



**CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY**

Name(s) John T. Grasel	Project Number J0809
Project Title Characteristics of Efficient Solar Water Heaters	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Enough solar energy reaches the earth in a half hour to provide the world's energy needs for a year. My objective was to see how easy it is to capture solar energy and to determine which variables affect a solar water heater's ability to heat water. After completing my research report, I hypothesized that a solar water heater with fast pump speed and thin, black tubes would create the largest temperature increase.</p> <p>Methods/Materials Using Statistical Experimental Design, I designed eight different solar water heaters to examine three different variables (pump speed, tube diameter, and tube color) at two different levels each. I constructed these heaters from two boards, ½ inch and ¼ inch black irrigation tubing, an insulated storage tank, white spray paint, and a fountain pump. I operated each heater in the sun for twenty minutes and recorded the temperature increase in the storage tank each minute. I also re-ran my best heater for eighty minutes.</p> <p>Results The best heater used fast pump speed and a black, ½ inch tube, and it raised the water temperature 21.2 degrees. The worst heater used a slow pump speed and black, ½ inch tubes and raised the starting temperature 11.9 degrees. The average temperature increase for all eight heaters was 14.8 degrees, with an approximate experimental error of 1.5 degrees. Using the statistical analysis, I calculated that the average effect of fast pump speed was 2.6 degrees, the effect of increasing tube diameter was 4.0 degrees, and having black tubes increased the temperature 2.1 degrees. There were no significant multifactor interactions. For the best heater, the temperature continued rising after 20 minutes and slowly leveled off after 30 minutes, at a temperature of 103 degrees F.</p> <p>Conclusions/Discussion From these results, I learned how to create an efficient solar water heater. I recommend using a high pump speed and ½ inch, black tubes. Of course, the longer you leave the heater out, the hotter the water will get. The fast pump speed is beneficial, because it gets heat to the storage tank faster, thick tube diameter provides more surface area to acquire more heat, and the black tubes absorb more heat.</p>	
Summary Statement Using Statistical Experimental Design, I ran eight experiments with solar water heaters, discovered the best operating conditions for this type of heater, and found an incredibly easy way to capture the sun's energy.	
Help Received My father helped me construct the heaters, and my mother proofread my reports. For my project last year, my parents taught me the basics of Statistical Experimental Design, and I was able to incorporate this knowledge into this year's experiment.	