Topic 4 – Practical 2

Experimental determination of refractive index

Safety

After prolonged use the ray boxes get hot – avoid contact.

Apparatus and materials

- semicircular Perspex block
- ray box
- power supply
- protractor
- sheet of paper
- ruler
- set square

Introduction

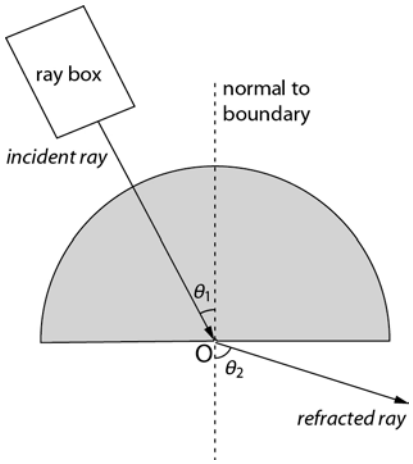
When a ray of light travels through a medium with refractive index n_1 and meets a boundary with another medium of refractive index n_2, it is partly reflected and partly refracted. If the incident angle is θ_1 and the refracted angle is θ_2, then:

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \quad \text{or} \quad \frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1}$$

This relationship is known as Snell's law.

Procedure

1 Draw a straight line in the middle of the sheet of paper (this will be the line normal to the boundary). Draw another line perpendicular to the first one.



2 Using the protractor mark angles of incidence, θ_1, of 10°, 20°, 30°, 40° and 50°.

3 Place the Perspex block on the sheet in such a way that the straight edge is aligned with the second line and the intercept of the two lines is in the middle of the straight edge (point O). Draw the outline of the block so it can easily be placed at the same position.

4 Connect the ray box to the power supply (use the voltage according to the ray box specification, usually 12 V) and use a narrow slit to form a ray. This is the incident ray.

5 Align the ray box so that the incident ray goes through the curved side of the block at 10° from the normal to the boundary (θ_1 = 10°) and meets the straight edge at point O.

6 The refracted ray should be visible. Mark this ray on the paper and measure its angle from the normal to the boundary, i.e. the angle of refraction, θ_2.

7 Calculate sin θ_1 and sin θ_2. Record your measurements and calculations in a suitable table.

8 Repeat steps **5**–**7** for angles of incidence, θ_1, of 20°, 30°, 40° and 50°.

9 Assuming that the refractive index of air is equal to 1, plot a graph with suitable axes that will allow you to determine the refractive index of Perspex from its gradient.

Questions

1 Were you able to take measurements for all incident angles?

2 What is the critical angle? How can you determine the critical angle for Perspex?

3 What do you expect to observe if instead of white light you used rays of blue and red light?