First Lab Report - Group 3
PHY 192

Question 3.1

In this first report, our group (Group 3) explores the refractive indices of lenses composed of different materials.

For the first part of the experiment, we aim to determine the index of refraction of a C-shaped lens by studying how it bends light when a red laser beam is shone through it.

Specifically, we will analyze the refraction angle (dependent variable) produced by the lens when the laser is incident at different angles (independent variable).

The relationship between the dependent and independent variables is governed by a fundamental equation in optics: Snell's Law. This equation is given by:

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2) \tag{1}$$

where n_1 and n_2 are the refractive indices of the two materials. The refractive index is defined as the ratio of the speed of light in a vacuum to the speed of light in the material. The angles θ_1 and θ_2 represent the angles of incidence and refraction, respectively.

Question 3.1.1

If the laser beam does not pass through the center of the lens, refraction will still occur, as light always refracts when transitioning between materials with different refractive indices.

However, a significant issue arises: the angles of incidence and refraction become difficult to measure. The proposed lab setup is designed to simplify the measurement of these angles, but deviation from the intended setup may introduce measurement challenges.

Question 3.1.2

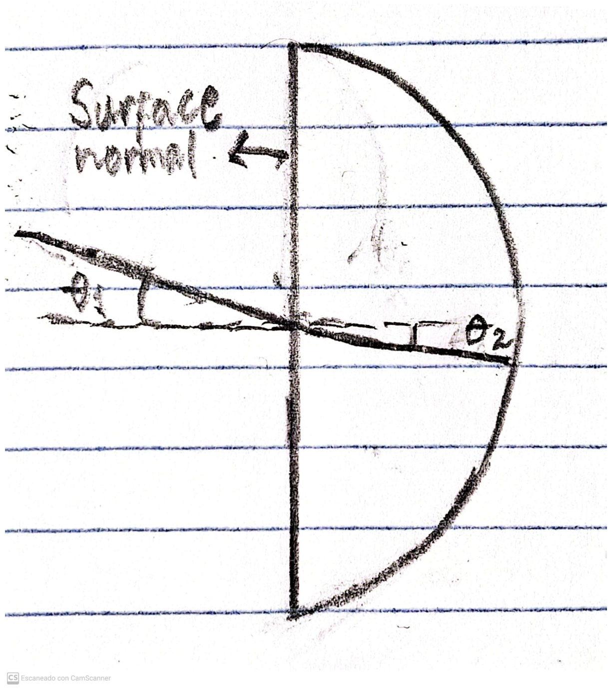

Figure 1: In this diagram the incident angle is marked with the label θ_1 and the refracted angle is marked with the label θ_2, the surface normal is also labeled as such.

Question 3.1.3

We have that the sine of the angle of incidence is given by:

$$\sin(\theta_1) = \frac{n_2}{n_1} \sin(\theta_2) \tag{2}$$

We can easily assume that n_1 being the refractive index of air is equal to 1, so the equation simplifies to:

$$\sin(\theta_1) = n_2 \sin(\theta_2) \tag{3}$$

It is also physically impossible for the refractive index of the lens to be less than 1 because that would imply that light is going faster than the speed of light in a vacuum which isn't possible. As such we can assume that $n_2 > 1$, as such we know as a fact that the sine of the angle of incidence is always less than or equal to 1, so we can conclude that the refracted angle is always more than the incident angle.

As the sine of an angle is directly proportional to the angle itself, we can conclude that the refracted angle is always greater than the incident angle.

Question 3.1.4 - 3.1.6

θ_0	θ_1	θ_{2L}	θ_{2R}	θ_2 avg	$d\theta_2$
0	10	5	7	6	0.5
0	20	10	15	12.5	0.5
0	30	15	21	18	0.5
0	40	21	26	23.5	0.5
0	50	26	33	29.5	0.5

Table 1: Here is a table where θ_0 is the normal angle, θ_1 is the angle of incidence, θ_2 is the angle of refraction, θ_{2L} and θ_{2R} are the angles of refraction measured on the left and right side of the lens respectively, and $d\theta_2$ is the uncertainty in the angle of refraction. **All the angles are measured in degrees.**

Question 3.2.2

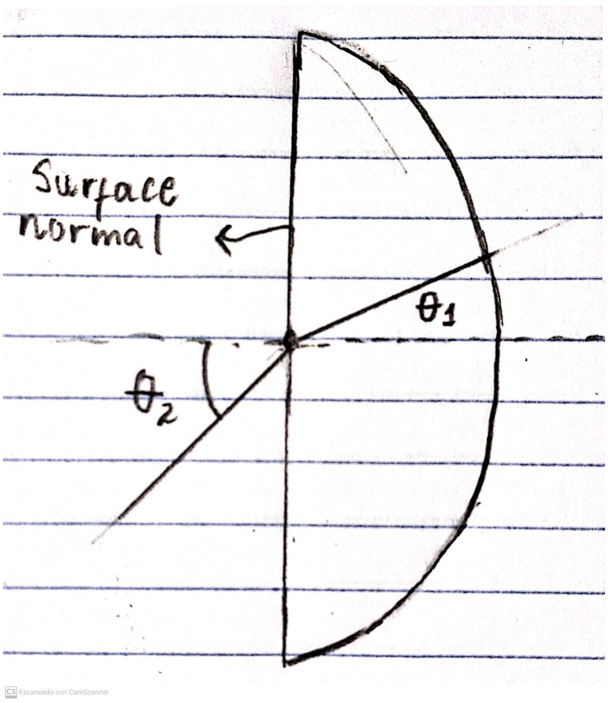

Figure 2: In this diagram the incident angle is marked with the label θ_1 and the refracted angle is marked with the label θ_2, the surface normal is also labeled as such.

Question 3.2.3

We have that the sine of the angle of incidence is given by:

$$\sin(\theta_1) = \frac{n_2}{n_1} \sin(\theta_2) \tag{4}$$

We can easily assume that n_1 being the refractive index of air is equal to 1, so the equation simplifies to:

$$\sin(\theta_1) = n_2 \sin(\theta_2) \tag{5}$$

It is also physically impossible for the refractive index of the lens to be less than 1 because that would imply that light is going faster than the speed of light in a vacuum which isn't possible. As such we can assume that $n_2 > 1$, as such we know as a fact that the sine of the angle of incidence is always less than or equal to 1, so we can conclude that the refracted angle is always more than the incident angle.

As the sine of an angle is directly proportional to the angle itself, we can conclude that the refracted angle is always greater than the incident angle.