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**Lab #4: Mirrors and Thin Lenses**

**Abstract:**

For this experiment, we wanted to find the focal length of a given convex lens. There are many ways we accomplished this, one was setting the lens far away from a light source and set a screen in front of the lens so that the image is in focus, then measure the distance from the screen and the lens, this distance should around the focal length of the lens. Another way is to set the lens at different distances from the light sources and find the distance from the lens that the resultant image is in focus. From these distances we can use the equation . where di is the distance from the lens to the resultant image, do is the distance from the light source to the lens, and f is focal length of the lens. After finding the focal length of the lens, we also wanted to find the focal length of a concave mirror by moving the mirror different distances from the light source and recording the distance away from the mirror a focused image appears on a screen. Using the same question, we can find the focal length

**Data:**

***Part A: Refraction through a converging lens***

*A1: Direct measurement of the focal distance*

Distance of lens from screen (di): 0.108 m

Real focal distance: 0.1 m

*A2: Images formed at different object distances*

do: Object distance

di: Image distance

h: Size of object

h’: Size and orientation of image (erect/inverted, +/-)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| do (m) | di (m) | h (m) | h' (m) | Real/Virtual |
| 0.4 | 0.13 | 0.049 | -0.014 | Real |
| 0.3 | 0.15 | 0.049 | -0.026 | Real |
| 0.2 | 0.19 | 0.049 | -0.045 | Real |
| 0.15 | 0.29 | 0.049 | -0.096 | Real |
| 0.105 | 1.375 | 0.0485 | -0.641 | Real |
| 0.05 | N/A | 0.049 | N/A | Virtual |

***Part B: Reflection from a concave mirror:***

Real focus length: 0.16 m

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| d (m) (object) | d (m) (image) | h (m) | h' (m) | Real/Virtual |
| 0.32 | 0.33 | 0.049 | -0.05 | Real |
| 0.47 | 0.25 | 0.049 | -0.027 | Real |
| 0.94 | 0.195 | 0.049 | -0.01 | Real |

**Data Analysis:**

***Focal Length (Lens):***

|  |  |  |
| --- | --- | --- |
| do (m) | di (m) | f (m) |
| 0.4 | 0.13 | 0.0981 |
| 0.3 | 0.15 | 0.1000 |
| 0.2 | 0.19 | 0.0974 |
| 0.15 | 0.29 | 0.0989 |
| 0.105 | 1.375 | 0.0976 |

***Focal Length (Mirror):***

|  |  |  |
| --- | --- | --- |
| d (m) (object) | d (m) (image) | f (m) (calc) |
| 0.32 | 0.33 | 0.162 |
| 0.47 | 0.25 | 0.163 |
| 0.94 | 0.195 | 0.161 |

***Magnification (Lens):***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| do (m) | di (m) | h (m) | h' (m) | m (from distance) | m (from size) | m %diff |
| 0.400 | 0.130 | 0.049 | -0.014 | -0.325 | -0.286 | 12.09% |
| 0.300 | 0.150 | 0.049 | -0.026 | -0.500 | -0.531 | 6.12% |
| 0.200 | 0.190 | 0.049 | -0.045 | -0.950 | -0.918 | 3.33% |
| 0.150 | 0.290 | 0.049 | -0.096 | -1.933 | -1.959 | 1.34% |
| 0.105 | 1.375 | 0.049 | -0.641 | -13.095 | -13.218 | 0.94% |

A negative m represents that the image is inverted.

The larger percentage differences only occurred when do was large. These large percentage differences can be due slight inaccuracies when measuring the size of the resultant image which was very small. These large differences can also be due to measuring larger distances because of the higher margin of error when reading the measurements on the ruler.

***Magnification (Mirror):***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| d (m) (object) | d (m) (image) | h (m) | h' (m) | m (from distance) | m (from size) | m % diff |
| 0.32 | 0.33 | 0.049 | -0.05 | -1.031 | -1.020 | 1.05% |
| 0.47 | 0.25 | 0.049 | -0.027 | -0.532 | -0.551 | 3.59% |
| 0.94 | 0.195 | 0.049 | -0.01 | -0.207 | -0.204 | 1.62% |

The negative m represents that the image is inverted.

***Graphs:***

***Comparisons:***

*“Infinitely” distant object:*

*Different object distances (lens):*

*Different object distances (mirror):*

*Graphical method:*

From all the experiments, the graphical method resulted in the lowest error percentage from all the other methods, where direct measurements resulted in the highest error percentage. From this, I would choose the graphical method because of its very low percentage error.

**Questions:**

1. Choose one of the setups from the lens and one for the mirror and sketch a “Light Ray Diagram”. Make your drawing to scale. Compare your calculated results with those from the light ray diagram.

Lens:

A graph with lines and dots

Description automatically generated

From do = 0.15 m (Object reads (-0.15 , 0.049), Image reads (0.3 , -0.098))

Mirror:

A graph with lines and dots

Description automatically generated

From do = 0.47 m (Object reads (-0.47 , 0.049), Image reads (-0.242581, -0.02529))

1. Quantitatively describe what happens to the size, type and position of an image from the mirror, as the object starts at “infinity” and moves towards the mirror. Identify the “special ranges” when characteristics change. Answer for both concave and convex mirrors.

A graph with lines and a red line

Description automatically generated with medium confidence

This Desmos graph is meant to show the relationship between di (x) and do (y), whereas one approaches infinity, the other approaches the focal point, and vice versa. in this case, the mirror/lens is at x=0, the focal point is at x=1, and the center of curvature (CoC) is at x=2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| do | Infinity | Before CoC | At CoC | Before f | At f | After f |
| di | At f | Between CoC and f | At CoC | Between CoC and Infinity | Infinity | In front of Lens/Behind Mirror |
| Real/Virtual | Real | Real | Real | Real | Real/Virtual | Virtual |
| m (-do/di) | 0 | Inverted and <1 | Inverted and =1 | Inverted and >1 | Infinity | Erect and >1 |