



**CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY**

Name(s) Noah G. Shartle	Project Number S1924
Project Title Chasing Michelson: Measurements of the Speed of Light in Air	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Calaveras County is known for its gold rush, the giant sequoia, and a celebrated jumping frog. Unknown to many, however, is that Calaveras County was the childhood home of Albert Michelson, the first American to win the Nobel Prize in Physics. In an effort to call local attention to Michelson's accomplishments, I attempted to measure the speed of light in air with greater accuracy than Michelson.</p> <p>Methods/Materials The beam from a .8 mW diode laser was modulated using a 1 MHz sinusoidal wave. The modulated beam was split into a first and second portion. The first portion traveled a short distance, and was then focused onto a first photodiode. The second portion traveled a longer distance, and was then focused onto a second photodiode. Output from the photodiodes was amplified, then connected as input to a digital oscilloscope. Signal from the first photodiode was used as a trigger, and the delay time between the two sinusoidal waves was measured. The difference in distance traveled was measured, then divided by the delay time to determine the speed of light in air. Multiple measurements were made across three distances.</p> <p>Results The delay time across 6.243 meters was 19.4 nanoseconds, the delay time across 10.279 meters was 32.9 nanoseconds, and the delay time across 16.721 meters was 53 .4 nanoseconds, on average. The coefficient of variation when measuring delay time across 6.243 meters was 7.36%, across 10.279 meters was 5.52%, and across 16.721 meters was 3.46%. Using these measurements, the speed of light was found to be 322,000,000 meters/sec, 312,000,000 meters/second, and 313,000,000 meters/second.</p> <p>Conclusions/Discussion The speed of light in air is 299,705,543 meters/second. Michelson's measurement of 1878 was 300,091,000 meters/second, off by + 0.13%. In my best measurement, I was off by about + 4%. Despite using modern equipment, I was unsuccessful in making measurements that are more accurate than Michelson's. In measuring the delay time between the sinusoidal waves, I found that the imprecision of the measurement decreased as the delay became longer. For this reason, taking measurements across greater distances could lead to improved precision, and accuracy. To make measurements at greater distances, a more powerful laser could be used, and the beam could be collimated, decreasing the divergence of the beam as it travels greater distances.</p>	
Summary Statement The goal of this study was to measure the speed of light in air with greater accuracy than Michelson.	
Help Received Experimentation was performed at home, with my parent's supervision. I borrowed an oscilloscope from a friend.	