



**CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY**

Name(s) Bryce W. Cronkite-Ratcliff	Project Number J0206
Project Title The Burning Mirror of Archimedes: A Weapon of Mass Destruction?	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Several accounts of the Roman siege of Syracuse in 213 BC, including those of Zonaras and Tzetzes, describe a weapon of immense power, one capable of setting entire fleets of quinqueremes aflame almost instantaneously. This "Burning Mirror of Archimedes" is presumably a system of mirrors used to concentrate the sun's energy into a single point. This experiment is an attempt to consider the scientific and practical aspects of inventing and using a "Burning Mirror" to determine, first, whether Archimedes could have constructed such a device and, second, whether he could conceivably have used such a contraption as an effective defensive weapon during the siege of Syracuse.</p> <p>Methods/Materials The basic project outline is as follows: 1) conduct a series of experiments relating to geometric optics in order to develop a scale model of a possible "Burning Mirror" with proportionate properties to one Archimedes might have used, 2) construct a mirror system based on the developed plan capable of igniting a model ship on fire, and 3) analyze the data and consider the possibility of Archimedes actually constructing and using such a system of mirrors in defending Syracuse.</p> <p>Results Results include 1) the geometrical optics properties of each mirror and the entire system 2) temperature profiles comparing temperature attained in the focal spot vs. number of mirrors 3) an estimate for the number of mirrors Archimedes would need to build an effective weapon 4) qualitative demonstrations of my system in action (setting objects, such as model Roman ships, on fire).</p> <p>Conclusions/Discussion My results address two basic questions: could Archimedes have constructed and used a mirror array to burn enemy ships and did he actually do so. In experimenting with an accurately scaled replica of a Burning Mirror design, I have observed that it is possible to construct a mirror array capable of burning enemy ships. However, it is improbable that the Burning Mirror of Archimedes was actually constructed and used due to the practical complications involved. That is, in order for the Burning Mirror to be effective, Archimedes would require sunny weather, the means by which to construct, adjust, and man an array of many hundreds of mirrors, and would have to consider a host of other logistical issues. While Archimedes' Burning Mirror could have been used, it is unlikely that such a device was used to defend Syracuse.</p>	
Summary Statement I constructed and tested a large (almost 700-mirror) solar "Burning Mirror" array to explore whether the classical story of Archimedes using such a weapon to defend Syracuse is plausible.	
Help Received My dad helped construct the modules (mainly using saws to cut the plywood and taking me to the hardware store to purchase materials) and conduct the experiments (sometimes it's a two person job). He also helped me understand some of the science involved in the project. My mom proofread my write-up.	