EXPERIMENT NO. 9
REFRACTIVE INDEX OF PRISM

Aim: To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence and the angle of deviation.

Apparatus: Drawing board, a white sheet of paper, prism, drawing pins, pencil, half-metre scale, office pins, graph paper and a protractor.

Formula:

The refractive index of the material of the prism is given by,

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

where, δm angle of minimum deviation and A angle of the prism.

Diagram:

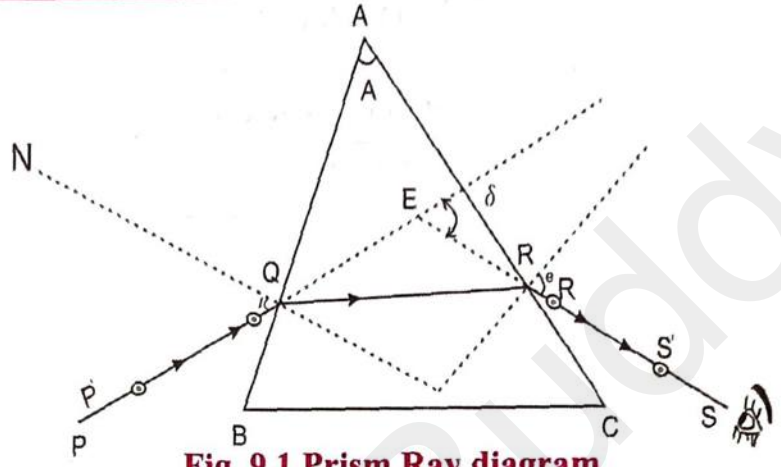


Fig. 9.1 Prism Ray diagram

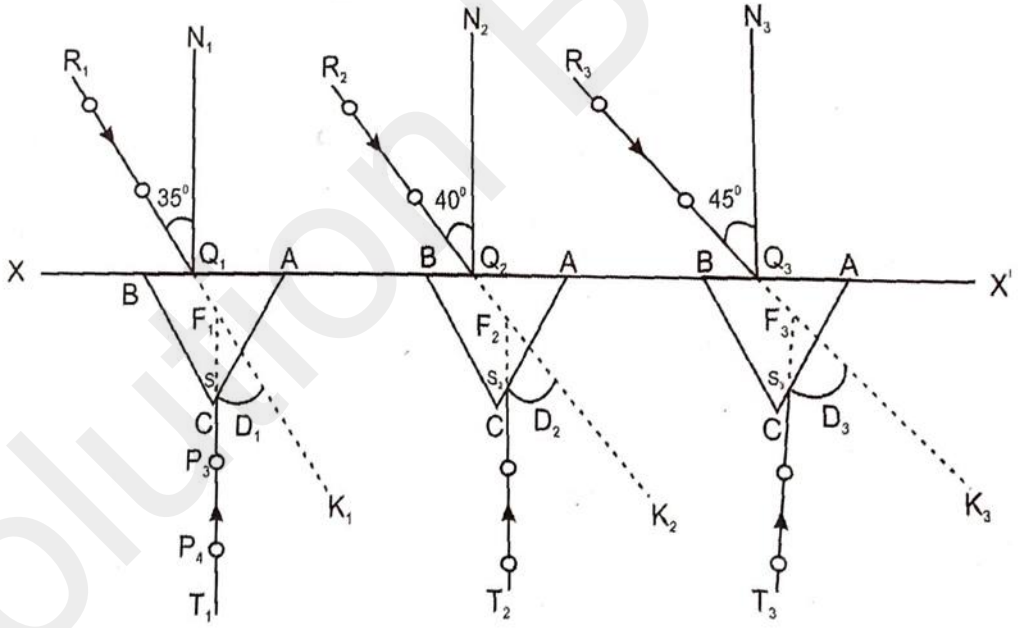


Fig. 9.2 Prism experiment

Procedure:

1. Fix a white sheet of paper on the drawing board with the help of drawing pins or tape.
2. Draw a straight line XX' parallel to the length of the paper nearly in the middle of the paper.
3. Mark points Q_1, Q_2, Q_3,... on the straight line XX' at suitable distances of about 5 cm.
4. Draw normal N_1Q_1, N_2Q_2, N_3Q_3,... on points Q_1, Q_2, Q_3,... as shown in diagram.

5. Draw straight lines R_1Q_1, R_2Q_2, R_3Q_3,... making angles of 35°, 40°, ... 60° (write value of the angles on the paper) respectively with the normal.
6. Mark one corner of the prism as A and take it as the edge of the prism for all the observations.
7. Put prism with its refracting face AB on the line XX' and point Q_1 in the middle of AB.
8. Mark the boundary of the prism.
9. Fix two or more office pin P_1 and P_2 vertically on the line R_1Q_1. The distance between the pins should be 10 mm or more.
10. Look the images of point P_1 and P_2 through face AC.
11. Close your left eye and bring open right eye in line with the two images.
12. Fix two office pins P_3 and P_4 vertically, and 10 cm apart such that the open right eye sees pins P_4 and P_3 and images of P_2 and P_1 in one straight line.
13. Remove pins P_3 and P_4 and encircle their pricks on the paper.
14. Repeat steps 7 to 13 with points Q_2, Q_3,... for i = 40°,..., 60°.

To measure δ in different cases

1. Draw straight lines through points P_4 and P_3 (pin pricks) to obtain emergent rays S_1T_1, S_2T_2, S_3T_3,.....
2. Produce T_1S_1, T_2S_2, T_3S_3, ... inward in the boundary of the prism to meet produced incident rays R_1Q_1, R_2Q_2, R_3Q_3,... at points F_1, F_2, F_3,...
3. Measure angles $K_1F_1S_1$, $K_2F_2S_2$, $K_3F_3S_3$, ... These give angle of deviation δ1, δ2, δ3,....
4. Write values of these angles on the paper.

To measure A

1. Measure angle BAC in the boundary of the prism. This gives angle A.
2. Record your observations.

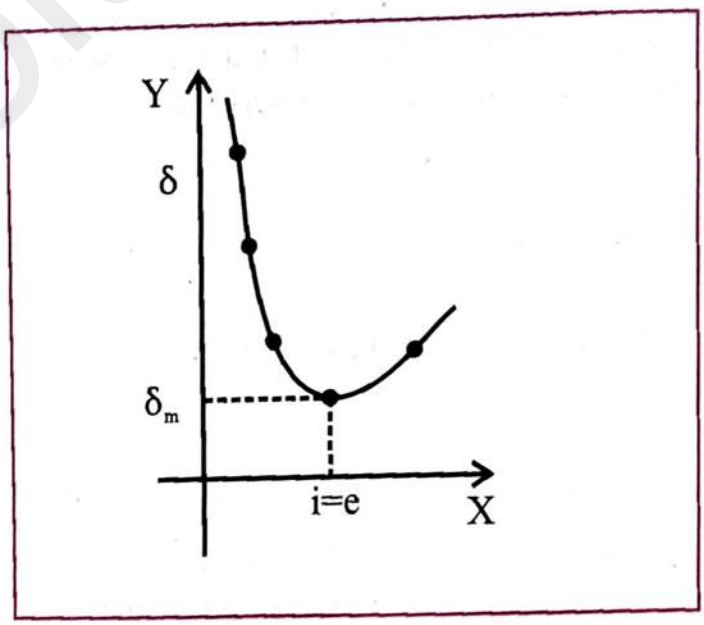
Observation table :

Angle of prism A = ...

Sr no.	Angle of incidence i in degree	Angle of deviation δ in degree
1	35	45
2	40	42
3	45	39
4	50	40
5	55	45
6	60	38
7	65	50

Graph:

Plot a graph between angle of incidence ∠i against angle of deviation ∠δ by taking ∠i along X-axis and ∠δ along Y-axis. From this graph, find the value of single of minimum deviation δm corresponding to the lowest point of the graph.



Calculations:

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

$$\mu = \frac{\sin\left(\frac{60+38}{2}\right)}{\sin\left(\frac{60}{2}\right)}$$

$$\mu = \frac{\sin(49)}{\sin(30)}$$

$$= \frac{0.75}{0.5}$$

$$= \frac{7.5}{5}$$

$$\boxed{\mu = 1.5}$$

Result:

1. i-δ graph indicates that as the angle of incidence (i) increases, the angle of deviation (δ) first decreases, attains a minimum value (δm) and then starts increasing for further increase in angle of incidence.
2. Angle of minimum deviation, δm = ...38°...
3. Refractive index of the material of the prism, μ = ...1.5...

Precautions:

1. The angle of incidence should lie between 35°-60°.
2. The pins should be fixed vertical.

3. The distance between the two pins should not be less than 10 mm
4. Arrow heads should be marked to represent the incident and emergent rays.
5. The same angle of prism should be used for all the observations.

Sources of error:

1. Pin pricks may be thick.
2. Measurement of angles may be wrong.

Additional experiment :

Repeat the same experiment by using laser beam instead of pin.

Multiple-choice Questions

1. Which of the following Colour suffers maximum deviation in a prism?

   a) Red b) violet c) yellow d) orange

2. How many refractions occur when a ray of light passes through a triangular prism?

   a) 1 b) 3 c) 4 d) 2.

Questions

1. On which factors does refractive index depend?

Refractive index of medium depends upon the refractive index the surroundings When you consider the light ray passing them the surrending into the medium optically density, wavelength of the light and temperature

2. State Snell's law of refraction.

According to snell's law, the ratio of the angle of incidence to the sin of angle of refraction for a given pair of medium is constant. This constant is called refractive index(n) of second medium with respect to first medium.

Remark and sign of teacher: .....