Experiment 7 Geometrical Optics

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We used a phet to measure the theoretical focal lengths of various lenses and the distances of the image of an object at different distances from the lens. We used the collected data to calculate the focal length of the lens using both the thin lens equation and lens maker equation. The percent errors in part one didn’t exceed 0.99%; in part two, 1.73%; in part three, 0.37%.

Results

The focal lengths determined by each method agrees with each other. In part one the thin lens equation led to a percent error of 0.99% while the lens maker equation led to a percent error of 0.70%. In part two the thin lens equation led to a percent error of 1.65 % while the lens maker equation led to a percent error of 1.73%. In part one the thin lens equation led to a percent error of 0.37% while the lens maker equation led to a percent error of 0.32%.

Questions for Discussion

1. The focal length determined in Part 1 is different from the focal length in Part 2, even though the index of refraction was not changed. State how the focal length changed from Part 1 compared to Part 2 and explain why the focal length changed.

The focal length decreased from part 1 to part 2 because the curvature radius decreased.

1. The radius of curvatures in Part 2 and Part 3 are the same, but the indices of refraction are different. State how the focal lengths for each part changed from Part 2 to Part 3 and explain why the focal length changed. State in your explanation how this is different from the change in focal lengths discussed in question 1?

The focal length increased from part 2 to part 3 because decreasing the index of refraction would bend the light less. In part 1 the material remained the same therefore the indices of refraction were also the same but the curvature of the radius changed.

1. Derive the Thin Lens Equation using Figure 1 and similar triangles. Show all step-by-step work. There will be several steps. Note: the distances from the center of the lens to each of the focal points are **equal** to each other. The object distance is **not equal** to the image distance. Similar triangles share an equal sized angle.

Let the height of the object be ho, and the height of the image be hi.

A picture containing text

Description automatically generated

1. The magnification of the image by a lens is equal to the negative of the ratio of the size of the image to the size of the object. This ratio is also represented as:

If the magnification results in a negative value, then the image is inverted. If it results in a positive value, then the image is upright. For the three object distances in Part 1 determine the corresponding magnifications. Write these three magnification values as part of your answer to this question. Comment on how the magnification changes as the object distance changes.

|  |  |
| --- | --- |
| object 1 | -0.7222 |
| object 2 | -1.5079 |
| object 3 | 3.0400 |

Magnification increased as distance decreased.