1. Title Page

Michael Smith

Jonte Johnson

Mauro Alvarez

Experiment 8 Thin Lenses

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1. Objective:

The objective of this experiment to be able to observe the way that light behaves when projected through multiple different lenses. As well as how lenses could be combined to manipulate the produced images.

1. Procedure and Results:

In this experiment we were provided the Blue Optical Box. Using its contents, we constructed a thin lens experiment. We set up the light source with a cross arrow pattern to be projected through a lens at a set distance away from the source. We then manipulated the object distance to observe different conditions, such as outside, on or inside the focal point of the lens. We did this for two different lenses: converging and diverging lens. We created a table to measure the observations for the ray tracings performed later:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Object Position | f  (mm) | Upright or Inverted | s (mm) | s’exp (mm) | s’th (mm) | % D |
| A | s > 2f | 75 | Inverted | 200 | 115 | 120 | 4.2% |
| B | s = 2f | 75 | Inverted | 150 | 142 | 150 | 5.3% |
| C | f < s < 2f | 75 | Inverted | 100 | 262 | 300 | 12.7% |
| D | s < f | 75 | Upright | 50 | X | -150 | X |
| E | s < f | -150 | Upright | 100 | X | -60 | X |
| F | s > f | -150 | Upright | 200 | X | -86 | X |

In this data table all the values are observed during the experiment except for the s’th; which is calculated by taking the (1/f) = (1/s) + (1/s’). To calculate the value for trial A: s’ = 1 / ((1/f) – (1/s)) = 1 / ((1/75mm) – (1/200mm)) = 120mm. After the observations, we created scaled ray tracings of each case. Using the provided h for the objects at 19mm we were able to trace out the h’ for each case.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Object Position | h  (mm) | h’  (mm) | Mex | Mth | % D |
| A | s > 2f | 19 | -13 | -0.68 | -0.60 | 14% |
| B | s = 2f | 19 | -18 | -0.95 | -1.0 | 5.3% |
| C | f < s < 2f | 19 | -51 | -2.7 | -3.0 | 10.5% |
| D | s < f | 19 | 67 | 3.5 | 3.0 | 17.5% |
| E | s < f | 19 | 11 | 0.58 | 0.6 | 3.5% |
| F | s > f | 19 | 8 | 0.42 | 0.43 | 2.1% |

In this data table we calculated the Mex from provided h values and the traced h’ values: which is calculated with Mex = h’/h. To calculate the value for trial A: Mex = -13mm/19mm = -0.68. As well we calculated the Mth value from the s and s’ values from the previous table: which is calculated with Mth = -s’ / s. To calculate the value for trial A: Mth = -(120mm/200mm) = -0.60.

1. Discussion:

During this experiment we were able to observe that there are two major cases when working with these lenses. Case one would be the projected image is real. This tends to be true when working with the converging lens. When the image is real and projected through the lens, the image comes out inverted. As the object distance is changed around the focal point of the lens, the image distance follows a distinct pattern. If the object distance is increased, the image distance will be decreased to remain in focus. In the ray tracing, we were able to keep this pattern true. The ray tracing would show the image past the lens, meaning that the image was real and projected through the lens. And it would be inverted and magnified to some scale. Case two for this experiment would be if the image was virtual. This was true for the case if the object is before the focal point on a converging lens, and all cases for a diverging lens. During this case, there was no projected image. In fact, you would have to look through the lens towards the source to observe the virtual object. During our observations the image was always upright when it was virtual. During further analysis with the ray tracings, we were able to keep the orientation and magnification correct to the observations. And the images were always projected “backwards” to a point before the lens. Our observations in both cases were able to remain in line with the theory behind the lenses. We were able to take these observations and apply them to real applications, such as a magnify glass being a converging lens with a far focal point. This would mean you put the object between the lens and its focal point and this would magnify the object of the observer. During this experiment I did receive some error when drawing the tracings. This would be due to human error and slight misalignment with my ruler when drawing straight rays.