

PHY 4021: Experiments in Optics

Experiment 1: Ray Optics

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1 Experiments

1.1 Introduction to Ray Optics

1.1.1 Straight Line Propagation of Light

1.1.1.1

While the rays are straight, they are not parallel with each other.

1.1.1.2

As the rays' distance from the Slit Plate increases, their width increases while their distinctness decreases.

1.1.1.3

All of the rays appeared to originate from the Light Source, even when viewed from a slight angle.

1.1.1.4

As the angle of the Slit Plate increases, becomes more horizontal, the width of the rays increases while their distinctness decreases.

1.1.1.5

The images are most distinct when the Slit Plate is entirely vertical, and they are least distinct when it is horizontal.

1.1.1.6

come back to this one

1.1.2 Ray Tracing: Locating the Filament

1.1.2.1

The distance between the reference mark in the center of the Ray Table and the point of intersection of the rays at the filament is $d_e = 24.1 \pm 0.05\text{cm}$.

1.1.2.2

The distance between the filament and the center of the Ray Table was measured to be $d_t = 25.6 \pm 0.05\text{cm}$.

1.1.2.3

The two measurements have a percent error, where $\%_{err} = \frac{|d_t - d_e|}{d_t} \cdot 100\%$, of $\%_{err} = 5.86\%$, and a percent uncertainty, where $\delta\%_{err} = \frac{\%_{err}}{d_e}$, of $\delta\%_{err} = 0.249\%$. Although the percent error, $5.86\% \pm 0.249\%$, is low, it is, nonetheless, present.

1.2 The Law of Reflection

1.2.1 Data

1.2.2 Questions

1.2.2.1

The results of the two trials are the same.

1.2.2.2

The incident ray, reflected ray, and normal all lie on the same plane because the reflected and incident rays are visible on the 2D surface of the Ray Table. Because they are both visible on the 2D surface, they must both reside in the same 2D plane.

1.2.2.3

The angle of incidence and the angle of reflection are both the same value.

1.2.3 Data

Incidence (degree)	Reflection ₁ (degree)	Reflection ₂ (degree)
0	0	0
10	10	10
20	20	20
30	30	30
40	40	40
50	50	50
60	60	60
70	70	70
80	80	80
90	90	90

Figure 1: **Table 2.1:** The two symmetric angles of reflection resulting from the indicated angle of incidence.

1.3 Image Formation in a Plane Mirror

1.3.1 Sketch

`{include pictures}`

1.3.2 Questions

1.3.2.1

The rays do seem to follow a straight line into the mirror.

1.3.2.2

The distance from the filament to the plane of the mirror (d_1) was measured to be $30.1 \pm 0.05\text{cm}$.

1.3.2.3

The perpendicular distance from the image of the filament to the plane mirror (d_2) was measured to be $30.0 \pm 0.05\text{cm}$.

1.3.2.4

The image will always appear to be the same distance away as if it were being viewed straight on without a mirror. ???

1.4 The Law of Refraction

1.4.1 Data

Incidence (degree)	Refraction ₁ (degree)	Refraction ₂ (degree)
0	0	0
10	7	6
20	13	13
30	20	20
40	25	26
50	31.5	31.5
60	36	36
70	41.5	42
80	n/a	n/a
90	n/a	n/a

Figure 2: **Table 4.1:** The two symmetric angles of refraction from each angle of incidence.

1.4.2 Questions

1.4.2.1

The ray is not bent when it passes into the lens perpendicular to the lens' flat surface.

1.4.2.2

The ray is slightly bent when it passes out of the lens perpendicular to the lens' curved surface.

1.4.2.3

While the two sets of measurements are very nearly identical, there are minor differences between the two. These differences may be attributed to our inability to perfectly align the ray with the Ray Table.