



# CALIFORNIA STATE SCIENCE FAIR 2012 PROJECT SUMMARY

<b>Name(s)</b> <b>Joshua D. Bates</b>	<b>Project Number</b> <b>S0601</b>
<b>Project Title</b> <b>Fizzy Relief: An Investigation of the Effects of Temperature, Surface Area, and Pressure on Rates of Reaction</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> One of the most used medications for common illnesses are those that are dissolved in water. One of the most widely known medicines of this type is Alka-Selzer. The three main components of Alka-Selzer are aspirin, sodium bicarbonate, and citric acid. When the tablet is dropped into water, the sodium bicarbonate and citric acid react to produce carbon dioxide. This project was designed to test three variables that affect the rates of this chemical reaction; temperature, surface area, and pressure.</p> <p><b>Methods/Materials</b> Alka-Selzer from the same lot number and the same type of bottled drinking water were used for the tests. Also, in each test, sample consisted of one tablet dissolved in two ounces of water with the reaction timed until the tablet was dissolved and the reaction complete. The first tests performed were for the effects of solvent temperature on the rate of reaction. Ten trials were done at seven separate water temperatures. Crushed ice was used to lower water temperature for the cold tests and water was heated for the hot tests. For the second tests, the effects of changing the surface area of the tablet were looked at. There were three tests done; using whole tablets, tablets cut in half, and tablets cut into quarters. The final tests were performed to examine the effects of pressure on the rate. For these tests, a small pressure chamber connected to an air data test set was used. As the altitude on the air data test set was changed; the pressure in the chamber would change correspondingly. A tablet delivery system was designed, built, and mounted over the water container. The delivery system was activated, dropping the tablet into the water. There were ten sample tests done at each of seven separate pressures from sea level to 6,000 feet above sea level.</p> <p><b>Results</b> The rate of reaction increased as the temperature increased in a non-linear fashion until the temperature was at 65.5 degrees C then it started to decrease. The rate of reaction increased non-linearly as the surface area increased. The rate of reaction increased linearly as the pressure decreased until 5,000 feet above sea level then it decreased.</p> <p><b>Conclusions/Discussion</b> Increasing the surface area has the greatest effect on the rate of reaction, followed by increasing temperature, and finally decreasing the pressure. The temperature at which the greatest reaction rate occurs, 65.5C, is about the temperature of a warm to hot cup of tea.</p>	
<b>Summary Statement</b> This project is an investigation of the effects of temperature, surface area, and pressure on rates of reaction.	
<b>Help Received</b> Father assisted in administrative tasks. Used pressure chamber equipment at Edwards Air Force Base Instrumentation Laboratory after training.	



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<b>Name(s)</b> <b>Paulomi Bhattacharya; Eesha Khare</b>	<b>Project Number</b> <b>S0602</b>
<b>Project Title</b> <b>Synthesis and Characterization of Novel Internal Alkyne-Stabilized Nanoparticle for Effects on Optoelectronic Properties</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Electronics has depended on the concept of miniaturization, building circuitry from increasingly smaller parts to maximize efficiency and minimize cost. However, this size reduction in silicon-integrated circuitry leads to significant power losses due to increased electron tunneling. To address this problem, molecular electronics proposes using nanoparticles instead of bulk materials because of their advantages in size, assembly and synthetic tailorability. This project synthesized and characterized a novel internal alkyne-stabilized ruthenium nanoparticle by changing interfacial bonding of the ligand to the ruthenium core from terminal to lateral. In order to evaluate effectiveness of the novel nanoparticles in replacing conventional circuitry, it is important to characterize intraparticle charge transfer and quantization of energy states, which can be changed by manipulating the interfacial bonding between the metal core and organic ligand.</p> <p><b>Methods/Materials</b> The new ruthenium nanoparticles were successfully synthesized. The new nanoparticle has alcohol groups and internal triple bonds, which cause lateral binding. The control particle has standard methyl groups and terminal triple bonds. The Ru core was synthesized following colloidal synthesis. Unlike the control particles, which have standard methyl groups, the alcohol groups on the ligand of the experimental particle make the particles insoluble in many different solvents. To address this problem, the alcohol groups were oxidized to carboxyl groups, increasing the particle solubility allowing the particles to be tested in spectroscopies such as FT-IR, UV-vis, and photoluminescence.</p> <p><b>Results</b> For our new particle, the ligand is bonded laterally onto the ruthenium instead of terminally, resulting in a conjugated system of alternating single and triple bonds. This structural change increased localization of electrons, increased quantization of energy states, and led to a much greater energy band gap in comparison to our control particle.</p> <p><b>Conclusions/Discussion</b> The new properties in our particle have not been observed before, and the even greater energy band gap prove that our particles may have the potential to replace key elements of electrical circuitry such as the silicon dioxide of an insulator. This work serves as an initial step in defining the potential of nanocomposite structures as mediators for controlling the properties of a material.</p>	
<b>Summary Statement</b> This project synthesized novel internal alkyne-stabilized nanoparticles, which exhibited new fluorescence properties, electron localization, and an even greater band gap or more quantization, to help reduce power loss in silicon circuitry.	
<b>Help Received</b> Worked at University of California Santa Cruz under the supervision of Dr. Shaowei Chen and Xaongwu Kang	



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<b>Name(s)</b> <b>Elina Blazhiyevska; Bonnie Chen; Mayia Vranas</b>	<b>Project Number</b> <b>S0603</b>
<b>Project Title</b> <b>The Abiotic Synthesis of Silicon-Based Life</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> This experiment was a physical simulation of a physical system. The purpose was to see if long polymers necessary in the creation of silicon-based life could be formed in conditions mimicking conditions on alien planets. It was hypothesized that if different degrees of heat are exerted on ammonium hydroxide and orthosilicic acid with 60,000 volt shocks of electricity mimicking lightning in a closed environment, then increasing temperatures will create large molecules. This experiment is inspired by the Miller-Urey experiment, but it searches for the origins of silicon-based life instead of carbon-based life.</p> <p><b>Methods/Materials</b> An apparatus was created to simulate an alien atmosphere. The apparatus consisted of a 2,000 mL flat-bottom flask that was heated to three different temperatures with a hot plate, including 150°C, 250°C, and 300°C. A condenser tube to cool the top of the apparatus had cold water running through it. Every 10 minutes for 20 seconds, 60,000 volts of electricity from an induction coil ran through the apparatus, simulating lightning. Inside the apparatus were 4 mL of ammonium hydroxide and 1 mL of orthosilicic acid. The heating at the bottom and cooling at the top of the apparatus created the equivalent of a water cycle, but with ammonium hydroxide instead of water. The experiment ran for 8 hours at each temperature in a ventilation hood provided by the school's chemistry lab. Afterwards, samples were collected and put through light resistance, chromatography, and HPLC testing to determine their size.</p> <p><b>Results</b> Based on three tests, it was concluded that longer molecules were formed under higher temperatures.</p> <p><b>Conclusions/Discussion</b> It was found that the results supported the hypothesis that large silicon polymers would be created under higher temperatures. This experiment was a physical simulation of a physical system. Understanding that silicon polymers can be formed on conditions that may be present on alien planets answers a basic question of life in the universe: can life arise in different forms? Answering this question encourages organizations like NASA to search for other forms of life in our universe instead of just carbon-based life like ourselves. Should silicon-based life be found, it would expand our understanding of life in the universe, allow for new medicines, help create new technology using silicon, and help us understand the limits of our own carbon-based life.</p>	
<b>Summary Statement</b> This experiment is a physical simulation of a physical system, the atmosphere of an alien planet, and strives to answer a basic question of life in the universe: can life arise in different forms?	
<b>Help Received</b> Mother and teachers helped edit the report, parent helped provide idea, Mr. Taylor provided a safe working environment and supervision, parents bought materials and provided testing sites, parent provided ammonium hydroxide	



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<b>Name(s)</b> <b>Ian Borchard; Colin Wikholm</b>	<b>Project Number</b> <b>S0604</b>
<b>Project Title</b> <b>Electronegativity and Reaction Violence</b>	
<b>Abstract</b> <b>Objectives/Goals</b> The purpose of this experiment is to discover the relationship between electronegativity and reaction violence (energy release). <b>Methods/Materials</b> To measure reaction violence, zinc, iron, magnesium, copper, and calcium are separately reacted with iodine in a water-vinegar solution. The temperature change of the solution caused by the reaction is measured with a calorimeter. <b>Results</b> The temperature rise of the vinegar/water solution was inversely proportional to the electronegativity of the reducing agents (ones that give up their electrons, namely Zinc, Iron, Magnesium, Copper, and Calcium). The larger the difference in electronegativity between the reducing agents and iodine, the more energy was released during the reactions. <b>Conclusions/Discussion</b> Data gathered from this experiment suggests that reactants with greater differences in electronegativity release more energy when reacted. This information could be applied as a general rule to industries and laboratories that use large amounts of chemicals. Knowing the possible danger of deliberate or accidental chemical mixtures could ensure safety and avoidance of disasters.	
<b>Summary Statement</b> This project investigates and reveals a relationship between electronegativity and energy released in reactions	
<b>Help Received</b> Used lab equipment at Villanova Preparatory School under the supervision of Mrs. Terry Maulhardt	



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<b>Name(s)</b> <b>Haylie Butler; Lucia La</b>	<b>Project Number</b> <b>S0605</b>
<b>Project Title</b> <b>Biodiesel: Fuel for the Future</b>	
<b>Objectives/Goals</b> Is algae oil biodiesel a comparable fuel source when compared to olive oil biodiesel in terms of viscosity, freezing point, and heat combustion?	
<b>Abstract</b> <b>Methods/Materials</b> The materials used include 80 ml 95% Ethanol Solution, 40 ml Olive Oil, 40 ml Algae Oil, 150 ml Distilled water, 1.4 g Sodium Hydroxide Pellets, 40 drops 0.1 M Acetic Acid, and 12 pellets Calcium Chloride. Make each ethanol biodiesel by combining 20 ml of ethanol with 0.35 grams of NaOH and stir until dissolved. Then add 20 ml of oil and heat until 40°C while stirring for thirty minutes. Pour the mixture into test tubes, cover, and leave overnight. Pipette the top layer of biodiesel into a graduated cylinder leaving the glycerol and then use a pH strip to measure the pH of the biodiesel. Neutralize the biodiesel by adding 20 drop of 0.1 M acetic acid and then measure the pH again using a pH indicator strip. To finish, add six pellets of calcium chloride to the biodiesel and stir the mixture. To test for heat combustion, puncture holes the base of the larger aluminum can and below the rim of both the large and small can. Measure the change in heat of the water. To test for viscosity, pour each of the algae biodiesel, olive oil biodiesel, and distilled water separately through a long necked funnel and time how long each takes to drain. To test for freezing point, combine ice and rock salt to make an ice bath. Place a test tube with 10 ml of biodiesel into the ice bath. Record the temperature of the biodiesel when the environment is -10°C and note the physical attributes of the biodiesel.	
<b>Results</b> Algae oil biodiesel is less viscous, handles a lower freezing point, and is comparable in terms of heat combustion when compared to olive oil biodiesel.	
<b>Conclusions/Discussion</b> Olive oil biodiesel was chosen to be the standard because of a previous experiment which determined that it was a good replacement for diesel. The independent variables were the different kinds of oils and the dependent variables were the viscosity, heat combustion, and freezing point. The experiment was a success. Based on tests, algae oil biodiesel is indeed comparable to olive oil biodiesel because the results yielded were similar to each other.	
<b>Summary Statement</b> Algae biodiesel is comparable to olive oil biodiesel in terms of viscosity, heat combustion, and freezing point.	
<b>Help Received</b> Used equipment at Cornelia Connelly School	



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<b>Name(s)</b> <b>Arun Chakravorty</b>	<b>Project Number</b> <b>S0606</b>
<b>Project Title</b> <b>Development of a Novel High Efficiency Chemical Sequester for CO(2) Reduction from Automobile Exhaust</b>	
<b>Objectives/Goals</b> The objective is to create a carbon dioxide sequester that reduces the carbon dioxide emissions from automobile exhaust in a cheap and efficient manner.	
<b>Abstract</b> <b>Methods/Materials</b> CO(2) concentration was measured using an infrared carbon dioxide sensor. The CO(2) concentration was reduced by chemically reacting it with the bases, NaOH and Ca(OH)(2), inside a sequester reactor. There were 3 design prototypes that differed in terms of reacting surface area and retention efficiency of the CO(2) in the reacting solution. The first prototype was a "filter" design where a rectangular metal duct was attached to the tailpipe and a sponge soaked with the basic chemicals would be placed in the duct. In the second prototype, a vessel with the chemical solutions(NaOH or Ca(OH)(2)) was made so that all the exhaust gas from the car would have to pass through the solution. The design was made such that the gas would have to bubble through the solution. Sponges were placed at the top of the vessel to increase the retention rate of the gas. The final prototype had a similar vessel design as prototype 2 but had sponges arrayed in a multi-chamber configuration compromising of porous solid and liquid zones.	
<b>Results</b> The first prototype showed a low sequestering efficiency of less than 10% decrease in CO(2) concentration. The second prototype decreased CO(2) concentration by an average of 78%. The final prototype design reduced CO(2) concentration by an average of 82%.	
<b>Conclusions/Discussion</b> The proposed sequestering approach is based on reacting the CO(2) with commonly available bases such as Ca(OH)2 and NaOH. Since Ca(OH)2 is a cheaper and safer chemical and showed the same sequestering ability as NaOH, Ca(OH)2 appears to be a far more appealing and viable candidate than NaOH for practical application. In addition, the byproduct of the reaction, CaCO(3) is a naturally occurring material that has several practical applications. For real life application, the sequester could be made to the size of a gas tank such that the high volume of chemicals would react longer and probably more efficiently due to the higher surface area as well.	
<b>Summary Statement</b> This project involved creating a novel carbon dioxide sequester for automobiles that can decrease CO(2) concentration in emissions by 82 percent using chemical reactions with NaOH and Ca(OH)(2) in a cost effective manner.	
<b>Help Received</b> My Dad helped make sure I used the proper safety equipment while handling chemicals.	



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<b>Name(s)</b> <b>Jade Chaves; Janine Sobers</b>	<b>Project Number</b> <b>S0607</b>
<b>Project Title</b> <b>Testing for the Presence of Bisphenol A Diglycidyl Ether in Canned Foods</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Our objective was to discover if bisphenol A diglycidyl ether (BADGE), a relative of bisphenol A (BPA), is present in canned foods.</p> <p><b>Methods/Materials</b> Materials: Agilent 1100 Model HPLC machine, HPLC vials, Vydac C4 column, 100% methanol, diH2O, acetonitrile, 25g bisphenol A diglycidyl ether, P-1000/200/20 pipettes &amp; tips, filter paper, 0.45 µm filter, samples (Campbell's Cream of Chicken, Cream of Mushroom, &amp; Cheddar Cheese Soup, Diet Pepsi, Del Monte Sliced Peaches, Del Monte Whole Kernel Corn, Arizona Raspberry Iced Tea, Trader Joe's Whole Kernel Corn, Trader Joe's Black Beans, Trader Joe's Organic Pinto Beans, Trader Joe's Albacore Solid White Tuna, Red Bull, Bumble Bee Wild Alaska Pink Salmon, Snapple Peach Tea) Methods: We began by making a stock solution of 10 ppm BADGE in 100% methanol, then 5 dilutions with varying concentrations of BADGE # 100, 50, 20, 10, &amp; 5 ppb. We then took samples of various canned foods and filtered them first through folded filter paper, then a 0.45 µm filter. Reverse Phase High Performance Liquid Chromatography (RP-HPLC) was used to analyze for the presence of BADGE. Using a Vydac Protein C4 column on the Agilent 1100 model, we placed our standard solutions and samples into the machine, and ran them, awaiting results.</p> <p><b>Results</b> All but one sample contained varying amounts of BADGE. In BADGE-confirmed, 2 of 3 had high BADGE concentrations, 1 low. In BPA-confirmed, all samples yielded very high concentrations, while most samples in BPA-free exhibited low concentrations. For our 3 unknowns, while 2 of 3 exhibited very large concentrations, Red Bull exhibited a concentration so low, it was essentially negligible. Highest overall concentration was Arizona Raspberry Iced Tea, at 88.49 ppb. Lowest overall concentration was Trader Joe's Whole Kernel Corn, at 3.35 ppb. Red Bull was the only sample to exhibit so low a concentration, we assume none is present.</p> <p><b>Conclusions/Discussion</b> Based on samples tested, a majority of canned foods do indeed contain BADGE. While BPA-free foods are best for reducing exposure to these types of toxic chemicals, they are not necessarily free of them.</p>	
<b>Summary Statement</b> In our project, we tested for the presence of bisphenol A diglycidyl ether (BADGE), a relative of bisphenol A (BPA) - both used in the manufacturing of epoxy resins - in canned foods using High Performance Liquid Chromatography (HPLC).	
<b>Help Received</b> supervision and instruction from Dr. Malhotra & Dr. Cauchon, supervision from many parents of students	



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<b>Name(s)</b> Seowoo Choi	<b>Project Number</b> <b>S0608</b>
<b>Project Title</b> <b>Investigating the Behavior of Cobalt(II) Chloride and Its Intermediate Complex Ions</b>	
<b>Abstract</b> <b>Objectives/Goals</b> The purpose of this experiment is to investigate the reaction of hydrogen peroxide, sodium potassium tartrate, and cobalt(II) chloride. The current literature does not present a definitive and detailed explanation of the reaction. This is an attempt to contribute to the understanding of this interesting reaction. <b>Methods/Materials</b> Cobalt(II) chloride, hydrogen peroxide solution(30%), Potassium sodium tartrate solution, tubes, beakers, distilled water, graduated cylinders, hot plate, spatula, stirring rod, thermometer, pH meter, and glowing splint method <b>Results</b> The catalyst cobalt(II) chloride is not consumed during the reaction. Speed of reaction increases as the temperature and molarity of the catalyst are increased. <b>Conclusions/Discussion</b> Many literatures say that the products of this reaction are carbon dioxide, water, sodium hydroxide, and potassium hydroxide. I did glowing splint test to show that the product of this reaction is oxygen. pH meter showed that the solution is not basic, which indicates that the sodium and potassium hydroxides are not produced. I formed my own explanation for this reaction. The first step of this experiment is heating the sodium potassium tartrate. When heat is applied to it, it would rotate to form a ring structure. Added hydrogen peroxide and cobalt(II) chloride would react with the ring-structured sodium potassium tartrate to form a final structure, 3,4-Dihydroxydihydro-2,5-furandione molecule. Therefore according to my explanation, the product of this reaction seemed to be oxygen gas, restored hydrogen peroxide, unconsumed cobalt(II) chloride, and 3,4-Dihydroxydihydro-2,5-furandione molecule.	
<b>Summary Statement</b> This project is performed to see if the result of reaction of cobalt(II) chloride, hydrogen peroxide and sodium potassium tartrate agrees with the current literature that does not give a definitive and detailed explanation of the reaction.	
<b>Help Received</b> Ribet Acadmey's Seebach Family Physics and Chemistry Lab	



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<b>Name(s)</b> Alice J. Chu	<b>Project Number</b> <b>S0609</b>
<b>Project Title</b> <b>Man-made Catalysts for Carbon Dioxide Capture</b>	
<b>Abstract</b> <b>Objectives/Goals</b> In a world where green house gases are creating global warming, finding a way to capture carbon dioxide is essential. The goal of my investigation was to test a catalytic solution that would speed up the rate of the absorption of carbon dioxide in basic solutions. Catalytic research will inevitably play a role in helping the productivity of solution absorption as catalysts are not used up in the reaction, making them environmentally friendly. <b>Methods/Materials</b> The experimental design was to determine the Cu-TETA (1,4,8,11-tetraazacyclotetradecane-1,4,8,11-tetraacetic acid) catalyst complex efficiency by testing a control of potassium carbonate solution and comparing the test to a solution of potassium carbonate and catalyst. To see how much carbon dioxide was absorbed, both solutions were subjected to a flow of Span Gas (14% carbon dioxide) from gas tanks into a round-bottom flask and the resulting pH drop was analyzed using graphical comparison for a significant increase in the rate. This experiment specifically tested the Cu-TETA catalyst complex because of its close resemblance to the naturally occurring enzyme carbonic anhydrase, which has shown to be effective in the hydration and dehydration of carbon dioxide in the body. <b>Results</b> The results were that the Cu-TETA catalyst was effective. The Cu-TETA catalyst was able to create a 14% pH decrease which is faster than the control's 12% pH decrease and was able to increase the rate of the pH drop by 15%. As compared to the enzyme, however, the enzyme was significantly better, creating a 20% pH decrease and an increase in rate of 72%. The Cu-TETA did not completely mimic the enzyme as the enzyme is still much more efficient and there is still a big gap between the man-made catalyst and enzyme. <b>Conclusions/Discussion</b> Though the Cu-TETA curve declined at a faster rate, however, the increase was by a smaller amount than expected and is not enough to qualify Cu-TETA for mass production. This, however, could mean that man-made catalysts are getting closer to mimicking enzymes. Since the catalyst was effective in increasing the rate of the pH drop and therefore also the rate of the carbon dioxide absorption, the mimicking of the structure must have had some positive effects and therefore more enzyme and biological catalytic research should be performed to perfect the man-made catalyst.	
<b>Summary Statement</b> My project is on testing man-made catalysts for effectiveness in capturing carbon dioxide in basic solutions.	
<b>Help Received</b> I used the lab equipment at the University of Kentucky under the supervision of Dr. Payal Chandan.	



# CALIFORNIA STATE SCIENCE FAIR 2012 PROJECT SUMMARY

<b>Name(s)</b> Cameron C. Coulter	<b>Project Number</b> <b>S0610</b>
<b>Project Title</b> A Composite Study of Bio-Diesel	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> This project investigates the potential of five plant oils as alternatives to petro-diesel, with the primary objective to investigate the added value, if any, resulting from trans-esterification of these oils into bio-diesel.</p> <p><b>Methods/Materials</b> Avocado, camelina, castor, coconut and palm oils, as well as their methyl-esters were studied for: i) physical properties of viscosity, freeze point, density, and pH; ii) fuel performance; and iii) comparative economics versus petro-diesel. Physical and chemical characteristics were measured using traditional techniques. Fuel performance was tested using a modified diesel generator and placing a constant load on the generator over a timed constant interval run and then measuring the fuel consumed in grams. Grams consumed over a test period was then converted to an equivalent miles per gallon in terms of percent efficiency relative to the petro-diesel baseline. In addition, aged avocado oil was tested to investigate a potential drawback of bio-fuels, oxidative stability.</p> <p><b>Results</b> Based upon physical and chemical properties, castor, coconut, and palm oils were eliminated as viable alternatives. However, all bio-diesels, including those of eliminated oils, proved viable, though coconut and palm diesels are constrained to serving as warm weather fuels. In evaluation of energy efficiency relative to petro-diesel, testing indicated a baseline performance of 131 grams diesel consumed, which was converted to a base equivalent of 42.0 mpg. Fuel efficiency of petro-diesel was followed by avocado and its bio-diesel at 38.4 mpg, then camelina and its bio-diesel at 38.3mpg and 38.4 mpg. These were followed by the remaining bio-diesels, with the worst performing fuel tested, castor bio-diesel at 34.3 mpg</p> <p><b>Conclusions/Discussion</b> For four of five fuels, conversion from oil to bio-diesel was an improvement in physical characteristics and performance. Camelina was the exception. Trans-esterification of camelina and avocado proved economically and environmentally unjustified though. Those two oils, as well as all five bio-diesels were found to be superior to petro-diesel in terms of environmental impact, and competitive with petro-diesel in performance measured on cost per mile basis. Furthermore, these can be produced at scale to be a measurable component of the total U.S. energy supply allowing for the potential for a substantial reduction in global CO2 emissions.</p>	
<b>Summary Statement</b> This project investigates the potential of five plant oils as alternatives to petro-diesel, with the primary objective to investigate the added value, if any, resulting from trans-esterification of these oils into bio-diesel.	
<b>Help Received</b> Father converted oils to bio-diesel for use in the project.	



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<b>Name(s)</b> Forrest D. Csulak	<b>Project Number</b> <b>S0611</b>
<b>Project Title</b> <b>Catalytic Conundrum 2: A Computational Method of Finding Cost-Effective Replacements for Platinum as Fuel Cell Catalysts</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Currently, energy is one of the primary concerns for the world. Many alternatives to the combustion of fossil fuels have been proposed, one of which is hydrogen fuel cell technology. It is efficient but very expensive. Much of this cost can be attributed to using a platinum (Pt) catalyst. Replacing the catalyst with a cheaper metal can make fuel cells a cheaper alternative to the present system. My experiment was conducted to find the viability of certain alternative catalysts by computationally modeling the reaction of those catalysts and comparing their reaction pathways and enthalpies to that of Pt. Based on strong chemical similarities to Pt, I hypothesized that palladium (Pd) and nickel (Ni) would make strong candidates for a less expensive replacement catalyst and would have similar exothermic reaction pathways.</p> <p><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 (B3LYP) functional with the Los Alamos National Laboratory 2-double-z (LANL2dz) basis set for Pt, Pd, and Ni and the 6-31G basis set for hydrogen and oxygen. Dimers of each metal and several alternate spin states and transition states were tested. Each configuration was recorded along with its energy and placed into an estimated reaction pathway for both the anode and cathode side of the fuel cell reaction.</p> <p><b>Results</b> For Pt, the reaction at the anode is largely endothermic with a comparative molecular energy of 768.93 kcal/mol. The reaction at the cathode was exothermic with a comparative molecular energy of -1035.31 kcal/mol. Overall, the reaction is exothermic. Pd and Ni show a similar trend. The reaction pathway for each is remarkably similar to that of Pt. The pathways indicate possible exothermic reactions, but alternate spin states and transition states need to be tested in order to confirm this observation.</p> <p><b>Conclusions/Discussion</b> I initially hypothesized that Pd and Ni would both have a similar reaction pathway to Pt and that the reaction for both would be exothermic. Due to the lack of some alternate spin states and transition states, this hypothesis could not effectively be supported or rejected. Based on the data I have thus far, my hypothesis is supported, but additional testing is needed to confirm this. I will be continually running these tests and wish to test other possible catalysts as well.</p>	
<b>Summary Statement</b> My experiment uses computational chemistry to model the activation of hydrogen on various metals (platinum, palladium, nickel) in an effort to discover an economically effective source for catalysts in proton exchange membrane fuel cells.	
<b>Help Received</b> Dr. Tiffany Pawluk of CSU Bakersfield provided access to Gaussian 09; My mom provided transportation.	



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<b>Name(s)</b> Alberto Diaz; Joseph Le	<b>Project Number</b> <b>S0612</b>
<b>Project Title</b> <b>AquaDefense: A Multipurpose Hydrophobic Material Synthesized via the Substitution of Polar Hydroxyl Groups</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Our objective is to create a hydrophobic material that can exhibit a contact angle that exceeds 90 degrees, hopefully achieving close to or surpassing the Lotus Effect. A parallel objective is to find a practical method of delivering and applying the material onto the surface of a variety of materials including but not limited to metals, cloth and glass surfaces. Additionally, we are investigating the feasibility of mass producing the product, examining aspects such as the economic and environmental factors. We would like to create a product that would be able to withstand a high amount of interaction with oil as current products are not capable of doing so.</p> <p><b>Methods/Materials</b> To produce the foundation for our material, silica gel, we combined 30ml of tetraethylorthosilicate with 31ml of ethanol. We added this solution to a solution of 38ml of distilled water with 4 drops of hydrochloric acid under constant stirring. We heated the solution in a sand bath heated to 60°C for 1.5 hours. Once done, cooled the solution and placed it in a drying oven at 60°C until the remaining liquid has evaporated. We also repeated the process using ammonium hydroxide in place of hydrochloric acid. For make the silica gel hydrophobic, we soaked the gel in a series of hexane and trimethylchlorosilane solutions of gradient concentrations. We used a high resolution digital camera in conjunction with a macro lens to take a highly detailed photo of the contact angle.</p> <p><b>Results</b> We successfully created a powdery material exhibiting an average contact angle of 114 degrees, exceeding all our preliminary experiments using off-the-counter products. A water droplet applied to the surface was immediately and clearly expelled.</p> <p><b>Conclusions/Discussion</b> Through the clear improvement in contact angles, we assume that the exchange of hydroxyl groups was successful. In this study, we managed to make a desiccant gel hydrophobic through the exchange of surface groups on the gel. The transformation is obvious as the gel repels water rather than absorbing the liquid.</p>	
<b>Summary Statement</b> Our project is an attempt of formulating a highly hydrophobic material through the modification of silica gel as well as an exploration of intermolecular behavior in water repellent materials.	
<b>Help Received</b> John Allen acted as our mentor; Kevin Lyter lent camera equipment as well as advice.	



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<b>Name(s)</b> <b>Rebecca Drake; Elizabeth Mazeika</b>	<b>Project Number</b> <b>S0613</b>
<b>Project Title</b> <b>Pesticides, Produce, and People: Buying Organic: Is It Really Worth the Price?</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Going green and organic is today's catch word. There is concern that we need to improve our overall health and well-being, but this comes at a higher price tag. The Federal Drug Administration and the Environmental Protection Agency have set standards for tolerable levels of toxins that consumers may encounter. For some, even a tolerable level of pesticides and other impurities in their food is too much and many are willing to pay a premium for organically grown food. However, is the amount of pesticide residues on produce sufficient to warrant the high cost of purchasing organically grown produce instead? We have chosen to test apples. Apples have been cited by the FDA as one of the most contaminated fruits containing pesticide residues. Many people attempt to clean the apples off by washing using just tap water or sometimes a wash, such as Trader Joe's wash "Environne". Since apples predominantly come from either Chile or the United States, we tested for two commonly used pesticides in Chile and the United States, which are azocyclotin and azinphos-methyl.</p> <p><b>Methods/Materials</b> We used a High Performance Liquid Chromatography (HPLC) for analysis. We created our pesticide calibration curve by running a set of six known pesticide concentrations for each pesticide. We then tested our 68 samples, from our apples (organic and regular), by running them through the machine once. We used a sample of distilled water as our control to confirm that the machine was testing properly.</p> <p><b>Results</b> Our results, however do not support our hypothesis. When tested for azinphos-methyl, the apples showed no traces of the pesticide. When tested for azocyclotin, the apples did test positive.</p> <p><b>Conclusions/Discussion</b> However, due to our improper use of the product, "Environne," we are unable to say whether or not the product served its purpose correctly and how wide-spread the pesticide residue is in the different variety of apples. While it may be wise to purchase organic apples, our experiment did not reveal enough pesticides to cause harm to an individual person.</p>	
<b>Summary Statement</b> Organic produce is very expensive, but do the lack of pesticides make it worth the price?	
<b>Help Received</b> Mrs. Mazeika stayed in the lab with my partner and me and purchased all the materials; We used the lab equipment at our high school TOHS under the supervision of Dr. Malhotra; Dr. Cauchon taught us how to use the HPLC machine and interpret our results.	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> McKenna P. Duzac	<b>Project Number</b> <b>S0614</b>
<b>Project Title</b> <b>The Synthesis of Quantum Dots for Application in Solar Cell Efficiency</b>	
<b>Abstract</b>	
<b>Objectives/Goals</b> The goal of my project is to synthesize quantum dots and apply them to solar cells to make them more efficient.	
<b>Methods/Materials</b> ZnSe quantum dots, composed of Zinc Acetate, Selenium, distilled water, ethanol glycol, and hydrazine hydrate were synthesized first. The solution was cooked in a water bath for eight hours, then rinsed with anhydrous ethanol and distilled water. The CdSe quantum dots required two precursors. The TOPSe precursor contained Selenium, octadecene, and trioctylphosphine, which was mixed until clear. The Cd precursor was a mixture of CdO, oleic acid, and octadecene, cooked in a heating mantle until the solution reached 225 degrees Celsius. Then 1ml of the TOPSe precursor was added and 1ml samples of the mixture were removed at five second intervals. These samples were mixed with ethyl alcohol in a centrifuge to remove excess liquid. Hexanes were then added to create the final CdSe quantum dot solution. For the application to the solar cells, the ZnSe quantum dots were also mixed in with hexane. The conductive glass used was one inch squares. A TiO2 slurry was created by mixing TiO2, distilled water, and TritonX-100 until the consistency of paint. This was then applied in an even coat to the conductive side of the glass and allowed to air dry before sealing over a bunsen burner. On other pieces of glass, graphite was applied to the conductive side. The quantum dots were applied by pooling the hexane quantum dot solution on the TiO2 and allowing the hexanes to evaporate, thus leaving the quantum dots. Each quantum dot square was clamped together with a graphite square. Before testing under an overhead light, an iodine solution composed of KI, Iodine, and ethylene glycol, was put between the two pieces of glass.	
<b>Results</b> The ZnSe quantum dots were determined unsuccessful. The CdSe quantum dots were much more successful considering they fluoresce under a UV light, as described by many scientific articles. For the application to the solar cells, the ZnSe quantum dots were not successful, having approximately the same potential energy than the test cell which only had TiO2, graphite, and the iodine solution. The CdSe quantum dot solar cells nearly doubled what the test cell produced.	
<b>Conclusions/Discussion</b> The quantum dot application to the solar cells was a success and has great potential for future consumer cell application.	
<b>Summary Statement</b> My project focused on improving solar cell efficiency through the application of quantum dots.	
<b>Help Received</b>	



# CALIFORNIA STATE SCIENCE FAIR 2012 PROJECT SUMMARY

<b>Name(s)</b> <b>Sophie R. Epstein</b>	<b>Project Number</b> <b>S0615</b>
<b>Project Title</b> <b>The Perfect Cookie: The Effect of Baking Ingredients on Cookie Texture</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The objective was to determine how adding, altering, or otherwise changing various baking ingredients would affect the mass, volume, density and perceived hardness, crispiness, heaviness, and crumbliness of chocolate chip cookies.</p> <p><b>Methods/Materials</b> I baked seven batches of cookies: one control, the second with added baking powder, the third with melted butter (instead of leaving it at room temperature), the fourth substituting one egg with one egg white, the fifth melting the butter and using one egg white, the sixth adding baking powder, melting butter, and using one egg white, and the seventh substituting Crisco for butter. I then measured mass, volume (through water displacement), and density, and had nine "raters" rate the cookies on a Likert scale (1-5) on hardness, crispiness, heaviness, and crumbliness.</p> <p><b>Results</b> Adding ½ tsp baking powder resulted in heavier cookies, an average of 34.0 grams as opposed to 24.0 grams, occurring by chance .332% of the time, as well as harder and crispier cookies. Melting butter resulted in heavier, harder, and crispier cookies. Using one egg white resulted in crumblier cookies, an average of a 2.6 adhesiveness rating as opposed to 4.1, occurring by chance .020% of the time. It also resulted in heavier, bigger, harder, and crispier cookies. Melting butter and using one egg white resulted in harder, crispier, and crumblier cookies. Adding baking powder, melting butter, and using one egg white resulted in crumblier, much harder (4.8 opposed to 2.3, occurring by chance .00079% of the time), and much crispier (5.0 opposed to 2.3, occurring by chance .000023% of the time) cookies. Using Crisco instead of butter resulted in heavier, harder, and crumblier cookies.</p> <p><b>Conclusions/Discussion</b> Cookies make the world a better place. Chocolate chip cookies are a staple in homes all across America, but few understand the chemistry behind them. The results of this experiment show that baking ingredients significant affect cookie texture. When bakers understand the effect of baking ingredients, they are able to understand how to best change their recipes to create their favorite type of cookie - whether it be chewy or crispy, crumbly or adhesive.</p>	
<b>Summary Statement</b> I tested how adding, altering, or otherwise changing various baking ingredients would affect the mass, volume, density and perceived hardness, crispiness, heaviness, and crumbliness of chocolate chip cookies.	
<b>Help Received</b> Two professional chefs supervised the baking process to ensure that the constants held steady for every batch.	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Tanvi K. Gambhir</b>	<b>Project Number</b> <b>S0616</b>
<b>Project Title</b> <b>Reappraisal of Chromium from Stainless Steel as the Cause of the Diabetic Epidemic around the World</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> This project has three objectives: To determine if chromium from stainless steel containers is capable of chelating when an acidic substance is stored in it; to see whether there is a relationship between the sample storage duration and the pH of the substance and the amount of chromium chelation; to prove whether storing acidic substances in stainless steel containers may be a source of the excess chromium we are exposed to, which may have biological consequences.</p> <p><b>Methods/Materials</b> Buttermilk was made from scratch and stored in a stainless steel container and a ceramic container (the control). Samples were taken after 0, 1, 4, 8, 12, and 24 hours. The pH of the buttermilk was taken during the sample extraction. These samples were first acid digested then analyzed for chromium content using an IPC Emission Spectrometry. The experiment was conducted twice; the pH of each sample and the sample after 8 hours were only taken during the second experiment, however everything else remained the same.</p> <p><b>Results</b> For the first trial, the chromium levels for all the samples taken from the ceramic container were below the detection level of 0.005 mg/L. Of the samples taken from the stainless steel container, only two samples, taken after 1 and 4 hours, were below detection level. The amount of chromium chelation increased to 0.005 mg/l between 4 and 12 hours and to 0.0075 mg/L between 12 to 24 hours. The results for the second trial are still pending.</p> <p><b>Conclusions/Discussion</b> From the first trial it was proven that chromium from stainless steel containers can be chelated in the presence of an acidic substance and that there is a positive correlation between sample storage duration and amount of chromium chelation. This data suggests that storing acidic substances in stainless steel containers is a possible source of excess chromium exposure. This is significant because studies suggest that high chromium exposure during preconception and fetal stage leads to the increased prevalence and development of type 2 diabetes and other biological consequences in the offspring</p>	
<b>Summary Statement</b> My project determines whether chromium from stainless steel utensils can be chelated under the presence of an acidic substance and observes the relationship between the storage duration, pH value and the amount of chromium chelation.	
<b>Help Received</b> I discussed this project with Dr. Prakash Gambhir, a pediatrician and geneticist in India ; Dr. Mona Othman from the USDA of Salinas contacted the UC Davis lab and provided the equipment to prepare my samples; the samples were analyzed at the UC Davis chemistry laboratory; Parents gave me moral	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Brenden J. Geary</b>	<b>Project Number</b> <b>S0617</b>
<b>Project Title</b> <b>Fuel on Tap: H(2)O Energy. How to Power an Engine with Water</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The need to create a clean burning fuel is unquestionable, scientists all around the world are scrambling to find one. My project was designed to solve this problem with hydrogen and oxygen gas derived from water mixed with an electrolyte. The concept is to build a scale model of a system that can be placed in an automobile or any other device powered by an internal combustion engine.</p> <p><b>Methods/Materials</b> A hydrogen dry cell, powered by one 12v deep cycle battery, breaks the chemical bonds of water as shown here: <math>2H_2O \rightarrow 2H_2 + O_2</math> this is achieved by the process of electrolysis. The hydrogen and oxygen gas mixture will then bubble up a column of water in the bubbler. This does two things; first it filters out sodium hydroxide fumes created by the electrolyte. Secondly in the event of an ignition of the gas, it prevents the explosion from reaching the hydrogen dry cell and the water tank. The output of the bubbler is connected to the fuel line of a 212cc four-stroke gasoline engine. The motor burns the hydrogen and oxygen gas in place of gasoline. The engine then turns an alternator producing DC current which charges the 12v deep cycle battery.</p> <p><b>Results</b> The hydrogen dry cell and its counter parts worked beyond expectation in terms of the amount of hydrogen and oxygen gas that was produced. The hydrogen dry cell produced 3 liter of gas in 43.6 sec. This was achieved with a half-gallon of water and ten tablespoons of sodium hydroxide drawing 23 amps of electric current.</p> <p><b>Conclusions/Discussion</b> I was able to start the engine on hydrogen and oxygen gas derived from water. The engine ran for a total of three hours and it could have run longer, but that was when I had collected enough data. The system operated just as I had designed it and met all of my design requirements. I believe with some refinements, my project can be scaled up and implemented into a full scale automobile.</p>	
<b>Summary Statement</b> Powering an engine with Hydrogen and Oxygen gas, derived from water.	
<b>Help Received</b> JLMC, Inc., a Sheet metal shop cut, formed and welded the parts I designed.	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Irfan S. Habib</b>	<b>Project Number</b> <b>S0618</b>
<b>Project Title</b> <b>Corrosion of Metals</b>	
<b>Objectives/Goals</b> Corrosion of metals costs companies millions of dollars each year either through replacing things or trying to prevent it from happening in the first place. For this reason it is vital to understand the chemistry behind this phenomenon in order to investigate cheaper and more effective ways of solving this problem!	
<b>Abstract</b> <b>Methods/Materials</b> 1. steel, zinc, copper, aluminium, tin, brass, gold, silver were placed into 4 different solutions (distilled water, salt water, soda, vinegar) for 7 days to see which metal corroded the fastest and in which solution 2. salt drop technique was adopted for plain steel, polymer coated steel (coke can), tin coated steel (soup can), zinc plated steel. Phenolphthalein and ferricyanide indicator solutions were used to detect presence of Iron(II) oxides. 3. voltmeter was used to determine ranking of metals in order of reactivity	
<b>Results</b> 1. Soda and distilled water did not speed up corrosion as much as salt water and vinegar. Zinc and plain steel corroded the fastest in all solutions. Surprisingly aluminium which is higher on the reactivity series than zinc showed little corrosion. Gold was inactive. 2. Salt drop technique showed that the polymer coated lid and galvanized metal did not corrode. However the tin-plated steel did. 3. It was possible to rank the metals using the voltmeter.	
<b>Conclusions/Discussion</b> Corrosion was most evident in plain steel. Salt water and vinegar caused the greatest corrosion in all metals however Gold was inactive. The salt drop technique showed that the polymer coated and galvanized metal did not corrode even when scratched. This is due to sacrificial protection of galvanized metal. Finally it was possible to rank the metals in order of reactivity by recording the voltage created between two metals in salt solution.	
<b>Summary Statement</b> Investigating the chemistry behind 'CORROSION OF METALS'	
<b>Help Received</b> Mother helped me understand the chemistry background.	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Mitchell A. Hutton</b>	<b>Project Number</b> <b>S0619</b>
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**Project Title**  
**Efficiency of a Fuel Cell Car**

**Abstract**

**Objectives/Goals**  
The purpose of this experiment is to discover how efficient a hydrogen fuel cell car is. In order to do this, I'll be using a small-scale fuel cell car and testing the distance it can cover in one tank of distilled water. The reason for all of this is that hydrogen fuel cell cars have been seen on the news and in magazines describing how they give off zero pollutants and are a much easier fuel source to obtain, especially with new salt to fresh water converters recently invented. However, nobody knows how far it can take you.

**Methods/Materials**  
Materials: Hydrogen and oxygen water fuel cell tank, Hydrogen and oxygen gas tanks, Electric motor (powered by electrolysis from fuel cell), Basswood frame, Fuel cell, Small tubing, Axels, Straws (to allow the cars axels to spin freely), Wheels, Battery pack, AA batteries, Electric wires for motor, Calculator, Sand paper, Video camera, Timer, Small post it slips, Epoxy glue, Distilled water, Small syringe

**Results**  
It turned out that the hydrogen fuel cell car in my small-scale model got an average of 31.6 miles per gallon (7.4 L/100km). It ranged from a high of 59.3 miles per gallon (4.0 L/100km) to a low of 20.3 miles per gallon (11.6 L/100km).

**Conclusions/Discussion**  
Throughout my experiment I have come to a conclusion that disproves my hypothesis. The gas mileage of a hydrogen fuel cell car is actually quite pleasing. I hypothesized that a hydrogen fuel cell car would not get that great of gas mileage since putting hydrogen and oxygen ions back together is such a simple process. I expected the process to go very quickly. However, the combination of hydrogen and oxygen ions through reverse electrolysis creates a strong, long-lasting electrical current to power the car for a considerably long amount of time. So my conclusion is that the fuel cell cars get a far greater gas mileage than most cars using internal combustion engines. If I could change the experiment I would like to find a more efficient way to measure the distance. The motor might not have run as long if it had been affected by friction from rolling on the ground.

**Summary Statement**  
My project is about testing the gas mileage of a fuel cell car to be able to compare it to that of a fossil fuel car to notice a difference in efficiency.

**Help Received**  
Dad helped me lay out the board.



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Michael L. Janner</b>	<b>Project Number</b> <b>S0620</b>
<b>Project Title</b> <b>Fabrication and Manipulation of One-Dimensional Photonic Crystals</b>	
<b>Abstract</b> <b>Objectives/Goals</b> Photonic crystals have been the subject of intensive research during the last two and a half decades due to their usefulness in controlling the flow of light. More recently, there has been interest in creating photonic structures that can be controlled with external stimuli. The objective of this experiment is to fabricate iron oxide nanocrystals and use them as building blocks for magnetically responsive photonic structures. <b>Methods/Materials</b> Iron oxide nanocrystal clusters were fabricated through the hydrolysis of iron chloride and coated with a layer of silica through a modified Stöber method. This silica layer was then made porous through etching by water. As the nanocrystal clusters exhibited superparamagnetism at room temperature, magnetic fields were used to assemble them into photonic structures. These photonic structures were retained through further silica coating. <b>Results</b> Upon application of an external magnetic field, the nanocrystal clusters aligned into dynamic chain-like structures with regular interparticle spacings, causing them to diffract light. The diffraction wavelength of the photonic chains could be tuned across the visible spectrum by varying the magnetic field strength. The porous silica layer significantly improved both the stability and the order of the photonic crystals, increasing the diffraction intensity to nearly 70%. At increased concentrations, the chains assembled into photonic labyrinthine structures with lengths of up to 3-4 mm. <b>Conclusions/Discussion</b> The nanocrystal clusters can easily be assembled into photonic crystals with a fast and fully reversible magnetic response, making them ideal for applications such as color displays, antifraud devices, and military camouflage. The transition from photonic chains to photonic labyrinths has also been demonstrated in this study. These photonic labyrinths are very promising, as their assembly can be manipulated in order to create labyrinths with a wide range of morphologies which can be retained for further use by a secondary silica coating.	
<b>Summary Statement</b> Iron oxide nanocrystal clusters were fabricated and assembled into chains and labyrinths which change color in response to external magnetic fields.	
<b>Help Received</b> Used lab equipment at the University of California at Riverside under the supervision of Dr. Yadong Yin and Qiao Zhang.	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> Chris Kim	<b>Project Number</b> <b>S0621</b>
<b>Project Title</b> <b>Finding the Sugar Concentration of a Solution</b>	
<b>Abstract</b> <b>Objectives/Goals</b> My objective was to observe if there is the relationship between the index of refraction and the concentration of a sugar solution and to use the angle of refraction to estimate the amount of sugar in unknown drinks by making an equation. <b>Methods/Materials</b> A container with sides of four microscope slides with the length of 7cm on each side was created. A laser pointer was set to enter the container to enter at 40 degrees, and the angle of refraction could be measured. The angle of refractions in 5%, 10%, and 15% concentration sugar solutions was measured, and each experiment was repeated six times. The index of refraction of these 3 sugar solutions was calculated by using Snell's Law. Finally, an equation was made from the collected data. Using this equation, the angle of refraction was measured in unknown drinks, and the sugar concentration was estimated. <b>Results</b> On the 5% sugar concentration, the average index of refraction was measured 1.332. On the 10% sugar concentration, the average index of refraction was measured 1.348. On the 15% sugar concentration, the average index of refraction was measured 1.358. From this collected data, the equation was sugar concentration = $3.6009 \times \text{index of refraction} - 4.7472$ . On Gatorade, the average index of refraction was measured 1.34. On Green tea, the average index of refraction was measured 1.33. On apple juice, the average index of refraction was measured 1.348. <b>Conclusions/Discussion</b> I believe that the result of my hypothesis supported my hypothesis. I found that as the sugar concentration increases, the index of refraction also increases. There are many people who are interested in the amount of sugar in what they drink. I hope my experiment can lead to a method to easily find out the concentration of sugar in unknown drinks.	
<b>Summary Statement</b> The concentration of sugar in a solution was estimated by measuring the refraction of light entering the solution.	
<b>Help Received</b> None	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Ruchi S. Pandya</b>	<b>Project Number</b> <b>S0622</b>
<b>Project Title</b> <b>The Effects of Eliminating Oxidizers from Various Substances to Form Flame Retardant Substances</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Every year, more than 475,000 structures are burned down due to fire. The purpose of this experiment is to create an affordable and practical flame retardant paint. Once this solution is found, it can be applied to homes and commercial buildings all over the world to prevent fires.</p> <p><b>Methods/Materials</b> To conduct this experiment, 11 by 1 inch strips of paper were painted with 0%, 10%, 20%, and 30% concentrated solutions of commonly found salts (Ammonium Chloride, Ammonium Phosphate Dibasic, Sodium Acetate, and Borax) and exterior house paint. The strips were allowed to dry. Detailed time experiments were conducted, measuring the combustion time and total burn time. The experiment was repeated with a weathering aspect, which allowed the flame retardant paint to be tested as a practical, long-term solution to fires. As the amount of salt added to the paint increased, the combustion time increased, as did the burn time.</p> <p><b>Results</b> Ammonium Phosphate Dibasic and Ammonium Chloride were the most effective solutions in both the weathered as well as the unweathered portions of this experiment. Ammonium Phosphate Dibasic had a 20 second combustion time in the weathered portion, and took an average of 104.73 seconds to burn. Ammonium Chloride did not ignite with the 30% concentration in the unweathered portion, proving to be an unbeatable flame retardant. Full internal structure of the strips painted with 20% and 30% concentrations of Ammonium Phosphate Dibasic or Ammonium Chloride and exterior house paint remained intact.</p> <p><b>Conclusions/Discussion</b> The painted solutions of Ammonium Phosphate Dibasic and Ammonium Chloride were effective to the point that some of the strips used for the experiment did not meet the combustion requirements. These strips served as excellent flame retardants. The acidic and basic properties of the strips served as barriers between the oxidizer and the surface of the paper. This experiment could be tweaked to fit different climate regions all over the world, as the unweathered and weathered portions (representing rain and no rain) were both effective. My hypothesis was that if the oxidizer, in most cases oxygen, was eliminated from the equation, then the flame would not ignite. The most effective solutions had strong acidic and basic properties, which eliminated the oxidizer.</p>	
<b>Summary Statement</b> Commonly found salts with acidic and basic properties, when mixed with exterior house paint in 20% and 30% concentrations prove to be a significant flame retardant because they eliminate the oxidizer, thus inhibiting the flame.	
<b>Help Received</b> Fume hood, burn stand, and salts that I wanted were provided by the school.	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Katrina I. Paras</b>	<b>Project Number</b> <b>S0623</b>
<b>Project Title</b> <b>The Effect of Water Temperature on the Ability of a Surfactant to Minimize the Surface Tension of Water</b>	
<b>Objectives/Goals</b> The objective was to determine the effect of water temperature on a surfactant's ability to decrease the surface tension of water.	
<b>Abstract</b>	
<b>Methods/Materials</b> Materials for the homemade balance were a cardboard tube, wire, two wood blocks, aluminum foil, needle, sewing thread, and a small piece of modelling clay. Other materials were distilled water, Tide laundry detergent, small pieces of paper clips, a quadra-beam balance, a liquid thermometer, a bowl, a measuring cup, a refrigerator, a microwave, and a calculator. The single beam balance was constructed, which would be used to lift the needle out of the water. A pan for weights was placed on one end and a needle tied by thread on the other. The distilled water sample was heated or cooled to the desired temperature, and surfactant was added to it. The needle was made to "float" on the solution. Weights were added to the pan until it was heavy enough to lift the needle out of the water. The weights used were massed in a quadra-beam balance to calculate the force in grams needed to lift the needle. These measurements were plugged into a formula to calculate the surface tension. 5 water temperatures were tested, with 8 tests for each.	
<b>Results</b> The average surface tension in milliNewtons per meter was 44.9 mN/m $\pm$ 2.15 mN/m at 10°C, 44.7 mN/m $\pm$ 2.38 mN/m at 15°C, 39.5 mN/m $\pm$ 0.741 mN/m at 23.3°C, 25.1 mN/m $\pm$ 1.85 mN/m at 30°C, and 15.7 mN/m $\pm$ 2.57 mN/m at 35°C. These are the reported values, which show the average surface tension and average deviation.	
<b>Conclusions/Discussion</b> The hypothesis was supported by the data in stating that the surface tension would be highest at 10°C. This was most probably because it is a proven fact that surface tension does tend to be lower with hotter temperatures. The effectiveness of the surfactant had to be concluded based on the data and previous research. It is very likely that the surfactant was more effective at higher temperatures. A possible reason for this is the fact that the detergent used is meant for washing clothes in hot water and would be expected to function best at those temperatures.	
<b>Summary Statement</b> This project was about determining how water temperature and a surfactant affect the surface tension of water.	
<b>Help Received</b> Father helped with constructing balance and taking photographs; Mother helped obtain materials; Mr. Antrim (teacher) provided guidance and materials	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Alexander S. Powers</b>	<b>Project Number</b> <b>S0624</b>
<b>Project Title</b> <b>Chemistry of Fruits: Optimization of Postharvest Storage Conditions Affecting Nutrients and Taste</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> American families lose an estimated \$2,000 a year to food spoilage. Complex chemical reactions result in loss of taste and nutrients such as essential Vitamin C (Ascorbic Acid, AA). This experiment was designed to quantify chemical changes in fruits and provide applicable conclusions to minimize damage. I hypothesized that an increase in temperature would accelerate the ripening process and decrease AA while enclosed environments would speed ripening.</p> <p><b>Methods/Materials</b> Fresh mandarins were stored over 10 days in five conditions: countertop at 20°C, fridge at 3.3°C, freezer at -17°C, closed bag, and closed bag with bananas (to produce ethylene). Weight, pH, and soluble solid changes were measured. After centrifugation, juice samples were assayed colorimetrically with DCPIP dye and quantitative Benedict's solution to test for AA and reducing sugars respectively. A syringe method was implemented to extract initial juice samples and thus, account for variation between fruit.</p> <p><b>Results</b> AA showed continuous and varied degradation with an average loss of 28.3%. The enclosed bag led to only 20% loss as opposed to 48% in regular air simulating a controlled atmosphere with lower O<sub>2</sub> levels and high humidity. Weight loss and AA loss had a positive correlation. High loss of 34% in refrigeration at 3.3°C can be attributed to chilling damage. Reducing sugar increased by an average of 22% with a maximum increase of 35% on the counter and a minimum of 7% in the freezer. The enclosed bag containing bananas had an increase of 25% attributed to the accelerated hydrolysis of starch into sugar by ethylene stimulation. A method for detection of high levels of ethylene gas with potassium permanganate was developed. Results overall had statistical significance with low standard deviations of 2-4%.</p> <p><b>Conclusions/Discussion</b> My hypothesis was not fully supported in that increasing temperature was not the only major factor to affect ascorbic acid loss. Losses are enhanced by extended storage, higher temperatures, low relative humidity, and chilling injury explainable on a chemical level. Increased temperature and ethylene did produce a statistically significant increase in concentration of soluble solids and reducing sugars. Although analyzing only a single fruit with limited factors, this experiment provides a basis for further exploration to efficiently minimize spoilage.</p>	
<b>Summary Statement</b> This experiment quantified chemical changes during fruit storage to find optimum conditions.	
<b>Help Received</b> Borrowed equipment from school for use at home	



# CALIFORNIA STATE SCIENCE FAIR 2012 PROJECT SUMMARY

<b>Name(s)</b> <b>Sulekha S. Ramayya</b>	<b>Project Number</b> <b>S0625</b>
<b>Project Title</b> <b>Increasing the Efficiency of DMFCs Using Different Supply Conditions, Temperatures, and Catalysts</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> This project was designed to improve the efficiency of Direct Methanol Fuel Cells by testing different factors including oxygen flow rate, methanol solution concentration, temperature, and the nano-particle catalyst used. The most significant component of the project was the lab-synthesized catalyst that was developed for the anode of the fuel cell.</p> <p><b>Methods/Materials</b> I constructed two different fuel cells by pressing two pieces of Teflon-coated carbon paper around a Nafion film. In both cells, the cathode was painted with a platinum black catalyst and the anode was painted with a carbon-supported platinum and ruthenium black catalyst. A commercial anode catalyst was purchased and compared to one synthesized in the lab using direct chemical reduction. This novel catalyst has a unique 90% carbon, 10% tantalum carbide support. This membrane-electrode assembly (MEA) was then placed within a fuel cell housing, and the entire fuel cell, using tubing, was fed with a methanol solution at the anode and oxygen at the cathode. After conditioning the cells, data collection began by evaluating current and voltage output at various oxygen flow rates, temperatures, and methanol solution concentrations. All of the data was collected on the computer using a fuel cell test system.</p> <p><b>Results</b> The maximum power density attained was about 55 mW/cm<sup>2</sup>. The cell did perform better at higher temperatures, as expected. The cell with the lab-synthesized catalyst was able to produce higher power density at lower currents. The stronger methanol solution, however, did not enable the fuel cells to perform significantly better. Overall, the second fuel cell with the synthesized catalyst had consistently better performance.</p> <p><b>Conclusions/Discussion</b> Ultimately, my hypothesis was supported and the synthesized catalyst allowed the cell to perform better than the commercial catalyst; more research could lead to its use in commercial cells, as these fuel cells have enormous application. The ease of production and cost effectiveness of methanol along with the ability of the DMFCs to perform at relatively low temperatures will enable these fuel cells to become a significant, portable energy source for the future.</p>	
<b>Summary Statement</b> I was trying to increase the performance of the fuel cell by testing different conditions but most importantly by developing my own novel, nano-particle catalyst in the lab.	
<b>Help Received</b> My mentor, Frederick Krause, gave me background information about the topic and helped me design my experiment, review my paper, and verify my claims.	



**CALIFORNIA STATE SCIENCE FAIR  
2012 PROJECT SUMMARY**

<b>Name(s)</b> <b>Jeeyeon Sohn</b>	<b>Project Number</b> <b>S0626</b>
<b>Project Title</b> <b>The Effect of D-limonene Contained in Various Citrus Oils on Disintegration of Polystyrene Foams</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The purpose was to determine the effect of d-limonene in oils extracted from various citrus fruit rinds on disintegration of two different types of polystyrene foams-expanded (EPS) and extruded (XPS). It was hypothesized that the d-limonene extracted from orange rind will disintegrate polystyrene foams most, and expanded polystyrene foam will be more disintegratable.</p> <p><b>Methods/Materials</b> The oils were extracted from four different citrus fruits-grapefruit, orange, tangerine, and lemon. The rinds were peeled and dried. The dried peels were grinded and put into separate 400.-mL beakers. Approximately 150.0mL of ethanol was added to each of the grinded dry peels. The mixture was filtered into a 125-mL Erlenmeyer flask. The liquid in each flask was the various citrus oils containing d-limonene. Two different types of foams, expanded (EPS) and extruded (XPS; Styrofoam), were each cut into 12 similar sized blocks. Each type of foams had a model block which was used to convert mass into volume and volume into mass. 2.00mL of citrus oil was put on each block of polystyrene foams using a 4.00mL pipette. The volume of each EPS and XPS blocks were measured using the water displacement method.</p> <p><b>Results</b> Grapefruit was found to be most effective on the degradation of EPS and orange and lemon oils were found to be most effective on the degradation of XPS. The mean disintegration of EPS by mass by grapefruit, orange, tangerine, and lemon oils were found to be 18%, 15%, 12%, and 11%, respectively. The mean disintegration of XPS by mass by grapefruit, orange, tangerine, and lemon oils were found to be 3.2%, 7.4%, 3.6%, and 7.4%, respectively. The percent deviation of grapefruit, orange, tangerine, and lemon oils of EPS trials were 5%, 4%, 8%, and 9%, respectively. The percent deviation of grapefruit, orange, tangerine, and lemon oils of XPS trials were 6%, 4%, 5%, and 4% respectively. The data was found to be precise, for the percent deviation was less than 9%.</p> <p><b>Conclusions/Discussion</b> The hypothesis was partially supported as EPS was more disintegratable than XPS, but it was grapefruit that was found to be most effective for EPS and orange and lemon for XPS. The information gathered can be used to improve the recycling of polystyrene foams in the landfill.</p>	
<b>Summary Statement</b> How d-limonene in various citrus oils effected disintegration of expanded and extruded polystyrene foams.	
<b>Help Received</b> Parents helped with materials; Mr.Antrim helped with planning	