

3 A student investigates the refraction of light using a semicircular transparent block.

Fig. 3.1 and Fig. 3.2 show his ray-trace sheet.

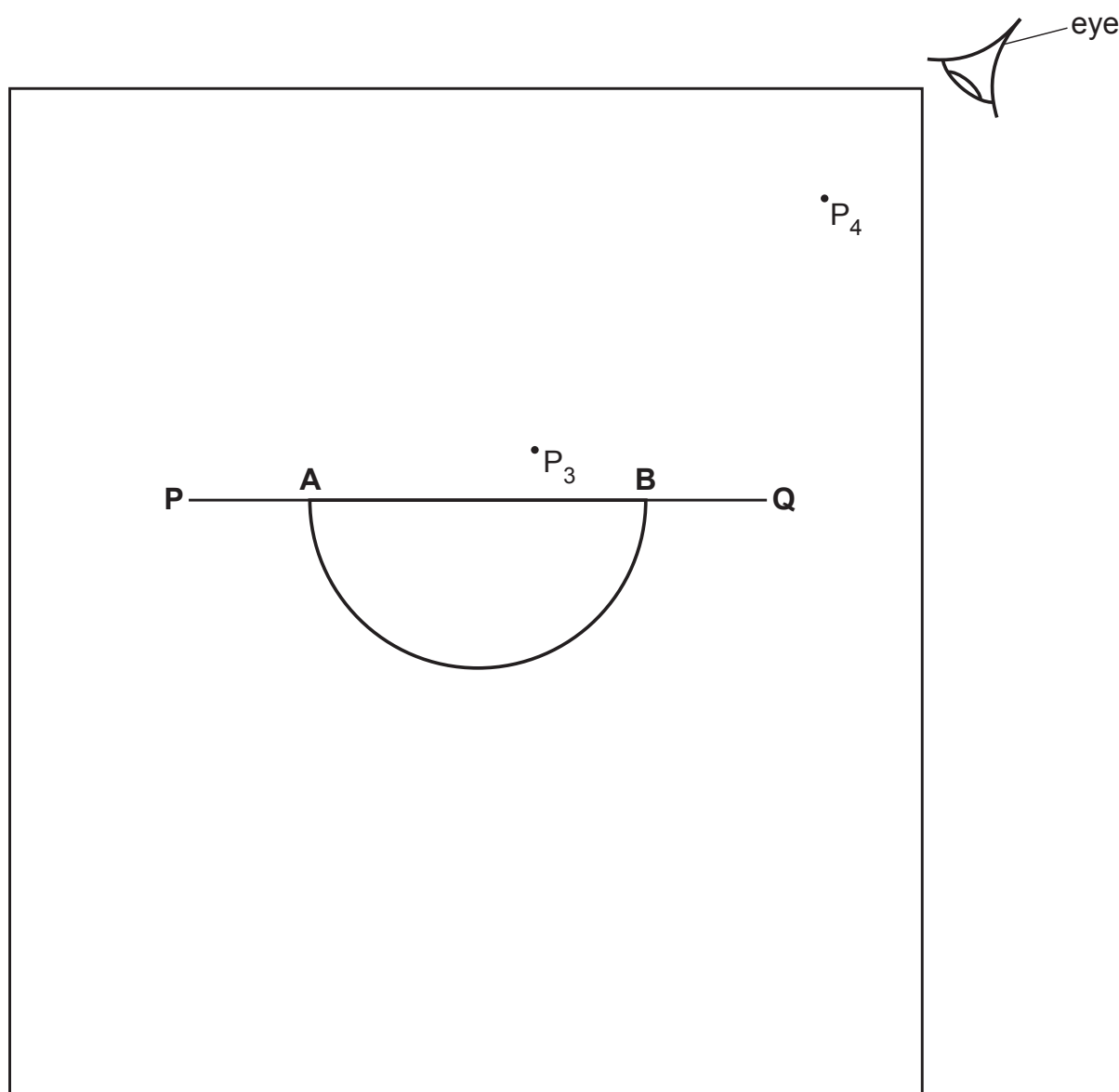


Fig. 3.1

- (a) • On Fig. 3.1, draw the normal **NL** through the centre of **AB**.
 • Continue the normal so that it passes through the curved side of the block.
 • Label the normal **NL**.
 • Label the point **C** where the normal **NL** crosses **AB**. [1]

- (b) (i) Draw a line **DC**, below line **PC**, at an angle $i = 30^\circ$ to the normal and to the left of the normal. [1]

- (ii) • Mark with neat crosses (X) the positions for two pins on line **DC** at a suitable distance apart for this type of ray-trace experiment.
 • Label the positions P_1 and P_2 . [1]

- (c) The student looks from the position of the eye shown in Fig. 3.1, to observe the images of P_1 and P_2 through side **AB** of the block. He adjusts his line of sight until the images of P_1 and P_2 appear one behind the other.

He places two pins, P_3 and P_4 , between his eye and the block so that P_3 , P_4 , and the images of P_1 and P_2 seen through the block, appear one behind the other.

The positions of P_3 and P_4 are shown on Fig. 3.1.

- (i) • Draw a line joining the positions of P_3 and P_4 . Continue the line to **AB**.
 • Label **E**, the end of the line furthest from **AB**. [1]

- (ii) Measure the acute angle α between the line **NL** and the line **CE**. (An acute angle is less than 90° .)

$\alpha = \dots\dots\dots^\circ$ [2]

- (d) State **one** precaution that you would take in order to produce an accurate ray trace.

 [1]

- (e) The student moves the transparent block to a new position on the ray-trace sheet, as shown in Fig. 3.2.

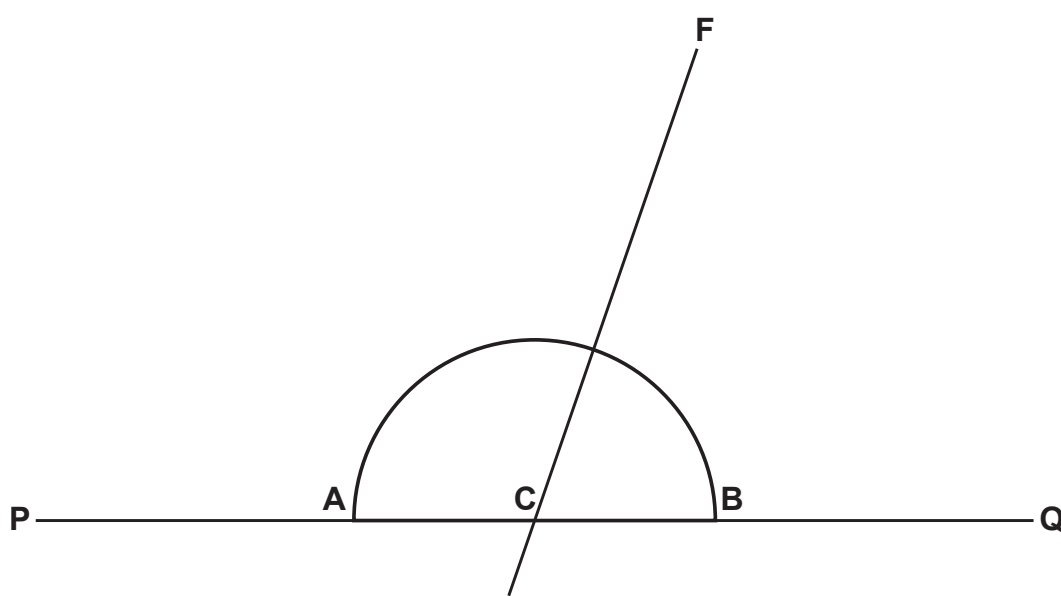


Fig. 3.2

He places pins P_1 and P_2 on line **DC** in the same positions used in (b)(ii). He observes the images of P_1 and P_2 through the curved side of the block.

He places pins P_5 and P_6 between his eye and the block so that P_5 , P_6 , and the images of P_1 and P_2 seen through the block, appear one behind the other.

He draws a line **CF** through the positions of P_5 and P_6 .

- (i) Measure the acute angle β between the line **AB** and the line **CF**. (An acute angle is less than 90° .)

$\beta = \dots\dots\dots^\circ$ [1]

- (ii) Calculate the angle θ between line **CF** and the normal to line **AB**. Show your working.

$\theta = \dots\dots\dots^\circ$ [2]

- (f) A student suggests that angle α should be equal to angle θ . State whether your results support the suggestion and justify your answer with reference to the results.

statement
 justification

 [1]