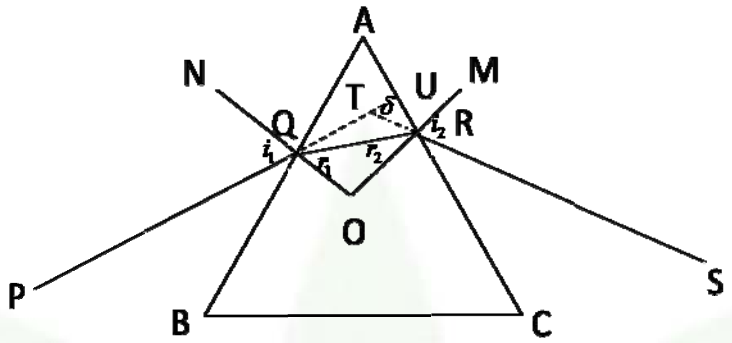
Refraction through prism:

A = Angle of prism



Had there been no prism, the ray PQ would have gone straight along PQU, but due to the prism the ray finally goes along RS. Hence the prism has deviated the ray through the angle

UTR=δ and is known as angle of deviation.

ON & OM are perpendiculars drawn on AB and AC respectively.

Let

$$\angle PQN = i_1 = \text{angle of incidence}$$
$$\angle RQO = r_1$$
$$\angle SRM = i_2 = \text{angle of emergence}$$
$$\angle AQO = \pi/2 = \angle ARO$$

In quodrilateral AQOR

Sum of two opposite angles $\angle AQO + \angle ARO = 180^o$

Hence AQOR is a co cyclic quadrilateral

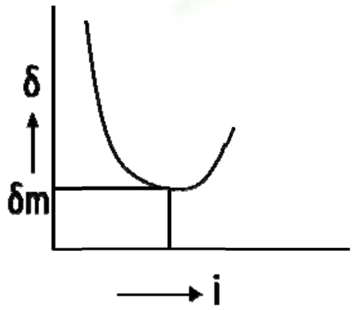
$$\angle QAR + \angle QOR = 180^o$$
$$A + \angle QOR = 180^o \rightarrow (1)$$

$In\ \Delta QOR$

$$r_1 + r_2 + \angle QOR = 180^o \rightarrow (2)$$

From equation (1) and equation (2):

$$A = r_1 + r_2 \rightarrow (3)$$
$$\angle TQR = i_1 - r_1$$
$$\angle TRQ = i_2 - r_2$$
$$\delta = (i_1 - r_1) + (i_2 - r_2)$$
$$\delta = (i_1 + i_2) - (r_1 + r_2)$$
$$\delta = (i_1 + i_2) - A \rightarrow (4)$$



From equation (4) we find that the angle of deviation δ depends on the angle of Incidence. Experimentally it is found that as the angle of incidence increases angle of deviation decreases, reaches a minimum value δm for a particular angle of incidence and then increases again.

The minimum value δm is known as the angle of minimum deviation. It can be analytically proved that when

$i_1 = i_2, r_1 = r_2$ i.e. the path of the ray through the prism is parallel to the base of the prism then only the angle of deviation is minimum.

Condiation for minimum deviation

$i_1 = i_2$ & $r_1 = r_2$

From equation (4)

$$\delta\text{m} = \text{i} + \text{i} - \text{A}$$

$$\text{i} = \frac{\text{A} + \delta\text{m}}{2}$$

$$A = r_1 + r_2 = r + r$$

$$A = 2r$$

$$r = \frac{A}{2}$$

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

For a thin prism the angle of prism A is very small

$$\sin \frac{A}{2} \approx \frac{A}{2}$$

$$\sin\left(\frac{\text{A} + \delta\text{m}}{2}\right) \approx \frac{\text{A} + \delta\text{m}}{2} \approx \frac{\text{A} + \delta}{2}$$

$$\therefore \mu = \frac{\frac{\text{A} + \delta}{2}}{\frac{A}{2}}$$

$$or\ \text{A}\mu = \text{A} + \delta$$

$$\text{or } \delta = \text{A}(\mu - 1) \rightarrow (6)$$

Equation (6) gives the deviation produced by thin prism.