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

Aim

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

Materials Required

- A drawing board
- A white sheet of paper
- A prism
- Drawing pins
- Pencil
- A half-metre scale
- Office pins
- Protractor
- Graph paper

Theory

Refraction occurs when a light ray travels from one medium to another resulting in deviation of the emergent ray from that of the incident ray. Following is the refractive index of the material used in the prism:

$$n = \frac{sin(\frac{A+D_m}{2})}{sin(\frac{A}{2})}$$

Where D_m is the angle of minimum deviation and A is the prism angle.

Ray Diagram
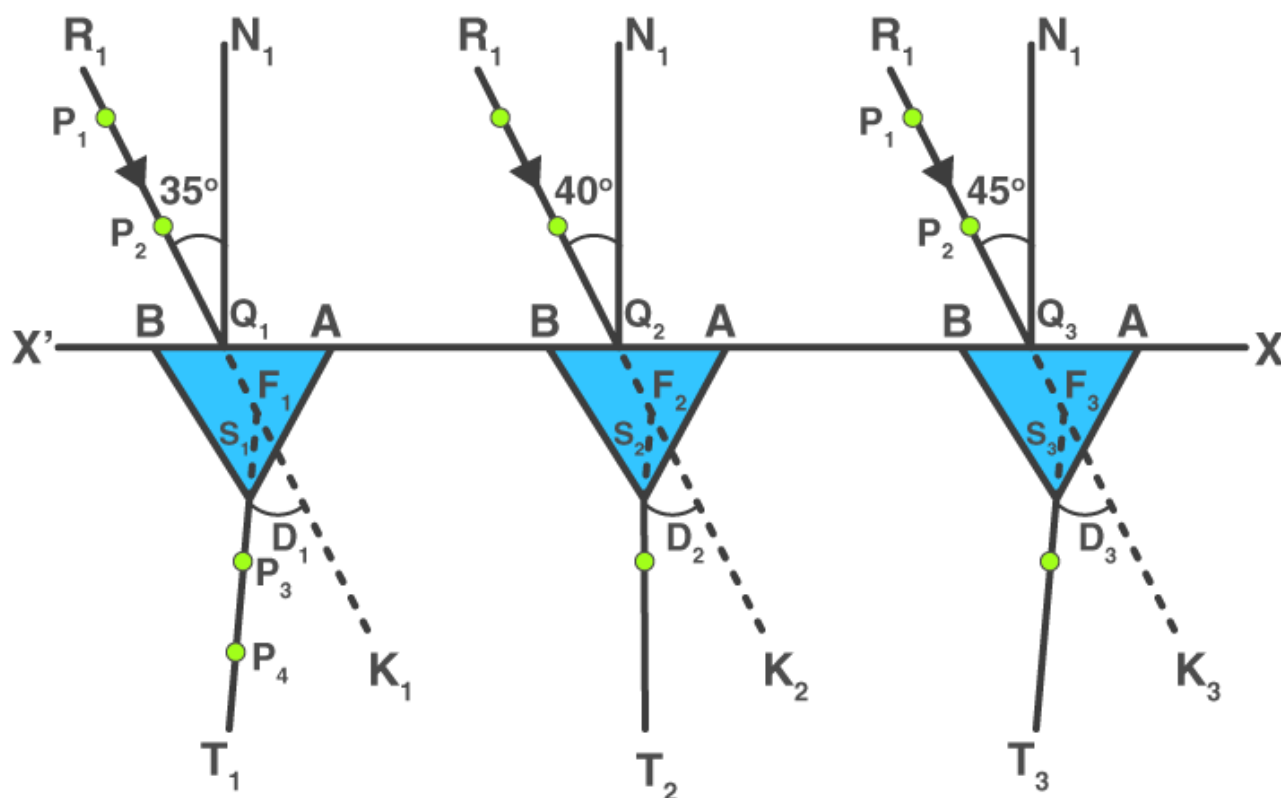
Procedure

- Place the white sheet of paper on the drawing board and fix it with the help of drawing pins.
- XX' is the straight line drawn parallel to the length of the paper such that it is in the middle of the paper.
- Mark points Q_1, Q_2, Q_3…… on the straight line XX' at a distance of 5 cm each.
- N_1Q_1, N_2Q_2,… are the normals that are drawn on the points Q_1, Q_2,… as shown in the ray diagram.
- Make angles of 35°, 40°,….,60° by drawing straight lines R_1Q_1, R_2Q_2,…….. With respect to the normals.
- To take one edge of the prism for all the observations, mark any corner of the prism as A.
- Place the prism with its refracting face AB on line XX' and on point Q_1 and also in the middle of AB.
- Mark the boundary of the prism.
- On line R_1Q_1, fix office pins vertically and mark them as P_1 and P_2. the distance between these pins should not be less than 10mm.
- Through the prism face, AC, look for the images of points P_1 and P_2.

- Close your left eye and with the right eye open, bring it in line with the two images.
- Fix the other two office pins vertically and name them P_3 and P_4. These pins should be 10cm apart from each other. P_3 and P_4 should be in one straight with respect to the images of P_1 and P_2.
- Encircle the pricks of pins P_3 and P_4.
- For points, Q_2, Q_3,…. for angle 40°, 45°,…..60°, repeat the steps 7 to 13.

To measure D in a different case

- To get emergent rays S_1T_1, S_2T_2,….. draw straight lines through P_4 and P_5.
- Inward the boundary of the prism to produce T_1S_1, T_2,S_2….. so that they meet incident rays R_1Q_1, R_2Q_2,…. at points F_1, F_2,…
- To obtain the angle of deviation D_1, D_2,…. measure the angles $K_1F_1S_1$, K_2F_2,S_2,…….
- Note these angles.

To measure angle A

- To get angle A, measure the angle BAC in the boundary of the prism.
- Record the observations.

Observations

The angle of the prism, A = 60°

Serial no.	Angle of incidence $\angle i$	Angle of deviation $\angle D$
1	35°	43°
2	40°	39°
3	45°	38°
4	50°	38°

5	55°	39°
6	60°	42°

Calculations

To plot the graph between the angle of incidence $\angle i$ and the angle of deviation $\angle D$, take $\angle i$ along the x-axis and $\angle D$ along the y-axis. The minimum deviation Dm can be found in the graph, which would correspond to the lowest point in the graph.

Graph between i and D
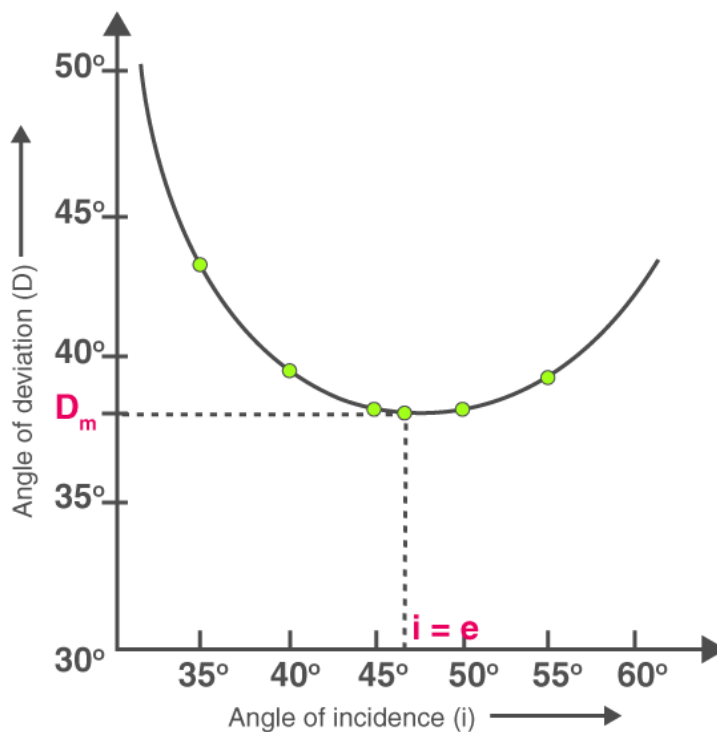
Let the value of the angle of minimum deviation, $D_m = 37°$

Then,

$$n = \frac{sin(\frac{A+D_m}{2})}{sin(\frac{A}{2})}$$

Putting the A = 60° and D_m = 37° in the above equation, we get n = 1.5

Result

- The angle of minimum deviation, D_m = 37°
- Refractive index of the material of the prism, n = 1.5
- The graph indicates as the angle of incidence increases, the angle of deviation first decreases to attain the minimum value of D_m and then again increases with the angle of incidence.

Precautions

- 35°- 60° are the angle of incidence that needs to be maintained.
- The placement of the pins must be vertical.
- The placement of two pins should be such that the distance is not more than 10mm.
- To represent incident and emergent rays, arrowheads must be marked.
- The angle of the prism used should be the same for all the observations.

Sources of Error

- The pricks made by the pins might be thick.
- Angles might go wrong while measuring them.

Viva Voice

Q1. Name the factors on which the angle of deviation depends.

Ans: Following are the factors on which the angle of deviation depends:

The angle of incidence
The refracting angle of the prism
Refractive index of the material used in the prism
The wavelength of the light ray
Q2. Define angular deviation.

Ans: Angular deviation is defined as the ratio of the angular dispersion of the two colours to produce the deviation by the prism.

Q3. Name the factor on which dispersive power depends.

Ans: Dispersive power depends on the refractive index of the material used in the prism.

Q4. Name the colours with the highest and smallest refractive index.

Ans: Violet colour has the highest refractive index, while red colour has the smallest refractive index.