



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Cailan A. Ackerman	Project Number S0601
Project Title Absorption of Glyphosate Based Herbicides by Microbeads	
Abstract Objectives/Goals The objective of this study is to determine whether or not microbeads are able to absorb glyphosate from water. Methods/Materials Separated microbeads from products, prepared three concentrations of pure glyphosate and DI water (0, 120, and 170 ppb) for testing. Added concentrations and beads together in cryogenic vials and placed them on a shaker for 74 hours. Collected water samples from each at 0, 5, 12, 24, 28, and 74 hours. Ran all the samples through an HPLC system to determine the concentration of glyphosate. Results The microbeads absorbed glyphosate at both the concentrations. They were able to accumulate the glyphosate over the course of 74 hours. Conclusions/Discussion These results indicate that the microbeads can absorb the glyphosate from the water. This implies that they are capable of carrying them into the food chain as they are the same size as many small aquatic organisms food. So not only are the organisms ingesting the plastic, they are also ingesting the pollutants that they carry as well.	
Summary Statement I found that microbeads are capable of absorbing glyphosate from aquatic ecosystems.	
Help Received My teacher Dr. Malhotra let me use her HPLC system and Dr. Gregory Cauchon also aided in my HPLC method and trouble shooting. Mr. Stiv Wilson also provided valuable information about microbeads as he is the lead researcher on them and responsible for the bill that passed to ban them in California.	



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

Name(s) Sakina Bambot	Project Number S0602
Project Title Bisphenol A Transfer from Receipts: Detection Using TOF-SIMS	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this experiment is to see whether Bisphenol A (BPA) from receipts will transfer onto surfaces such as your hand. Another objective is to see if BPA levels in receipts have decreased over the years.</p> <p>Methods/Materials Receipts from 1980, 1981, 1995, 1997, 2001, July 2015, November 2015, and December 2015 were used. Each receipt was rubbed against a piece of silicon wafer. Additionally, three control wafers which were not rubbed on receipts were used. The silicon wafer pieces were then mounted onto the TOF-SIMS instrument holder and a 0.2 by 0.2 millimeter area on each silicon piece was analyzed. It was examined for the presence of BPA by looking for a peak at mass 213 (a peak at mass 213 is indicative of BPA presence). The ratio of the counts under the peak at mass 213 to the total number of counts in the spectra was calculated in order to determine the normalized intensity. This intensity was compared among the samples.</p> <p>Results BPA was observed in all of the receipts. There was no clear trend observed in the level of BPA with the progression of years. The December 2015 receipt showed a much lower level of BPA than the other receipts while the one from November 2015 showed the highest level. In some cases, a high standard deviation was seen, suggesting a high trial to trial variability in the transfer of BPA.</p> <p>Conclusions/Discussion The fact that BPA levels were found in receipts from all the years, indicates that nothing has been done to eliminate BPA from receipts. Higher and lower levels of BPA within 2015 may have been due to the differing receipt manufacturers as these receipts were from different stores. In the future, this procedure can be used to determine what other harmful substances are transferred from receipts.</p>	
Summary Statement Using the TOF-SIMS technique, I found that receipts from the year 1980 to 2015 did transfer Bisphenol A, and that transfer did not decrease over the years.	
Help Received Evans Analytical Group allowed me to use their TOF-SIMS instrument under the supervision of Dr. Ginwalla and provided me with clean pieces of silicon. My parents for drove me around and supported me. Ms. Bisaha provided me with older receipts.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Reid A. Barton	Project Number S0603
Project Title The Effect of Chloride Ion Concentration in Organolead Halide Perovskite Crystal Based Solar Cells	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The purpose of this research project is to investigate the formation of perovskite crystals from a variety of precursor solutions and their respective semiconductor properties. Although many of the highest efficiencies have been achieved in technical labs with solar cell areas much too small to be practical, the goal of this project was to create low grade cells with greater surface area to experiment with different crystal combinations and test relative efficiencies. In addition, tandem (stacked) cells were constructed by combining perovskite cells with commercial silicon-based solar cells to improve total efficiency.</p> <p>Methods/Materials Formamidinium lead halide perovskite crystals with a 2-to-1 molar ratio iodide to chloride ions were used as a control. The cells were then modified with different chemical compositions in an attempt to achieve higher output voltages. For this research the molar ratio of chloride and iodide ions in the perovskite precursor solution was altered to achieve crystal structures with different band gaps. The more chloride, the higher the band gap. To test the cells in a controlled environment, the cells would be exposed to equal amounts of light and their voltage could be measured.</p> <p>Results During this project, a perovskite crystal based solar cell was constructed with an output voltage of up to 520 millivolts, comparable to traditional silicon solar cells. However the internal resistance of the cells was much too high to produce any sort of usable current or measure any reliable total efficiency. Interestingly, the experiments where molar concentrations of solutions was altered suggested that a two to one ratio of formamidinium chloride (FACl) to lead (II) iodide produced the semiconductor crystals with the highest output voltage. Additionally, the perovskite crystal solar cell was used successfully in improving the overall voltage of a silicon and perovskite tandem cell.</p> <p>Conclusions/Discussion The studies showed that rudimentary perovskite crystals could be fabricated at low cost with basic laboratory equipment that give an indication as to which precursor chemicals and concentrations serve as best recipes for final semiconductor crystals. Additionally, the studies show that perovskite semiconductor layers with band gaps of increasing value could be applied to today's silicon cells to improve overall efficiencies.</p>	
Summary Statement I altered the light absorption properties of perovskite based solar cells through the use of varying precursor solutions.	
Help Received I built the cells in my high school fume hood. My teacher, Mrs. Messenger gave me advice on basic lab skills and techniques. I also had a couple of questions about perovskites answered from researchers Sameer Patwardhan of NorthWestern and Giles Eperon of Oxford.	



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

Name(s) Audrey Cheng	Project Number S0605
Project Title Enhancing the Efficiency of Self-Assembled Organic Solar Cells with the Addition of a Second Electron Donor and Graphene	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Solar energy, as the largest energy resource on Earth, is a viable source of renewable power because it is free and easily available. Organic solar cells are a promising low-cost renewable energy technology that offers multiple advantages, including flexibility, semi-transparency, significantly lower manufacturing costs, and possible integration into a variety of products, over their inorganic counterparts. Organic photovoltaics are limited, however, by their low power conversion efficiencies and narrow absorption ranges. The goal of this project was to expand the absorption spectrum and increase efficiency by incorporating two photoactive polymers, Poly(3-hexylthiophene) (P3HT) and Poly[9#-hepta-decanyl-2,7-carbazole-alt-5,5-(4#,7#-di-2-thienyl-2#,1#,3#-benzothiadiazole)] (PCDTBT), and graphene into self-assembled organic solar cells.</p> <p>Methods/Materials Absorption spectra of the devices obtained through ultraviolet-visible spectroscopy elucidated the interactions between the photoactive polymers. Transmission electron and atomic force microscopy were used to show the formation of columnar structures within the devices and study the changes in morphology brought about by the additives.</p> <p>Results The addition of polystyrene created vertical nanostructures that enlarged the interfacial areas between the donor and acceptor materials. Analysis of AFM images using surface roughness and contact angle values revealed that graphene gathered at the sides of the self-assembled columns and induced the diffusion of both electron donor and acceptor materials, resulting in greater electricity generation. Measurements of short circuit current indicated that P3HT expanded the spectral ranges of the solar cells. Addition of a second electron donor led to a 12.4% increase in solar cell efficiency. A 95.2% increase in efficiency was achieved with the incorporation of graphene.</p> <p>Conclusions/Discussion This project is the first time that the effects of a secondary electron donor and graphene on the morphology of a self-assembled active layer have been studied and presents an economical way of increasing device performance. This research advances the development of organic solar cells and increases their potential towards application in clean energy.</p>	
Summary Statement I obtained the highest energy generation efficiency to date of self-assembled organic solar cells through the novel incorporation of multiple electron donors and graphene.	
Help Received My research mentor, Professor Miriam Rafailovich, explained the procedures for making the solar cells and supervised me during experimentation. She operated the AFM and TEM to scan my samples and collected device performance data at Brookhaven National Lab.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Isaac W. Chizhik	Project Number S0606
Project Title Mixing Up a Better Lab: Wavelength Choice Affects Accuracy and Consistency of the UV-Vis Spectroscopy Analysis	
Abstract Objectives/Goals For this study, I moved to scientifically ascertain the source of the inconsistencies in the results of the students who performed the UV-Vis Spectroscopy Lab as part of their Analytical Chemistry 251 lab at SDSU, and then to remedy it. Thus, I asked the question, #what causes unreliable results when using spectrophotometry to find the concentration of Iron (II) and how does one overcome such obstacles?# Methods/Materials I predicted that the wavelength used by the original lab procedure, 562nm, was not best for detecting the iron in the solution and was, thus, the source of the inconsistencies reported by the students. I thought that changing the wavelength to one that can detect a higher absorbance would negate such unfortunate effects by rendering any error insignificant. I first measured the absorbances of a single solution of Iron (II) marked with 1, 10 phenanthroline in a spectrophotometer at different wavelengths to find the one with the highest results. I then measured the absorbances of solutions with a constant amount of unknown and varying amounts of standard at the original wavelength and the new one to find the concentration of the unknown (absorbance is directly proportional to concentration). Results The wavelength with the maximum absorbance was found to be 512nm. After using the relative absorbances for the known concentrations of the standards to derive the concentration of the unknown at both 512nm (experimental) and 562nm (control), I found that the error of the experimental wavelength was 3 times smaller than that of the control. Its results were also reproducible, falling consistently within an error of 10%. Conclusions/Discussion the experiment concluded that the wavelength that was used by the students before this study, 562nm, was too high and not as sensitive to the particular shade of green that was absorbed by the solution. Meanwhile, 512nm was an excellent wavelength that allowed for optimal measurements to be made under the circumstances and the skills being used.	
Summary Statement I found that the source of the inconsistencies in the UV-Vis Spectroscopy Analysis were due to the wavelength being too high at 562nm, with the lower wavelength at 512nm being optimal for detecting Iron (II).	
Help Received I performed the lab and did all of the math myself. The project was given to me by Dr. Harrison of the Chem department of SDSU and the hypothesis came out of a discussion that we had. He also provided me with all of my equipment. However, everything else was of my own doing.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Bradley Chun; Jaden Locke	Project Number S0607
Project Title An Analysis of the Effects of CO₂ on the Dissolution CaCO₃ in Marine Life	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Carbon dioxide levels in the atmosphere are rising at an alarming rate, putting many marine ecosystems at risk of irreparable damage. The objective of this study was to isolate a correlation between levels of carbon dioxide in an aqueous solution and calcium carbonate dissolution rates.</p> <p>Methods/Materials The correlation was calculated by setting clams into tanks with various concentrations of CO₂, with one being a control. The tanks were then all filled with water and CO₂ was pumped into all of the tanks except for the control. The clams were monitored weekly for mass, length, width, and volume loss. The tanks were monitored for CO₂ concentration, pH, and temperature.</p> <p>Results The data revealed a direct correlation between CO₂ concentration and CaCO₃ dissolution rates.</p> <p>Conclusions/Discussion This corroborates the hypothesis that heightened CO₂ concentrations in the atmosphere could severely damage the CaCO₃ shells of marine invertebrates.</p>	
Summary Statement Clams were submerged in tanks with varying levels of added CO ₂ and measured for changes mass, width, length, and volume.	
Help Received The University of California, Riverside supplied us with materials like tanks, CO ₂ , and a fume hood, but the research performed was performed independently by the authors of this project and without the guidance of the UCR faculty.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Jona Victoria G. Cruz	Project Number S0608
Project Title Dissolving Alka-Seltzer Tablets in Different Liquids	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of this project is to determine which liquid is the most efficient in dissolving Alka-Seltzer tablets by measuring how fast the tablets will be dissolved, with the most effective solvent determined by the shortest time.</p> <p>Methods/Materials One Alka-Seltzer tablet in four same-sized beakers, each containing a different liquid (water, Sprite, apple juice, and Lemon-Lime Gatorade). A thermometer was used to make sure that temperature was constant in the liquids across all trials and a stopwatch measured the dissolving times. The procedure was repeated five times per liquid for a total of twenty trials.</p> <p>Results Water had the fastest average dissolving time (63 seconds) while Sprite had the slowest dissolving time (86 seconds). Sprite, Tree Top Apple Juice, and Gatorade had standard deviations that indicated they had similar dissolving times. By contrast, water had a standard deviation that did not overlap those other three liquids and it produced significantly lower dissolving times.</p> <p>Conclusions/Discussion Based on the results, water was concluded to be the most efficient solvent. This is most likely due to the absence of acid within the water that is present in the other liquids. Since water is commonly used to dissolve Alka-Seltzer tablets for consumption, its efficacy was further supported through this study.</p>	
Summary Statement By comparing the times it took different types of beverages to fully dissolve a solid Alka-Seltzer tablet, I determined that water dissolved the tablets faster than the rest of the liquids in this experiment.	
Help Received Pamela Durkee (Ph.D, York School Biology Teacher) helped me revise my papers and provided me with beakers, a graduated cylinder, and a thermometer for my experiment.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Max Freedman	Project Number S0609
Project Title Bang for Your Buck: Designing and Building Hydrogen Fuel Cells	
Abstract Objectives/Goals This project investigates the properties and feasibility of hydrogen fuel cells made from common materials as an alternative energy solution. Methods/Materials Built a hydrogen fuel cell with a PEM (proton exchange membrane) and hydrogen generator. Tested power efficiency and performance with various voltages. Results The hydrogen fuel cell performance is determined by flow rate of hydrogen. As power into the generator increases the hydrogen flow rate increases, but reaches a limit and then performance declines. At its peak performance, fuel cell output was a constant 0.75 volts. The fuel cell is most efficient operating levels of power 14-21W. Conclusions/Discussion Performance of this fuel cell changes depending the rate of hydrogen produced. When rate of hydrogen is too fast, the efficiency drops. To get the best efficiency from the cell, more testing is required to determine the optimal rate of hydrogen. Possible variables include temperature, Nafion ratings, and pressure in the cell playing a part in changing the efficiency.	
Summary Statement I built and test a hydrogen fuel cell and generator using common materials.	
Help Received Adam Draeger helped me with apparatus construction. Max Dobrushin helped me with background research and edits. Patty Freedman helped me with graphic design and display board.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Linett Garcia	Project Number S0610
Project Title Using Ice to Determine the Efficiency of Basic Types of Salt	
Abstract Objectives/Goals The objective of this study is to find out what type of basic salt melts ice the fastest. Methods/Materials The materials used were a scale to weigh the salt (30 grams), table salt (Morton Iodized Salt), sea salt (Hain Pure Foods Sea Salt), kosher salt (Morton Coarse Kosher Salt), tray to make ice cubes, container to place four cubes, and a stopwatch. Results The time was the dependent variable because it was affected by the independent variable (salt). The average time for each type of basic salt was recorded. Kosher salt was the most efficient when melting the ice. Conclusions/Discussion After several trials, the average time to melt ice indicated that kosher salt had a faster reaction with the ice than the other salts. The time it took for the ice cubes with no salt to melt was significantly longer than the ice cubes with salt because they weren't reacting with any chemicals. The deviations noted, show that there weren't significant differences between the averages for table salt and sea salt. However, it was concluded that kosher salt was the most efficient because it was the purest salt meaning that it didn't have any additives.	
Summary Statement After recording the average time for each different type of basic salt to melt ice, it was noted that kosher salt was the most efficient since it was the purest salt.	
Help Received My biology teacher helped me throughout the process revising the methods and results.	



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

Name(s) Alexandra K. Harakas	Project Number S0611
Project Title The Effect of Wood Ash on the Fire Retardancy of Paint	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this study is to determine if wood ash is a suitable fire retardant paint additive. If the potassium bicarbonate content found in wood ash can release enough carbon dioxide, retaining its fire extinguishing properties, then when it is added to latex paint it will lengthen the amount of time for the painted drywall to catch fire and will reduce its flammability.</p> <p>Methods/Materials The most essential materials for this experiment include thirty pieces of drywall measuring one and three fourths inches wide and eleven and three fourths inches long, one lighter, one can of indoor wall paint, four ounces of completely burned and ground wood ash, one assistant, and one stopwatch. The experimenter must add four ounces of wood ash to one paint sample of four ounces and stir thoroughly. Paint fifteen drywall samples with the treated paint and the remaining fifteen with regular paint, allowing them to dry overnight. Hold the lighter perpendicular to the drywall sample and begin the timer. Continue to hold the flame to the sample until it has begun to smoke and the paint begins to peel. Stop the timer when these things have occurred and record the results.</p> <p>Results The drywall pieces painted with regular paint quickly caught fire and burned through the coat of paint, quickly smoking. However, the pieces painted with the paint containing ash took longer to burn through the coat of paint, and as soon as the flame was removed the smoking subsided. The drywall pieces painted with the paint containing four ounces of ash burned three times slower than the regularly painted drywall on average.</p> <p>Conclusions/Discussion The results of this experiment supported the hypothesis. Each sample painted with the paint containing wood ash was more fire retardant than the samples coated with regular paint. Both the results of this experiment and the results of past experiments in that the wood ash used has shown fire resistant characteristics. With further study on the fire retardant quality of wood ash, the science community will be closer to understanding how to implement this natural substance into the paint industry, potentially preventing structural fires.</p>	
Summary Statement I found that when wood ash is added into wall paint, drywall coated in that paint takes longer to catch fire.	
Help Received I designed and executed the exact specifications of modifying the paint burning the painted samples myself. Tammie Harakas assisted in timing under my direction as I burned the samples.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) James G. Karroum, II	Project Number S0612
Project Title Inhibiting the Corrosion of Metals Using Cathodic Protection	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals In this project I determined how metal type and anode surface area affect the corrosion rate of a metal protected by cathodic protection. My hypothesis was that if two metals form a galvanic cell, then corrosion rate of the anode will increase with its surface area and electrode potential difference between metals, and corrosion rate of the cathode will decrease with anode surface area and electrode potential difference between metals over the course of the experiment. I believed that standard electrode potential could be correlated with the ability of an electrode to corrode.</p> <p>Methods/Materials I created six galvanic cells; each consisted of a copper strip in a 0.5 M solution of CuSO₄. Two were connected to zinc, two to aluminum, and two to iron strips, in 0.5 M Zn(NO₃)₂, Al(NO₃)₃, and FeCl₃ solutions, respectively. Salt bridges and alligator clips completed each cell. Each day I wrote down observations and found the voltage of each cell. I found the mass of each electrode before and after five days. Change in mass was measured after scraping off corrosion from the metals.</p> <p>Results After averaging the voltage of each cell over time, I found that the electrode potential difference had no observable relation to rate of corrosion between instances. All cathodes gained mass over the course of the experiment, and all anodes lost mass; iron's change in mass was much greater than that of zinc and aluminum. I attributed this to the passivation of zinc and aluminum, which formed an oxide layer protecting the metal beneath from further corrosion. Corrosion rate was proven proportional to anode surface area, because mass lost per unit of anode surface area was the same for each instance of a metal anode.</p> <p>Conclusions/Discussion Metal type was proven to affect the rate of corrosion of electrodes, but not for the reason thought. The ability of a metal to undergo passivation, instead of its electrode potential, affects its rate of corrosion in a galvanic cell. This was contrary to my hypothesis. My experiment showed that increases in surface area increase the corrosion rate of the anode, which proved that aspect of my hypothesis correct. In practice, an effective sacrificial anode would consist of a metal that will not undergo passivation, and is of a large surface area. The gain in mass of cathodes showed that corrosion can be reversed in certain scenarios, due to the transfer of electrons to the cathode.</p>	
Summary Statement I determined how metal type and anode surface area affect the corrosion rate of a metal protected by cathodic protection.	
Help Received My chemistry teacher and science fair moderator each provided me a laboratory setting to work in, and all the materials, instruments, and substances I needed.	



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

Name(s) Anjini Karthik	Project Number S0613
Project Title Combating Viral Outbreaks: Rapid and Selective Detection of Viruses Using Inexpensive Polymer Films	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Viral diseases are a leading cause of death worldwide. In order to control the spread of viral infections and minimize fatalities, we must be able to detect virus pathogens rapidly and accurately. However, the methods we currently use to diagnose viral infection, such as PCR, take far too long - often taking hours to days, when results are required in minutes. These methods are also laboratory based, expensive, and labor-intensive. An urgent need exists for a tool that can detect viral pathogens rapidly, selectively, at the point of care, and at a low cost. This study addresses this need by producing a virus imprinted polymer (VIP).</p> <p>Methods/Materials A nanopatterned polymer film of polydimethylsiloxane (PDMS) was produced by curing a prepolymer in the presence of a template with the target virus on it; after the polymer hardened, the template was removed, leaving on the imprinted surface cavities (mean size of 120 ± 4 nm) that were complementary in shape and could specifically capture the target virus. Two inactivated viruses with similar shape, Influenza A (HK68) and Newcastle Disease Virus (NDV), were employed as model strains.</p> <p>Results Evaluation of the VIP revealed that it has distinct advantages over existing viral detection methods. The VIP captures a target virus from an aqueous suspension of ultralow volume (5 microL) after only 1 minute of contact, detects viruses at concentrations found in influenza infections, and is sensitive down to 8 fM without requiring any additional device. The polymer film, which was first imprinted with HK68 and exposed sequentially to suspensions containing fluorescently labeled NDV and HK68, was able to preferentially bind HK68 at a capture ratio of 1:8.0. When the procedure was reversed and the polymer was imprinted with NDV, the capture ratio was 1:7.6. These results were obtained within 20 minutes of static exposure and indicate that the VIP distinguishes between viruses with a similar size and shape on the basis of chemical recognition.</p> <p>Conclusions/Discussion Production of virus-imprinted films can be readily scaled to large quantities and yields a disposable, simple-to-use device that allows for rapid detection of viruses. Thus, it is envisioned that the VIP can be used in the field as a disposable tool for the rapid and selective detection for viruses at the point of care, without electricity, and in line with the World Health Organization guidelines.</p>	
Summary Statement I produced a wipe to detect viral infection rapidly (within 1 minute), selectively, at the point of care, and at a low cost, using a virus imprinted polymer (VIP).	
Help Received I acknowledge my family and teacher for constant support; Dr. Ren, Dr. Margulis, and Dr. Zare from Stanford University for guidance and for giving me the opportunity to develop my project in their lab; Dr. Leung for providing virus particles; and the journal Nanoscale for publishing this research.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Richard A. Korshkov	Project Number S0614
Project Title Got Water? Salt Water to Fresh Water	
Objectives/Goals -What is a more effective desalination process? -Can fresh water be produced from decanoic acid and coconut oil at various temperatures. Is the directional solvent extraction method efficient?(MIT Model)	
Abstract Methods/Materials Mix 35g of NaCl, pour into 1000mL of deionized water. (Dissolve). Place 5 grams of decanoic acid and 200mL of Coconut oil and heat the mixture to 40°C. Mix 10 grams of the salt solution with the heated acid mixture. Continue to mix for 60 minutes, while keeping the mixture at 40°C. Separate the acid from the beaker into conical tubes, incubate in a 34°C water bath, for 72 hours. Repeat steps 1-4 for 50°C and again for 60°C. Complete 7 trials minimum for each temperature range. After 72 hours, puncture a hole at the bottom of the conical tubes, and collect the freshwater. Don't allow any of the acid to be collected with the water. Measure the salinity of the water. Weigh the mass of the water and acid. Allow the water to sit again for 72 hours. 1000mL Distilled water, 600 mL coconut oil, 35g Sodium Chloride, Erlenmeyer Flask, 15g Decanoic Acid solid/powder, 400 mL beakers, 25mL beakers, Hot Plate, Magnetic stirrers, Conical Tubes, Thermometers, Water Bath, Salt Meter, Mass Scale, Fume Hood, pipettes, Sharp instrument, Safety Equipment All equipment borrowed from school except for the water bath, conical tubes and the pipettes, which were ordered online.	
Results 50°C: The mass of the acid ranged from 20.09g. to 20.45g., water/coconut oil solvent ranged from 0.71g. to 1.03g. The acid and water had a mean of 20.32g and 0.88g. 60°C: The mass of the acid ranged from 18.12g. to 20.41g., water/coconut oil solvent ranged from 0.67g. to 1.59g. The acid and water had a mean of 19.82g. and 1.25g.. Most freshwater was produced. 70°C: The mass of the acid ranged from 20.20g. to 20.63g., water/coconut oil solvent ranged from 0.51g. to 0.75g. The acid and water had a mean of 20.36g and 0.65g.. Least amount of freshwater.	
Conclusions/Discussion Despite many obstacles, I experienced a measure of success. Although I was not able to separate the two materials, I was able to separate the acid and salt from the water and coconut oil, which was the main purpose for this experiment. All in all, it is reasonable to say that the decanoic acid method of desalination is an energy, and cost efficient way of desalination.	
Summary Statement Desalination of salt water using decanoic acid and coconut oil in a directional solvent extraction method.	
Help Received Scientific Advisors/Mentors: Angela Ziegler(CLS), Kelly Samuelson(Teacher). MIT(Research Cited)	



CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s) Matthew C. Krock	Project Number S0615
Project Title Optimization of Period IV Transition Metal-Phosphate Complex Concentration for Efficient Water Electrolysis	
Objectives/Goals The primary objective was to analyze the efficiency of transition metal-phosphate complexes as catalysts for the electrolysis of water, specifically Iron(III) and Cobalt(II) in order to either support or provide evidence contrary to a hypothesis developed as a result of previous research. This focused on identifying whether or not transition metals with greater oxidation states would be more efficient as catalysts, as they have more electrons, and therefore have an increased capacity to conduct electricity in solution.	
Abstract Methods/Materials I tested the efficiency of the process with each transition metal by adding samples of each nitrate salt at specific concentrations from 0.02 M to 0.20 M to 25 mL samples of monobasic potassium phosphate solution. By measuring the current and voltage over a 5 minute period while connected to a DC power supply, I was able to calculate the energy input for the reaction. By collecting hydrogen gas through water displacement in a test tube, I calculated the amount of gas produced and used the Gibb's free energy of water synthesis to calculate the energy output obtainable from an ideal hydrogen fuel cell. Through comparing these two values, I was able to calculate the efficiency for each test.	
Results As a result of my research, I found that the cobalt(II) was about 26.4% more efficient than iron(III) when used to form a transition metal-phosphate complex as a catalyst. The peak efficiency of the cobalt(II) reached 28.6%, whereas the peak efficiency of the iron(III) only reached 22.5%. While the cobalt(II) only produced a peak gas output of 1.91×10^{-4} moles compared to the iron(III)'s peak of 2.18×10^{-4} moles, the iron was rather inefficient in producing that gas, having an efficiency of 16.7% as opposed to the cobalt(II)'s 21.1% efficiency at its peak gas production.	
Conclusions/Discussion My hypothesis was inaccurate in asserting that an increased number of oxidation states contributed to increased efficiency, as my research provided evidence to the contrary, showing that cobalt(II) was more efficient than iron(III). Moving forward, I hypothesize that because of the increased number of oxidation states, the iron(III) is conducting too much current, causing there to be more electricity in solution than can be used to effectively collide with the water molecules, and that the cobalt(II) is more efficient because of how it restricts the current in solution.	
Summary Statement I investigated the use of transition-metal phosphate complexes as catalysts for the electrolysis of water through analysis of their efficiencies.	
Help Received My chemistry teacher provided the chemicals. My Father provided the garage and the supplies within.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Sophia Lau	Project Number S0616
Project Title The Effect of UV Radiation on the Photoelectrochemical Conversion System of Organic Dye-Sensitized Photovoltaic Cells	
Objectives/Goals The purpose of this experiment is to reveal effect of varying durations of UV radiation on the performance of organic dye-sensitized photovoltaic cells; in this study, the juices of raspberry, blueberry, and blackberry were used. This investigation would aid in understanding UV radiation's effect on a solar cell's efficacy in producing electrical energy, and in discovering which organic composition is most resilient to UV radiation and is best fit for possible long term/large scale use.	
Abstract Methods/Materials An anode and cathode side of each cell were created on conductive 1x1 inch glass slides. A mixture of titanium dioxide and dilute nitric acid created a paste for the anode side before it heated to strengthen the molecular bonds of the chemicals. The cathode sides were placed over a fire until carbon soot, a catalyst, blackened the slide. Berries were blended and filtered with a mass to water ratio of 1:2, then exposed to various durations of UV radiation with a UV Transilluminator. They were then used to stain the titanium on the anode before offsetting the anode and cathode together and placing a few drops of redox electrolyte to generate an electric current. Voltages were measured and recorded in mV.	
Results Although blueberry cell trials initially had significantly higher voltages than the others, with an average of 191.3 mV, blackberry cells with an average of 173.3 millivolts, and raspberry cells with an average of 160 millivolts, blackberry cell trials was most effective in withstanding the negative effects of UV radiation. Blackberry cell trials had a 91% total decrease in mV upon UV exposure while the blueberry cell trials had a 95% and the raspberry cells with 94%. The blueberry trials ended up experiencing the largest drop in voltage, despite performing best at first.	
Conclusions/Discussion In conclusion, my hypothesis was incorrect. Although the blueberry dye sensitized cell trials performed the best prior to UV exposure, following radiation, it had become clear that such a superior beginning does not necessarily imply a consistent end. Therefore, the levels of antioxidants in the juice of each cell definitely have a factor in determining a DSSC's efficacy. However, perhaps there is another, hidden aspect to the dynamics of the cell and its ability to withstand UV radiation, leaving the door open for future investigation to increase the potential for real-life application.	
Summary Statement Higher levels of antioxidants in a dye-sensitized solar cell does not necessarily correlate to its resilience against UV radiation, indicating the need for further investigation on the dynamics of the cell's efficiency.	
Help Received My teacher, Mr. Cervantes, introduced the idea of the dye sensitized solar cell to me, and I used that as an inspiration to build upon a meaningful focus for my project. He also aided in obtaining the materials needed, while I conducted all of the research, procedures, and data collection on my own.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Channing C. Lee	Project Number S0617
Project Title Sports Drinks vs. Fruit Juices: Which Has a Higher Conductance, Meaning More Electrolytes?	
Objectives/Goals The objective of this experiment was to test the conductance of sports drinks and juices to see which has the most electrolytes. My hypothesis stated that if I run an electric current through a variety of fruit juices and sports drinks, then the fruit juices will have a higher conductance because they contain natural ingredients, and therefore more electrolytes.	
Abstract A simple conductance sensor was made using a disposable drinking straw and copper wire wrapped around the ends. A 2 in. tail was left from each piece. The Electrolyte Challenge Kit was set up following the instructions online. I tested Gatorade, PowerAde, Vitamin Water, Body Armor, coconut water, orange juice, grapefruit juice, and pomegranate juice. Each liquid was poured in its respective bowl, at room temperature. The conductance sensor was placed in each drink, completely immersed. All liquids were tested thrice to obtain a total of three measurements each.	
Methods/Materials Each liquid was poured in its respective bowl, at room temperature. The conductance sensor was placed in each drink, completely immersed. All liquids were tested thrice to obtain a total of three measurements each.	
Results Fruit juices had a higher electrolyte content overall.	
Conclusions/Discussion Overall, fruit juices had a higher current in mAs than sports drinks. Surprisingly, coconut water had the highest average current measurement among the fruit juices. Therefore, my experiment supported my hypothesis, and fruit juices had a higher conductance.	
Summary Statement The conductance of sports drinks and fruit juices were tested to determine that fruit juices have a higher electrolyte content overall, with coconut water as the leading drink.	
Help Received My biology teacher taught me how to perform statistical analysis tests and how to choose the most appropriate test for my experiment.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Victoria Lee	Project Number S0618
Project Title Nanowire Sensing of Iron (III) in Millimolar Concentrations	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of the prototype was to test the detection of a metal ion, specifically of iron (III), using a nanowire array in millimolar concentrations, instead of standard expensive and comparatively time-intensive equipment, such as spectroscopy tests. The ultimate aim is to apply this technology to medical or environment testing involving iron (III) and to even apply it to other chemicals, such as glucose sensing by changing the chelator.</p> <p>Methods/Materials The seven-step LPNE process was followed, involving nichromix-sulfuric acid solution, chromium, gold, nickel, a potentiostat with a three electrode-system, positive photoresist and developer, gold and chromium etchants, a contact mask, nickel and gold evaporators, a UV lamp and aligner stage, and PEDOT-deferoxamine solution to pattern and etch the nanowire trenches and to grow the nanowires. Then using the potentiostat, and various concentrations of zinc and iron (III) solutions and a sodium background, the change in electrical resistance was measured.</p> <p>Results The results of the zinc and iron concentrations against the sodium background proved to show increases in resistance across the nanowire array. And as expected, the tests run in iron (III) showed a much larger drop in the resistance measurements than in the zinc solutions, which some changes are expected as charges may be carried across the gap by the ions. The measurable differences shown after 20 minutes to equilibrate indicate that the design has the ability to relay a reading much quicker than most modern commercial processes at a millimolar scale.</p> <p>Conclusions/Discussion The goal of the prototype was to test the detection of a metal ion, specifically of iron (III), using a nanowire array in millimolar concentrations. The nanowire array and the 20 minute equilibrium time, which may be shortened with further testing, showed distinct responses, allowing for much faster, more inexpensive, and greater efficiency as opposed to various spectroscopy tests and testing from nanowire arrays doped with ethylenediaminetetraacetic acid, which requires a 200 to 400 minute wait to attain a response to low millimolar concentrations. The detection and results confirm that the nanowire array design has the capability for effective testing and lasting durability as it underwent over five hours in various solutions, suggesting that the nanowire array design and method is viable for practical applications.</p>	
Summary Statement PEDOT-DFA nanowire arrays in millimolar solutions, ranging from 10^{-5} to 10^{-9} concentration of iron (III), were tested to examine the efficiency and capabilities of this technology.	
Help Received I fabricated all of the nanowire arrays and conducted all the testing, but relied on the training and guidance from Rajen Dutta and Mya Le-Thai. I used the faculty and equipment provided in Professor Penner's Laboratory at the University of Irvine: California and the consulted previous research from	



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

Name(s) Marcus X.S. Luebke	Project Number S0619
Project Title Running on Water: Electron Superhighway for Optimization of Real-Time Production of H₂ and O₂	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals In order to fix the problem of climate change and increasing CO₂ levels, we have to find a different fuel source to power our cars and our homes. Hydrogen is a promising candidate as it burns cleanly and can be produced through electrolysis of water. However, in order to provide safe, efficient, and commercially viable access, we need to produce the hydrogen cheaply and directly where and as it is needed so complex and hazardous hydrogen storage and transportation is not required. My objective is to find the materials to efficiently make hydrogen at a high rate while using the minimal amount of material and funds.</p> <p>Methods/Materials First coat a thin & cheap material with graphene (eg. aluminum foil); this creates a superhighway for electrons to provide the needed current for high production rate reactions, using a minimal amount of materials. Then, electroplate a thin layer of an efficient and inexpensive electrocatalyst onto the reacting surface of the material, which decreases the energy required for the electrolysis reactions. For this I selected the combination of Nickel (Cathode for Hydrogen Evolution Reaction) & Nickel-Iron Oxide (Anode for Oxygen Evolution Reaction).</p> <p>Results A Nickel (Ni) and Nickel-Iron Oxide (NiFeO₂) electrocatalytic coating was successfully applied through electroplating to steel, aluminum, and copper. As a base electroplating material, the steel developed the highest quality coatings in minimal time. For manufacturing graphene, a high-quality coating could not be achieved as the graphite oxide did not fuse evenly. As an alternative, Aluminum sheets with Graphene were purchased & used for the experimental data. As an electrocatalyst, Steel performed much better than Copper, Brass & Aluminum for Hydrogen production via electrolysis of water. When a Ni cathode coating and a NiFeO₂ anode coating was applied, production increased for all materials. At 12V, Ni/NiFeO₂ coatings increased H₂ production ~30% on Steel and ~500% on Aluminum A Graphene backing also increased productivity (~30% on Aluminum foil at 12 V) by moving electrons throughout the material.</p> <p>Conclusions/Discussion I was able to produce an minimalist, inexpensive, efficient, and high-rate material for electrolysis by using a thin foil material coated with graphene and then electroplating Nickel/Nickel-Iron Oxide onto the reacting surfaces, and I am now one step closer to reducing the world's use of fossil fuels.</p>	
Summary Statement I researched aluminum foil coated with graphene and electroplated with Nickel and Nickel-Iron Oxide in order to create a commercially viable high-rate hydrogen production system.	
Help Received The Jaramillo Group (Graduate Chemical Engineering lab) at Stanford University recommended different electrocatalytic materials and gave some techniques for electroplating.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Leslie J. Macias	Project Number S0620
Project Title Electrolyte Challenge: Gatorade vs. Orange Juice	
Abstract Objectives/Goals My objective is to prove that orange juice has more electrolytes than sports drinks and delivers them best by making a conductance sensor to test the electrical conductivity of both orange juice and sports drinks. Methods/Materials The materials that I used to make a conductance sensor were digital multimeter, two alligator clip leads, a kOhm resistor, copper wire, 24-gauge, a 9V battery clip, a 9V battery, and a plastic straw. The materials I used to have my tests go through efficiently were paper towels, tap water in room temperature, orange juice in room temperature, Gatorade in room temperature, glass bowls, a lab notebook, and distilled water (dH2O) in room temperature. Clean the eight small bowls with warm soapy water, rinse thoroughly, and dry them right away with a clean dry cloth or paper towel. This will remove ions in the tap water. If you want to be extra careful, rinse the bowls with distilled water before drying. Use these bowls to rinse the conductance sensor between uses. Now place the conductance sensor in the tap water. Tap the sensor on a paper towel to remove drops of tap water. Place the sensor in the sports drink and measure the current. Record the current in the lab notebook, and remember to record units of milliamps. Tap the sensor dry, and then dip the sensor in tap water, then in the three bowls of distilled water. Rinse the sensor in the tap water and then in all three distilled water bowls. Results I completed three trials and combined the results to get the my result. The final result for the conductivity of Gatorade is 26.3 milliamps or if converted to amps, .063 amps. The final results for the conductivity of orange juice is 46 milliamps or if converted to amps, .046 amps. This pertains to my objective of proving that orange juice has a higher conductivity than Gatorade. Conclusions/Discussion I think my results would have come out more efficiently than what my results came to be. The copper wire kept on slipping when I put the conductance sensor in the drinks, and the multimeter was reading 0.00 at first, but I got my results after a few trial and errors. I also think that there would have been more variety in the results in knowing more drinks and the conductivity of different drinks.	
Summary Statement What my project is about is proving that orange juice has a higher conductivity than Gatorade.	
Help Received I built the conductance by myself after an internet research about conductance sensors.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Zachary D. Moxley	Project Number S0621
Project Title Characterization of Biomedical Graphene	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals My project tested for three properties--diffusion, structural integrity, and coefficient of friction--in graphene to determine whether it is a viable material for biomedical engineering. The objective was to utilize graphene's properties as a material for tissue engineering or prosthetics.</p> <p>Methods/Materials Important materials for this project included multi-layered graphene, a side-by-side diffusion cell, a small pulley, and various solutions. My experiment was broken up into three test, each for a separate property of a biomedical material. I used the diffusion cell to calculate graphene's permeability and rate of diffusion, and I calculated graphene's friction coefficient using a simple pulley system. Material durability was tested in a 10 percent acetic acid solution.</p> <p>Results The diffusion test showed that graphene is an impermeable membrane because it did not diffuse ions in solution. However, the material is more durable than metals and alloys as demonstrated by the durability test in acetic acid. Furthermore, Graphene has a low coefficient of friction, comparable to that of synovial fluid in humans.</p> <p>Conclusions/Discussion Graphene is a viable material for biomedical engineering. Based on the results, it is stronger than most metals and alloys; further research projects a graphene-based material capable of diffusing ions across a barrier. The tribological interactions between sheets of graphene successfully resemble those of synovial fluid in human joints. A porous graphene may be most compatible in the human body when it is engineered within a composite structure of cell tissue.</p>	
Summary Statement This project characterized graphene and demonstrated its viability as a biomedical material.	
Help Received Dr. Nikki Malhotra, advisor. Jeff Lewis and Dr. Greg Cauchon, mentors.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Joshua M. Pritz	Project Number S0622
Project Title Investigation and Applications of the Lithium-Oxygen Battery Cell Cathodes	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This research examines the most integral, yet disputed component of the avant garde lithium air battery: the cathode. The cathode of this battery, which utilizes oxygen gas in an oxidation reduction reaction responsible for producing electricity, must conduct electricity, facilitate the flow of oxygen gas, and catalyze the reduction of oxygen gas. The porous carbon black based cathode has elsewhere demonstrated a keen ability to satisfy all three criteria both theoretically and practically. The chemical composition of such cathodes were varied with respect to carbon black, the conductive material, and dibutyl phthalate, the sacrificial material, to optimize performance.</p> <p>Methods/Materials The chemical composition of such cathodes were varied with respect to carbon black, the conductive material, and dibutyl phthalate, the sacrificial material, to optimize performance. Performance was measured in terms of electrical conductivity and air diffusion rates. Conductivity was measured in a simple electrical circuit, while diffusivity was calculated using measurements of pH via diffusion of H⁺ ions through the membrane over time.</p> <p>Results Of the five cathodes created using this method, Cathode 1 demonstrated an ohmic resistance of 0.28 ohms and a sixty minute hydrogen ion diffusion of 3.22e-6 molar. Cathode 2 recorded a resistance of 39.0 ohms and a sixty minute diffusivity of 1.47e-4 molar. Cathode 3 recorded a resistance of 460 ohms and a diffusivity of 2.68e-4 molar. Cathode 4 recorded a resistance of 1120 and a diffusivity of 4.39e-4 molar. Lastly, cathode 5 recorded a resistance of 253,000 ohms and a diffusivity of 4.91e-4 molar.</p> <p>Conclusions/Discussion The cathode with the highest percentage of carbon black proved to be the most conductive and the cathode with the highest percentage of dibutyl phthalate demonstrated the best ability to conduct air flow. Ultimately, an ideal cathode for the lithium air battery is a major step in making such batteries commercially feasible.</p>	
Summary Statement Five cathodes for use in the lithium-oxygen battery were created, in which the concentration of dibutyl phthalate and carbon black were varied, and tested with regard to conductivity and diffusivity to optimize their composition.	
Help Received I designed and performed my experiments by myself. I used equipment provided by Thousand Oaks High School and Dr. Nikki Malhotra. Dr. Greg Cauchon assisted me with scientific writing and method revision.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Bhavin T. Shah	Project Number S0623
Project Title Diffusivity and Solvation of Alkali and Halogen Ions in Solid and Aqueous Battery Electrolytes	
Abstract Objectives/Goals Although lithium-ion batteries are effective for current small-scale applications, wider adoption of Li-ion batteries is hindered by their limited energy density, gradual rate of decomposition, and dangerous risk of flammability. The objective of this project is to employ molecular dynamics simulations in order to determine (a) whether there are alkali, alkaline earth, and halogen metals that outperform lithium in various battery electrolytes and (b) whether solid polymer electrolytes offer significant benefits over liquid electrolytes. Methods/Materials The molecular dynamics simulator LAMMPS along with Visual Molecular Dynamics (VMD), Python, TCL, and Matlab were used to generate and process all simulations. Simulations were performed on several test environments consisting of various alkali, alkaline earth, and halogen ions submerged in either a solid PEO (polyethylene oxide) electrolyte or liquid DME (dimethyl ether) electrolyte. Results The simulations revealed that, in terms of their relative rates of ionic diffusivity, solid electrolytes were generally outclassed by their liquid counterparts. Lithium in particular performed poorly in both the solid and liquid electrolytes, while other ions (especially the halogens) experienced high rates of diffusivity and encountered less dense solvation shells. Conclusions/Discussion Given the fact that solid polymer electrolytes will eliminate the intrinsic drawbacks of liquid electrolytes, these results point to the possibility of solid polymer electrolyte (SPE) batteries featuring ions other than lithium. Not only that, but the data generated suggests that synthetic polymers designed to maximize ionic diffusivity by minimizing the density of solvation shells within electrolytes could be the future of next-generation rechargeable batteries.	
Summary Statement Molecular dynamics simulations were used to analyze the performance of various alkali, alkaline earth, and halogen ions in solid and aqueous electrolytes with the goal of finding better materials for future batteries.	
Help Received Mentored and supervised by the Miller research group at Caltech.	



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

Name(s) Kimberly A. Stahovich	Project Number S0624
Project Title What Are the Effects of External Carbohydrate Contaminants on Blood Glucose Measurements Made with a Glucometer?	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this study is to determine if, and to what extent, carbohydrate contaminants on the skin raise blood glucose measurements made with a glucometer.</p> <p>Methods/Materials Carbohydrates (e.g., syrup and jelly), glucometer, syringes for measurement, and simulated blood (glucometer control solution). Experiment 1 simulates a typical life event: a finger is dipped in a carbohydrate and is quickly wiped off, a drop of simulated blood is applied, and the glucose level is measured with a glucometer. Experiment 2 is similar to Experiment 1, but the finger is wiped thoroughly. Experiment 3 examines tiny, quantified amounts of contaminants. Dilute carbohydrate solutions are created by dissolving small amounts of carbohydrates in water. Using a syringe, 0.01 mL samples are placed on a glass plate and allowed to dry. Using another syringe, 0.005 ml of simulated blood is applied to each sample and the glucose level is measured with a glucometer.</p> <p>Results In Experiment 1, the contaminants substantially raised the glucose measurement compared to the 125 mg/dL of uncontaminated simulated blood. For syrup the average was 298.3 mg/dL, for honey the average was 232.3 mg/dL, and for jelly the average was 279.3 mg/dL. Experiment 2 showed that even careful wiping was insufficient to prevent contamination. Here the average glucose level for syrup was 189.6 mg/dL. In Experiment 3, tiny, precisely-measured amounts of dried syrup solution produced an average measurement of 199.8 mg/dL, while dried glucose tablet solution produced an average of 455.4 mg/dL. These values quantify the amount of contaminant needed to cause measurement errors.</p> <p>Conclusions/Discussion Experiment 1 shows that small amounts of contaminant can even double the blood glucose measurement. Experiment 2 shows that even careful wiping is insufficient to eliminate the error in glucose measurements. Experiment 3 shows that a spherical speck of glucose tablet with a diameter of 0.77 mm increases the glucose by 260%, and a 0.8 mm diameter speck of syrup can increase it by 60%. The main lesson that can be gained from these experiments is that washing hands to remove contaminants is extremely important. Small amounts of contaminants can cause significant errors. The consequences of having a false glucose measurement can be disastrous for diabetics and physicians. An incorrect glucose measurement can result in the wrong treatment or diagnosis.</p>	
Summary Statement I showed that even tiny amounts of carbohydrates, such as honey and jelly, can cause substantial errors in blood glucose measurements made with a glucometer.	
Help Received I developed the idea for the project and designed and conducted the experiments. I got help in measurement methods from Professor Stahovich in the Department of Mechanical Engineering at the University of California, Riverside. He also provided guidance on technical writing.	



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

Name(s) Clarissa M. Tacto	Project Number S0625
Project Title The Intermolecular Attraction of Aspirin and Acetaminophen in Plastics	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The amount of acetaminophen and aspirin that is retained by plastics placed in saturated solutions was measured to determine if plastics treated with either of these molecules could serve as an alternative to over the counter tablets. I also hoped to find a correlation between the concentration of the solution to the amount of the molecule retained.</p> <p>Methods/Materials Aspirin's ability to remain on a plastic surface is tested independently of the amount of acetaminophen that is retained. Laboratory grade aspirin and acetaminophen are placed in distilled water with varying concentrations, creating an aqueous solution. These solutions are treated with ferric chloride which creates a violet color as a result of the iron(III)-phenol complex formed. The intensity of the violet produced is dependent on the concentration of the acetaminophen or aspirin so each solution was analyzed under a spectrophotometer. The results were placed on a Beer's Law Plot and used as the control. 80 square centimeters of polystyrene or polyethylene were placed in saturated solutions and placed on a magnetic stirrer to ensure that the solution was homogeneous. The plastic was then extracted, placed in distilled water, and treated with ferric chloride. The intensity of the purple was compared using the Beer's Law Plot to determine the amount of aspirin or acetaminophen that the plastic was able to retain.</p> <p>Results The Beer's Law Plot was used to calculate the amount acetaminophen or aspirin that was retained by a plastic. While different plastics were used in this experiment, the correlation between the concentration of the solution that the plastics were placed in and the amount that was retained remained the same. Aspirin was retained at higher quantities for both plastics. The difference in plastics did not produce a significant difference in the amount of acetaminophen retained.</p> <p>Conclusions/Discussion The amount of aspirin or acetaminophen retained by plastic is directly proportional to the concentration of saturated solution that it was originally exposed to. Because more aspirin is retained by both plastics, I conclude that it is more attracted to the plastic than the acetaminophen. While a significant amount of aspirin and acetaminophen was retained by the plastic, it is less than the amount in over the counter tablets, making it an inadequate alternative.</p>	
Summary Statement I tested the intermolecular attraction between acetaminophen and aspirin in plastics and concluded that aspirin is more attracted to plastic.	
Help Received My former chemistry teacher, Dr. Gian Grant, supervised me in the lab.	



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Michael D. Wu	Project Number S0626
Project Title An Analysis of SOA Produced from a Novel Liquid-Phase Reactor and Their Impacts on Climate	
Objectives/Goals The goal is to determine the impacts that aerosols after ozonolysis have on climate. One of the unresolved questions is to what extent can originally white aerosols become colored after ozonolysis and thus contribute to warming. The objectives were to devise a valid novel, liquid-phase reactor for producing Secondary Organic Aerosols (SOA) from volatile and involatile compounds and to identify compounds that become more absorbing after ozonolysis. The liquid-phase reactor would be much cheaper, more accessible, and would expand the field of compounds available for ozonolysis in the laboratory compared to conventional methods.	
Abstract Methods/Materials Reacted 9 precursor compounds with ozone in a novel liquid-phase setup Achieved this by using a flask filled with solvent for the reactor. Dissolved one of the 9 compounds into the solvent and bubbled ozone through it until the reaction was complete System validation: Limonene and guaiacol SOA from the liquid-phase reactor were compared to a conventional flow tube through UV spectroscopy and mass spec. Once validated, seven compounds were reacted with ozone and its SOA were analyzed using UV/Vis and mass spec.	
Results For the setup validation process, Limonene SOA from the two systems differed optically by 5.7% and Guaiacol SOA 13.3%. The mass spec results were comparable. For all seven compounds, each increased in visible light absorption after ozonolysis with catechol and indole having the largest change in absorption and composition. MAC is used to quantify absorption. Catechol SOA increased 10,000 MAC and Indole SOA increased 45,000 (1,000 MAC is significant). Interestingly, Indole's MAC values increased with higher concentrations despite the fact that MAC already factors concentration into the equation.	
Conclusions/Discussion The novel liquid-phase reactor is a valid method for generating SOA, making it more accessible, cheaper, and most importantly broadens the scope of compounds. Every compound with a C=C increased in MAC after ozonolysis. This will significantly aid our understanding of aerosols and global warming. Indole and Catechol SOA indicate that after ozonolysis, compounds can become significantly more	
Summary Statement This project analyzes aerosols, their reactions with atmospheric oxidants, and how this will impact the climate using a novel liquid-phase mechanism for SOA generation.	
Help Received Professor Sergey Nizkorodov from AirUCI was my PI and mentor, allowed me to work in his lab; Dian Romonosky, graduate student from AirUCI helped train me, supervise, and edit	



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

Name(s) Erika Yang	Project Number S0627
Project Title Developing a NanoFET Biosensor Based on MoS2 2D Material for Detecting Low Concentration Illness-Related Molecules	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this study is to use advanced MoS2 2D material to chemically bind onto a silicon wafer in order to attempt to fabricate a biosensor that has the sensitivity strong enough to detect low concentration of biological molecules, such as early stage cancer.</p> <p>Methods/Materials</p> <ul style="list-style-type: none">- 6 inch diameter silicon wafers with SiO2 layer;- MoS2, Au tape- Photoresist SPR, developer MF-139, DI water, photomask, lithographic exposure tool;- Tumor necrosis factor alpha (TNF-alpha);- Optical microscopy, hot plate, exposure tool <p>Results</p> <ul style="list-style-type: none">- MoS2 is a new and unique type of material to use when creating a sensitive transistor biosensor to detect low concentration of nanoscale molecules such as early stage forms of cancer.- Unique advantages of emerging 2-D materials for biosensing applications: Atomically thin structure => very sensitive to external stimulation => very high sensitivity.- The multiple sensors can be utilized to enable quantification of low-abundance biomarker molecules as well as the affinities and kinetics of antibody-mediated binding events. The sensors exhibited a TNF-alpha; detection limit as low as 60fM.- The real-time association/dissociation processes of the antibody-(TNF-alpha) pair were also quantified using multiple sensors. This detection capability can reduce the assay time, having the ability to detect the antigens several minutes to few hours. <p>Conclusions/Discussion</p> <p>I was able to experimentally demonstrate through multiple trials that the MoS2-based transistor biosensors are capable of detecting illness-related biomarker molecules with detection limit as low as 60 fM. MoS2 proved to be an attractive choice because of its flexibility and high sensitivity. This is very useful and sensitive to the early detection of illness-related biomarker molecules, such as cancerous cells, and can provide a much more efficient and effective process of detecting early stages of cancer development.</p>	
Summary Statement I successfully demonstrated through multiple trials that the MoS2-based transistor biosensors are capable of detecting low concentrations of illness-related biomarker molecules, such as early stages of cancerous cells.	
Help Received University of Michigan	