intends to answer the question, #Can the most optimized positioning of water molecules in a multidimensional system, in order to reach the lowest possible system energy, be created by randomly generated simulations?# The hypothesis that the most optimized system can be generated via simulation after initial randomized placement of water molecules will be accepted if the data returned from the program is comparable and realistic data, in comparison to a real system of interacting water molecules. The hypothesis will be rejected if the program is mathematically incapable of producing a system close to minimal system energy. Minimal system energy will be determined by the angle of the individual water molecules and their distances apart from one another. The total energy of the system will then be calculated by taking the summation of the individual iterations of Coulomb Energy between each atom of each water molecule in the system. Coulomb Energy will be calculated through looping processes and dipole moment interaction algorithms.</p> <p><b>Methods/Materials</b> Little physical materials were used in this software-based experiment. Apple MacBook Pro, Mid 2012, Netbeans IDE, Jmol, Git, Github, &amp; Microsot Excel 2011</p> <p><b>Results</b> By mathematical definition, the closer the molecules, the lower the energy.</p> <p><b>Conclusions/Discussion</b> The program, being able to generate system energies that were close to infinitely approaching zero, shows potential with future versions of this program. The purpose of having a program that can do these water molecule energy calculations will be helpful not only because it is more efficient than when done by the human hand, but also to find answers to questions about different molecular interactions in chemistry. Water molecule optimization can help the world of science better understand how substances dissolve in water, as well as gain a better understanding as to how molecules tightly pack themselves together during the process of freezing. In the future, the program will include things like how systems of water molecules interact with different materials in different situations, like in a zero gravity situation, in a cup, or even on a polar surface like a table. This leads to a new feature of the software that could have the capability of modeling the surface tension.</p>	
<b>Summary Statement</b> Software was written to model three-dimensional water molecule interactions and energy trends.	
<b>Help Received</b> Advisor helped explain math.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Echo Sit; Hilarie Sit</b>	<b>Project Number</b> <b>S0622</b>
<b>Project Title</b> <b>Catching the Greenhouse Culprit II, Extraditing the Culprit: Building and Recycling a Carbon Dioxide Filter at Home</b>	
<b>Objectives/Goals</b> The purpose of this project is to build an environmental friendly CO <sub>2</sub> filter that is safe and economical for home use, and a CO <sub>2</sub> absorbent recycling machine that is capable of recycling the CO <sub>2</sub> absorbent so that the CO <sub>2</sub> filter can be made reusable many times, as well as finding a way to utilize the extracted carbon dioxide from the recycling process so that it will have an overall negative carbon dioxide impact on the environment.	
<b>Abstract</b> <b>Methods/Materials</b> By adjusting carbon dioxide level to 1,000 ppm, the CO <sub>2</sub> absorption rate of equal molar of CaO, MgO, and ZnO absorbents were determined and compared via a CO <sub>2</sub> monitor and a timer. Then the experiment was conducted with the constructed filter machine so as to determine the efficacy of the machine for improving the CO <sub>2</sub> absorption rate. For the recycling process, 10g of MgO was heated to 550 degrees Celsius for 2 min and weighed; then the procedure was repeated by increasing 2 min interval for 60 min.	
<b>Results</b> From experiment 1, ZnO was eliminated as absorbent material (too slow) and the Molar Equivalency Ratio of 1.56 was found for MgO. From experiment 2, the average efficacy percentage (20 min interval) are 343% for 1 mole of CaO, 436% for 1.5 mole of MgO, and 727% for 2 mole of MgO; also, by using 1.65 mole of MgO, the curve approximate well with that of 1 mole of CaO. From experiment 3, the rate of MgO production is obtained (Graph 3b) and an equation to describe the curve is found; for 80 min, at least 90% of the MgO was regenerated from MgCO <sub>3</sub> .	
<b>Conclusions/Discussion</b> The main conclusions from this project are that MgO can be used as a CO <sub>2</sub> absorbent material and that the machine is efficacious in increasing the CO <sub>2</sub> absorption rate of the absorbents. Also the absorbent recycling machine is effective in converting MgCO <sub>3</sub> back to MgO. Despite the CO <sub>2</sub> absorption rate of MgO is slower than that of CaO, it is more suitable for home use due to its safety. In fact, when increase the amount of MgO to its Molar Equivalency Ratio, its CO <sub>2</sub> absorption rate can match that of CaO. Our filter is environmental friendly because the by-product, MgCO <sub>3</sub> , can be reusable and recyclable by our recycling machine as demonstrated; also there are also many other uses of MgCO <sub>3</sub> , such as in fire proofing and extinguishing materials and medicines.	
<b>Summary Statement</b> This project is to build an environmental friendly CO <sub>2</sub> filter that is suitable for everyday use at home and build a recycling machine to regenerate the absorbent material.	
<b>Help Received</b> Teacher taught us the exponential decay function; Father helped us with the safety of all experiments; Mother helped purchase the necessary materials. We would like to thank Mrs. Anderson and Ms. McKay for their support.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Jiyoung Song</b>	<b>Project Number</b> <b>S0623</b>
<b>Project Title</b> <b>A Study of Various Factors Concerning the Selectivity and Adsorption Rate of Molecular Imprinted Polymers</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The purpose of this experiment was to find out how the amount of ethylene glycol dimethacrylate (EGDMA) and the concentration of solvent used to remove the templates from the molecular imprinted polymers affected the selectivity and adsorption rate of the polymers.</p> <p><b>Methods/Materials</b> The molecular imprinted polymers were made with acrylic acid, MMA, 4-hydroxybenzoic acid, and EGDMA along with the tetrahydrofuran (THF) solvent and the radical initiator azobisisobutyronitrile (AIBN). Then, the templates were removed from the grinded polymers by the ethanol solvent. The polymers without the templates were put in the solutions of hydroxybenzoic acid isomers to test their selectivity and adsorption rate.</p> <p><b>Results</b> The selectivity of the polymers whose templates were removed in 10% ethanol averaged 2.42686629, while that of the ones with their templates removed in 100% ethanol averaged 1.56319778. The polymers whose templates were removed in 10% ethanol averaged 14.3582031mg/MIP 1g, while the ones with their template removed in 100% ethanol averaged 15.80058197mg/MIP 1g.</p> <p><b>Conclusions/Discussion</b> The selectivity of the polymers was not affected by the amount of EGDMA but by the concentration of the ethanol solvent. The adsorption rate was also concluded to be affected by the concentration of the solvent not by the amount of EGDMA. Although it is proven through the experiment that that the selectivity and the adsorption rate of the molecular imprinted polymers are higher for the 10% ethanol solvent than for the 100% solvent, because only the two concentrations were tested in the experiment, it cannot be concluded that 10% is the best concentration in raising the selectivity and the adsorption rate.</p>	
<b>Summary Statement</b> Amount of ethylene glycol dimethacrylate and concentration of ethanol solvent that is used to remove the templates are manipulated to see how they affect the selectivity and the adsorption rate of the molecular imprinted polymers.	
<b>Help Received</b> Although I got a permission to use the lab at the University of California, Irvine, there was not any assistance given for me to complete the experiment.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Ali Valamanesh</b>	<b>Project Number</b> <b>S0624</b>
<b>Project Title</b> <b>Faraday's Second Law of Electrolysis</b>	
<b>Abstract</b> <b>Objectives/Goals</b> Objectives/Goals: The purpose of my project is to investigate and verify Faraday's Laws of Electrolysis. also this investigation will manipulate the following factors: 1. Time 2. Concentration of the electronic medium 3. Concentration of the acidic catalyst 4. Voltage 5. Current 6. The optimum acid for the system 7. Temperature 8. Width of electrode. <b>Methods/Materials</b> I used a voltameter in a circuit with different solutions and measured the mass of the cathode of this electrolytic cell before and after the electrolysis. I changed different variables to check if the results vary too according to the laws. <b>Results</b> By varying different variables the mass transferred changed according to Faraday's Laws of Electrolysis, and the average mass transferred was near the theoretical value by a small percentage difference. <b>Conclusions/Discussion</b> According to the combination of Faraday's laws of electrolysis which is: $m = z I t$ while the electrochemical equivalent (z) for copper is constant, factors that directly affect the amount of copper transferred to the center copper plate are the current (I) and the time(t). The amount of copper transferred to the center plate is directly proportional to the current(I) and the time(t), which verified Faraday's Laws of Electrolysis.	
<b>Summary Statement</b> The project is based on Faraday's Laws of Electrolysis.	
<b>Help Received</b> I used the lab equipment at ribet academy under the supervision of science teacher Mr. John Shirajian	





**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Ryan J. Bunk</b>	<b>Project Number</b> <b>S0694</b>
<b>Project Title</b> <b>Nanoporous Niobium Oxide</b>	
<b>Abstract</b> <b>Objectives/Goals</b> This project was to determine if photoelectrochemical etching ("photoetching") would successfully increase surface area of thin films by increasing nanoporosity. <b>Methods/Materials</b> Samples of niobium metal foil thicknesses 0.5-1mm thickness were heated until the oxide layer was lustrous dark blue, indicating thin film formation. 5 Samples were set aside as control, 8 samples were put in experimental. Experimental samples were photoetched under 1 molar sulfuric acid, ultraviolet C light, and a 1.5V electrical potential for 45 minutes. Control samples were not processed further after heating. Samples were analyzed by immersing in a solution of aqueous 70% isopropanol and elemental iodine, and determining quantity of solution absorbed by redox titration. Surface buildup of iodine solution by wetting was removed by pressing against the side of the beaker prior to titration. <b>Results</b> The samples that had been photoetched, on average, increased in solution absorption 172%, indicating that the samples had experienced an increase in nanoporosity. The samples were not discolored by etching, indicating that increases in macroporosity or other large material removal were negligible. <b>Conclusions/Discussion</b> The experimental, photoelectrochemically etched samples had successfully increased in nanoporosity, and by extension, increased in surface area.	
<b>Summary Statement</b> Increasing surface area of photocatalytic niobium V oxide thin films.	
<b>Help Received</b> Used lab equipment and materials at Adolfo Camarillo High School under the supervision of Mr. Tanner, Parents and Mr. Inouye reviewed and made suggestions on report, abstract, and poster	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Daniel S.K. Lee</b>	<b>Project Number</b> <b>S0695</b>
<b>Project Title</b> <b>Leaching of Diethylhexyl Phthalate from Polyvinyl Chloride</b>	
<b>Objectives/Goals</b> <b>Abstract</b> The objective of this project is to detect the presence of diethylhexly phthalate in nonprescription pharmaceutical medication and dietary supplements through liquid chromatography. Diethylhexly phthalate(DEHP) is a carcinogen and endocrine disruptor. It is used to create polyvinyl chloride, third most widely-used plastic. Many studies have indicated that there was leaching of phthalates from various brands of bottle made from polyvinyl chloride(PVC). This project investigates the potential of DEHP leaching from various over-the-counter medication bottles and dietary supplements from different brands of bottles. My null hypothesis was tested through high performance liquid chromatography(HPLC). PVC containers from ten brands of over-the-counter medications were extracted with methanol water solvent and assayed for pthalates.	
<b>Summary Statement</b> Carcinogens in Medication and Dietary supplements	
<b>Help Received</b> Dr. Couchon helped me obtain the chemicals i needed for my project, Dr. T donated ACN, and Dr. Malhotra supervised my work	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Alexander S. Powers</b>	<b>Project Number</b> <b>S0696</b>
<b>Project Title</b> <b>Effects of Nanocrystal Shape on Efficiency of Quantum Dot Sensitized Solar Cells</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Nanocrystal (NC) research mainly focuses on the effects of NC size. NC shape has been relatively unexplored in its application to photovoltaics. I hypothesize that elongated NC shapes will impact optical and electrical properties and consequently alter the efficiency of a NC solar cell compared to spherical NCs.</p> <p><b>Methods/Materials</b> Colloidal CdSe quantum dots were synthesized by an organometallic route. CdO, myristic acid, and hexadecylamine in octadecene were heated under nitrogen to 220C. Then Trioctylphosphine-Se was injected and samples were withdrawn at various reaction times and purified. Growth of anisotropic NCs was achieved with a recently developed gold nanoparticle seeding method. The gold surfaces provide a low energy path for CdSe nucleation and result in different growth rates on different crystal faces. Gold nanoparticles in toluene were synthesized via the Brust-Schiffrin method. To measure photochemical characteristics, NC solar cells were designed based on dye cells. NCs were adsorbed onto mesoporous TiO<sub>2</sub> thin films on conductive FTO glass. The counter electrodes were carbon coated and the cell filled with iodide electrolyte. Anthocyanin dyes and bare TiO<sub>2</sub> were used as positive and negative controls respectively. The second cell design improved performance with a sealed cell and mercaptopropanoic acid as a bifunctional linker molecule to improve NC adsorption.</p> <p><b>Results</b> NC morphology and optical properties were characterized. HRTEM revealed a unique homogenous tripod nanocrystal with arm lengths of 17.8+/-7.2nm and arm diameters of 3.4+/-0.7nm. Photoluminescence and absorbance spectroscopy demonstrated typical quantum confinement properties; longer growth times (larger particles) were red shifted due to smaller band gaps. Calculations revealed that tripod behavior was determined by arm diameter rather than length and had a band gap of 1.96eV.</p> <p><b>Conclusions/Discussion</b> Despite low quality materials, efficiencies of nearly 0.1% were obtained for tripod-sensitized cells, 45% greater than the efficiency of dot-sensitized cells. These results support the hypothesis. The improved photochemical characteristics of the tripod over dots may be the result of an elongated shape, producing a dipole that improves charge injection into the TiO<sub>2</sub>. This is the first time tripod NCs have been tested in solar cells. The tripod shape is promising for biomedical diagnostics, quantum computing, and photovoltaics.</p>	
<b>Summary Statement</b> This project demonstrates that a new shape for semiconductor nanocrystals - tripods, rather than simple spheres - increases efficiency of nanocrystal sensitized solar cells.	
<b>Help Received</b> TEM imaging performed by local company (Charles Evans Analytical). Some materials obtained from Stanford and Santa Clara Universities	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Arpita Singhal</b>	<b>Project Number</b> <b>S0697</b>
<b>Project Title</b> <b>Herbalism as an Anticancer Agent: Characterization and Evaluation of the Bioavailability of Curcumin Nanoparticles</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Goal: To create nanoparticles by encapsulating hydrophobic Curcumin in PLGA, an FDA-approved, biodegradable polymer, and to characterize and evaluate its bioavailability. 7.6 million people die from cancer each year. Curcumin, an anticancer polyphenol, interferes with cell signaling pathways involved in apoptosis, metastasis, and oncogene expression. Curcumin decreases the expression of inflammatory cytokines, so the growth of cancer cell lines is inhibited and inflammation-mediating enzymes, such as protein kinase C, are down-regulated. However, clinical use of Curcumin is limited due to its poor bioavailability; its instability and biodegradation in physiological pH limits its delivery to cancerous tissue.</p> <p><b>Methods/Materials</b> Curcumin nanoparticles were prepared. Nanoparticles were characterized using DSC, FTIR, an optical microscope, and Fluorescence. The loading and encapsulation efficiencies were calculated. Solubility and stability tests for Curcumin and the nanoparticles were conducted. The bioavailability of the nanoparticles was evaluated using an in vitro release study.</p> <p><b>Results</b> FTIR results showed that PLGA and Curcumin did not chemically react. DSC results showed that the nanoparticles became amorphous. Curcumin's peak corresponded to the melting point of its crystalline regions; a small relaxation peak was seen for PLGA. The microscope identified the nanoparticle size from 100 to 200 nm. Fluorescence data showed that Curcumin did not lose its photophysical properties in nanoparticle form. The loading efficiency was 5.79%, and the encapsulation efficiency was 89.7%. Curcumin stability decreased by 85% in 12 hours, whereas the nanoparticle stability decreased by 15% in 12 hours. Curcumin solubility was 0.06 mg/mL; the nanoparticle solubility was 3.42 mg/mL. The highest Curcumin release in intestinal juice was 81%; the highest Curcumin release in gastric juice was 47%.</p> <p><b>Conclusions/Discussion</b> Creating Curcumin nanoparticles increased Curcumin's solubility, stability, and bioavailability. Encapsulating a hydrophobic drug in PLGA may result in sustained and controlled drug delivery for efficient treatment. Using nanoparticles helps increase the uptake into cells, such as those present in cancerous tissues. Further research: Once characterized and evaluated, the nanoparticles can be tested in cancer cells; also, other hydrophobic drugs can be encapsulated in PLGA to increase their bioavailability.</p>	
<b>Summary Statement</b> PLGA was used to create biocompatible Curcumin nanoparticles to improve Curcumin's bioavailability, and this test identified Curcumin nanoparticles as a potential alternative for cancer and inflammation.	
<b>Help Received</b> I thank Dr. Roger Terrill from San Jose State University for his guidance and allowing me to work in his laboratory and use his equipment; my science teacher for her guidance; and my family for their support.	



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Michael L. Janner</b>	<b>Project Number</b> <b>S0698</b>
<b>Project Title</b> <b>Assembly of Magnetic Particles and Magnetic Holes into 1D, 2D, and 3D Photonic Crystals</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Photonic crystals are structures with a periodic index of refraction that can prevent the propagation of light within a certain range, known as the band gap. This photonic effect occurs only in dimensions with the appropriate periodicity, so it is therefore possible to create photonic structures that act in only specific directions. The objective of this experiment is to fabricate one-, two-, and three-dimensional photonic crystals and to manipulate the assembly of these structures so that their morphology and photonic response may be controlled.</p> <p><b>Methods/Materials</b> Building blocks for the photonic crystals included porous silica-coated iron oxide nanocrystal clusters, which were fabricated through the hydrolysis of iron chloride, and uniform polystyrene beads, which were fabricated through emulsion polymerization. The polystyrene beads were placed in a ferrofluid, also created in a hydrolysis reaction, so that they acted as magnetic holes. Patterned templates were created from polydimethylsiloxane and polyurethane and were used to direct the assembly of the photonic crystals into specific arrangements.</p> <p><b>Results</b> Magnetic fields were used to assemble the nanocrystal clusters into 1D photonic chains, which could be reassembled into 2D photonic labyrinths by increasing concentration and magnetic field strength. The photonic labyrinths could be controlled using patterned templates and glass spheres in order to create photonic crystals with varying structures. Polystyrene beads acting as magnetic holes were assembled into not only 1D chains and 2D labyrinths, but also proved to be uniform enough to create 3D photonic crystals with high interior order and an exterior shape that could be easily manipulated.</p> <p><b>Conclusions/Discussion</b> The ability to fabricate photonic assemblies with precise control over the structure, diffraction wavelength, and directions of diffraction marks a development that will allow photonic crystals to be created for highly specific purposes with narrow constraints for the photonic properties. Such crystals may find use in applications such as flexible computer and television displays, color-changing clothing, and photonics-based computer chips.</p>	
<b>Summary Statement</b> Hydrolysis and emulsion polymerization reactions were used to create building blocks for magnetically responsive photonic crystals with highly tunable structures and photonic properties.	
<b>Help Received</b> Used lab equipment at the University of California at Riverside under the supervision of Dr. Yadong Yin and Le He.	



CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY

<b>Name(s)</b> Akshay K. Srivastava	<b>Project Number</b> <b>S0699</b>
<b>Project Title</b> <b>The Work Enacting Capabilities of Methanol and Its Application to Electricity Production Processes</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> This experiment aimed to determine whether or not Methanol(CH<sub>3</sub>OH) would be a more efficient coolant in electricity production processes than water. In order to accomplish this, an experiment was designed to determine if Methanol could produce amounts of pressure, and work by extension, equal to those produced by water.</p> <p><b>Methods/Materials</b> In this experiment a flask was filled with 150 mL. of the sample, Methanol or Water. This flask was then sealed with a double-holed rubber stopper and placed on a hot plate. A piece of glass tubing and a thermometer were then placed into each of the holes in the rubber stopper, and a gas pressure gauge was attached to the end of the glass tube. The gauge was then supported with a test tube clamp attached to a ring stand and the entire apparatus was placed under a fume-hood. In order to ensure that none of the gaseous Methanol escaped from the apparatus Parafilm was applied to the conjunction of the gas pressure gauge and the glass tubing. After the construction of the apparatus, the hot plate was activated and periodic temperature and pressure measurements were taken until the rubber stopper discharged. At this point in time the hot plate was deactivated and the entire apparatus was allowed to cool.</p> <p><b>Results</b> It was found that the Methanol was able to generate equal, and sometimes greater, amounts of pressure than the water at any given temperature. It was also found that the Methanol took a shorter amount of time than the water to increase its temperature, when exposed to the same heat conditions as the water.</p> <p><b>Conclusions/Discussion</b> From this experiment, it was shown that Methanol is able to generate equal amounts of pressure than water when exposed to lesser amounts of energy. This implies that the Methanol could be used more efficiently as a coolant in energy production processes than Water. It was also, however, found that Methanol costs 150 times the amount of water per gallon, and hence it would be economically inefficient to use Methanol as a coolant in energy production processes.</p>	
<b>Summary Statement</b> This experiment aimed to determine the adequacy of Methanol as an efficient replacement for Water in electricity production processes by comparing the amount of pressure it was able to generate to that generated by water.	
<b>Help Received</b> Used lab equipment at Apple Valley High School under supervision of Kathy Meyer.	