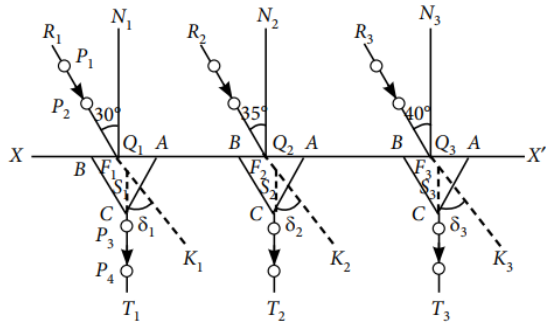
## Experiment - 14 : The plot of angle of the deviation vs angle of incidence for a triangular prism.

The apparatus required is a drawing board, white sheets of paper, prism, drawing pins, pencil, scale of office pins, graph paper and protractor.

The white paper is pinned to the drawing board and the prism is fixed at a place. The outline of the prism is marked on the paper. Then an incident ray say (at 30°) is drawn on one of the faces of the prism and two pins are inserted at $P_1$ and $P_2$ on the ray as shown below.




When viewed from the other face the pins are along a particular line. We place pins $P_3$ and $P_4$ in line with the images of $P_1$ and $P_2$ as seen in the prism. Thereafter line $P_3P_4$ is drawn which represents the emergent ray.

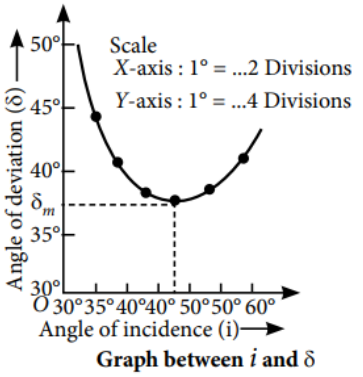
Lift the prism and make the dotted lines and discover the angle of deviation $\delta_1$ here. This angle can be measured by a protractor.

Several such observations for angle of incidence ranging from 30° to 60° can be made and the corresponding angle of deviation can be measured. Plot a graph between δ vs i. A sample graph is drawn below:

From the graph the minimum value of deviation can be obtained.

Angle A can be measured by the protractor from the outline of the prism.

To get refractive index of the material of the prism, prism formula is used as follows:



**Graph between *i* and δ**

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

# MCQs Corner

## Experiment – 14

60. In an experiment for determination of refractive index of glass of a prism by i – d, plot, it was found that a ray incident at angle 35°, suffers a deviation of 40° and that it emerges at angle 79°. In that case which of the following is closest to the maximum possible value of the refractive index?

(a) 1.5 (b) 1.6 (c) 1.7 (d) 1.8

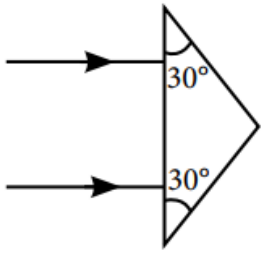
61. There is a prism with refractive index equal to 2 and the refracting angle equal to 30°. One of the refracting surfaces of the prism is polished. A beam of monochromatic light will retrace its path if its angle of incidence over the refracting surface of the prism is

(a) 0° (b) 30° (c) 45° (d) 60°

62. The minimum deviation produced by a glass prism of angle 60° is 30°. If the velocity of light in vacuum is $3 \times 10^8$ m/s, then the velocity of light in glass in m/s is

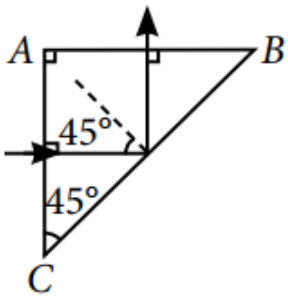
(a) $2.9 \times 10^8$ (b) $3.1 \times 10^8$ (c) $2.121 \times 10^8$ (d) $2.72 \times 10^8$

63. Two parallel light rays are incident at one surface of a prism of refractive index 1.5 as shown in figure. What is the angle between the rays as they emerge?




(a) 30° (b) 37° (c) 45° (d) 49°

64. A light ray is incident perpendicular to one face of 90° prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45°, we conclude that the refractive index



(a) $n < \frac{1}{\sqrt{2}}$ (b) $n > \sqrt{2}$

(c) $n > \frac{1}{\sqrt{2}}$ (d) $n < \sqrt{2}$

65. An equilateral prism deviates a ray through 45° for two angles of incidence differing by 20°. μ of the prism is

(a) 1.567 (b) 1.467 (c) 1.5 (d) 1.65

## Answer Key

60. (a) 61. (c) 62. (c) 63. (b) 64. (b) 65. (a)

## Hints & Explanation

**60. (a) :** Here, $i = 35°$, $e = 79°$, $\delta = 40°$

We know, $\delta = i + e - A \Rightarrow A = i + e - \delta$

$\therefore \quad A = 35° + 79° - 40° = 74°$

Refractive index of prism, $\mu = \dfrac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

$$\mu = \frac{\sin\left(37° + \dfrac{\delta_m}{2}\right)}{\sin 37°} = \frac{5}{3}\sin\left(37° + \frac{\delta_m}{2}\right)$$

Maximum value of $\mu$ can be $\dfrac{5}{3}$, so required value of $\mu$ should be less than $\dfrac{5}{3}$.

Also, $\delta_m$ will be less than 40°, so

$$\mu < \frac{5}{3}\sin\left(37° + \frac{40°}{2}\right) = \frac{5}{3}\sin 57°$$

$$\mu < \frac{5}{3}\sin 57° < \frac{5}{3}\sin 60° = 1.44 \ \therefore \ \mu < 1.44$$

So the nearest possible value of $\mu$ for the given arrangement should be 1.5.

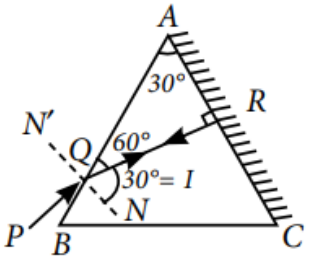
**61. (c) :** See figure below. It is clear from the figure that the ray will retrace the path when the refracted ray QR is incident normally on the polished surface AC. Thus, angle of refraction r = 30°.

We know that $\mu = \dfrac{\sin i}{\sin r}$

$\therefore \ \sin i = \mu \times \sin r$

$\sin i = \sqrt{2} \times \sin 30° = \sqrt{2} \times \dfrac{1}{2} = \dfrac{1}{\sqrt{2}}$

$\Rightarrow i = \sin^{-1}\dfrac{1}{\sqrt{2}} = 45°.$




**62. (c) :** $\mu = \dfrac{\sin\dfrac{(A+\delta_m)}{2}}{\sin\dfrac{A}{2}} = \dfrac{\sin\dfrac{(60+30)}{2}}{\sin\left(\dfrac{60}{2}\right)}$

$$= \frac{\sin 45°}{\sin 30°} = \frac{0.7070}{0.5000} = 1.414$$

Now velocity of light in glass = $\frac{c_{air}}{\mu}$

$$\Rightarrow \quad c_g = \frac{3 \times 10^8 \text{ m/s}}{1.414} = 2.121 \times 10^8 \text{ m/s}$$

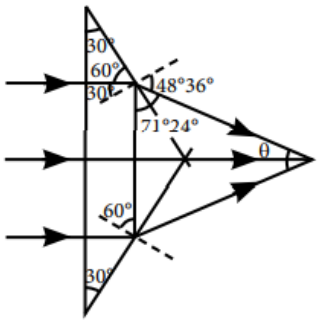
**63. (b) :** See figure.

$$\frac{\sin 30°}{\sin r} = \frac{1}{\mu} = \frac{1}{1.5}$$

$\sin r = 1.5 \times (1/2) = 0.75$

$r = 48° 36'$

$\therefore \quad \theta = 180° - 2(71° 24') \approx 37°$




**64. (b) :** For total internal reflection at glass-air interface critical angle $C$ must be less than 45°.

Now $n = \frac{1}{\sin C}$ or $C = \sin^{-1}\left(\frac{1}{n}\right) < 45°$

or $\frac{1}{n} < \sin 45°$ or $n > 1/\sin 45° \quad \therefore n > \sqrt{2}$.

**65. (a) :** We know that $\delta = i_1 + i_2 - A$

$45° = i_1 + i_2 - 60°$ or $i_1 + i_2 = 105°$

Given that $i_1 - i_2 = 20°$

Solving eqs. (i) and (ii), we get

$i_1 = 62° 30'$ and $i_2 = 42° 30'$

Now, $\mu = \frac{\sin i_1}{\sin r_1} = \frac{\sin i_2}{\sin (60° - r_1)}$

or $\sin i_1 (\sin 60° \cos r_1 - \cos 60° \sin r_1) = \sin r_1 \sin i_2$

$0.8870 (0.866 \cos r_1 - 0.5 \sin r_1) = 0.6756 \sin r_1$

Solving, we get $\tan r_1 = \frac{0.8870 \times 0.866}{1.1191}$

$\Rightarrow r_1 = 34°28' ; \mu = \frac{\sin i_1}{\sin r_1} = \frac{0.8870}{0.5659} = 1.567$