



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Brian A. Clark	Project Number J0906
Project Title Resistance Is Futile: A Study of Superconductivity and Critical Current Density	
Abstract Objectives/Goals Scientists have discovered that certain materials can carry electricity with no resistance at cryogenic temperatures. However, as more current is put through a superconductor, it loses its superconducting properties. I hope to discover that a superconductor has a higher density than a copper wire of its same cross section. Methods/Materials Superconducting 4 point probe: 1. YBCO, 2. Attached type T thermocouple; Liquid Nitrogen; Small thermos capable of holding superconductor and liquid nitrogen; Thermos for carrying and pouring liquid nitrogen; Gloves, safety glasses, and a smock; 2 multi-meters; 70A room; Power source capable of generating .5 amp of current; 6 alligator clips (3 red and 3 black); 2 banana plugs. To determine if the hypothesis is correct, the critical current of YBa ₂ Cu ₃ O ₇ superconductor is obtained experimentally. Then, to obtain the critical current density, the critical current is divided by the cross section of the superconductor. A comparison to a copper wire is necessary to determine if a superconductor has a higher current density than a copper wire of its same cross section. To find the density of the copper wire, divide the maximum rated current by the cross section of the wire. Then, the current density of the superconductor is compared to the current density of the copper wire to test the hypothesis. Results Based on my experimental results, I calculated that the copper wire had a density of ~2.8 A/mm ² and the superconductor had a critical density of .0167 A/mm ² . The experiment's results showed that the superconductor couldn't carry more current than a copper wire, disproving the hypothesis. Conclusions/Discussion My results were contrary to my research because the superconductor was a very crude sample with many imperfections. Scientists have high quality superconductors that have much higher critical current densities than what I found. I should have also tried different types of superconductors other than YBCO, and also try to use type 1 superconductors in my experiments because Dr. Hamilton said that they have high critical current densities. I couldn't get either different types of superconductors or type 1 superconductors in my experiment because other types of superconductors are expensive and type 1 superconductors need liquid helium to superconduct, which is expensive and hard to find.	
Summary Statement In my experiment, I attempted to determine if a YBCO superconductor had a higher density than a copper wire of the same cross section.	
Help Received Dad helped with experiment and handling liquid nitrogen; Dr. Clark Hamilton explained anomalies in results.	