



**CALIFORNIA STATE SCIENCE FAIR  
2011 PROJECT SUMMARY**

<b>Name(s)</b> <b>Zachary P. Sercel</b>	<b>Project Number</b> <b>J0617</b>
<b>Project Title</b> <b>Your Morning Cup of Coffee! Solubility of Caffeine in Various Organic Solvents</b>	
<b>Objectives/Goals</b> The purpose of this experiment is to compare the solubility of caffeine in liquid CO <sub>2</sub> , 1,1Difluoroethane and Methyl Alcohol. I believe that methanol will be the best solvent and liquid CO <sub>2</sub> will be the worst because caffeine is a polar molecule and methanol is a polar solvent.	
<b>Abstract</b> I made packages of powdered caffeine tablets in coffee filters and soaked them in 5 milliliters of each solvent. My apparatus for liquid carbon dioxide is a thick plastic test tube screwed to a soda bottle cap with a brass needle sticking into it. The needle is attached to a 4-way brass pipe attached to a pressure gauge, a manual pressure release valve and an automatic pressure release valve good for up to 100 psi. Dry ice begins melting in the setup at approximately 60 psi. I weighed sample boats in a Mettler Balance, soaked the caffeine packets in the solvents, added the liquid to the sample boats, let it evaporate, and weighed the boats again. Then I recorded the difference. I tested the samples for fillers with sodium hydroxide and for caffeine with Dragendorff's Reagent.	
<b>Methods/Materials</b> I made packages of powdered caffeine tablets in coffee filters and soaked them in 5 milliliters of each solvent. My apparatus for liquid carbon dioxide is a thick plastic test tube screwed to a soda bottle cap with a brass needle sticking into it. The needle is attached to a 4-way brass pipe attached to a pressure gauge, a manual pressure release valve and an automatic pressure release valve good for up to 100 psi. Dry ice begins melting in the setup at approximately 60 psi. I weighed sample boats in a Mettler Balance, soaked the caffeine packets in the solvents, added the liquid to the sample boats, let it evaporate, and weighed the boats again. Then I recorded the difference. I tested the samples for fillers with sodium hydroxide and for caffeine with Dragendorff's Reagent.	
<b>Results</b> All the samples left a residue. The residue was caffeine with no fillers. I found that the longer I left the packets in, the bigger the sample was up to a certain point when the solvent became saturated. My hypothesis was correct and methanol was the best solvent. Liquid CO <sub>2</sub> was the worst. By accident, I also discovered that some brands of tonic water do not contain quinine even though the labels say they do.	
<b>Conclusions/Discussion</b> Although CO <sub>2</sub> is the worst solvent, it is very useful in factories because it can be kept under very high pressure (2000 psi) and heated to 100 degrees F and it will become supercritical, which makes it a better solvent. It is also completely non-toxic and is a gas at room temperature so cannot leave any bad tastes or residues. Difluoroethane is nasty because even though it is a gas at room temperature it is addictive and explosive. When it explodes it creates very toxic gases. Although methanol is a very good solvent for caffeine, it is flammable and must be evaporated or boiled off because it is a liquid at room temperature. Also, it is very toxic. I think that the best solvent for caffeine would be dimethyl ether because it does not form explosive peroxides and is very polar.	
<b>Summary Statement</b> This experiment is to compare the solubility of caffeine in liquid CO <sub>2</sub> to its solubility in other organic solvents.	
<b>Help Received</b> My mom helped me with my data analysis, specifically using Microsoft Excel. She taught me about error analysis. My Dad made me get an automatic pressure relief valve and paid for it. Also Raffi at Pasadena Community College let me use the high precision scale in their Chemistry Department.	