



CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

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| Name(s) Tyler D. Fair | Project Number J1507 |
| Project Title How Lenses Work: Testing the Lensmaker's Formula | |
| <p style="text-align: center;">Abstract</p> <p>Objectives/Goals Problem: When does a lens bring an image into focus; that is, what is the relationship between lens-to-object distance (o) and the lens-to-image distance (i)? Hypothesis: Every lens has a characteristic focal length (f). The relationship between o, i, and f is</p> $1/o + 1/i = 1/f$ <p>This formula is known as #The Lensmakers Formula# or #The Thin Lens Formula.# The formula is used in making eyeglasses, microscopes and telescopes.</p> <p>Methods/Materials Setup: Actual focal lengths for five lenses of different nominal focal lengths and diameters were measured using the sun an "infinitely far away" light source. The sunlight was focused to as small a dot as possible on cardboard, and the distance from lens to cardboard measured with a tape measure. It was hard to get an accurate measure, and the measured focal lengths could be as much a 25% off from what was nominally claimed. Procedure: Initially an attempt was made to test the Lensmakers Formula by trying to find the position where the lens best focused an "X" written on cardboard. However, data was not repeatable. Different observers got substantially different results! The second approach was to simply replicate the setup as shown in the picture above with a candle. Results were much easier to replicate. See photo for illustration of measurement setup. The distance from candle to lens was varied. Then, a cardboard screen was moved until the inverted image of a candle was sharply in focus. The lens-to-object distance (o) and the lens-to-image distance (i) were measured to collect about half a dozen data points for each of the five lenses.</p> <p>Results Results: Results from the measurements are shown in the tables below. All data is captured in inches. The values for (1/o + 1/i) are generally consistent with each other within a few percent. The measurements that differed the most from the average values tended to be the ones when it was most difficult to tell if the object was in the best focus. The calculated values can differ significantly from both nominal and measured inverse focal lengths.</p> <p>Conclusions/Discussion Within the bounds of the precision of the experiment setup, the Lensmaker Formula was confirmed.</p> | |
| Summary Statement Showing that experiment confirms the Lensmakers Formula, $1/o + 1/i = 1/f$ | |
| Help Received Dad helped with the setup and data analysis. Mom helped with the report and display board. | |