3 A student investigates the refraction of light in the material of a transparent block.

Fig. 3.1 shows the ray-trace sheet. The student places a transparent block on the sheet and labels the block **ABCD**.

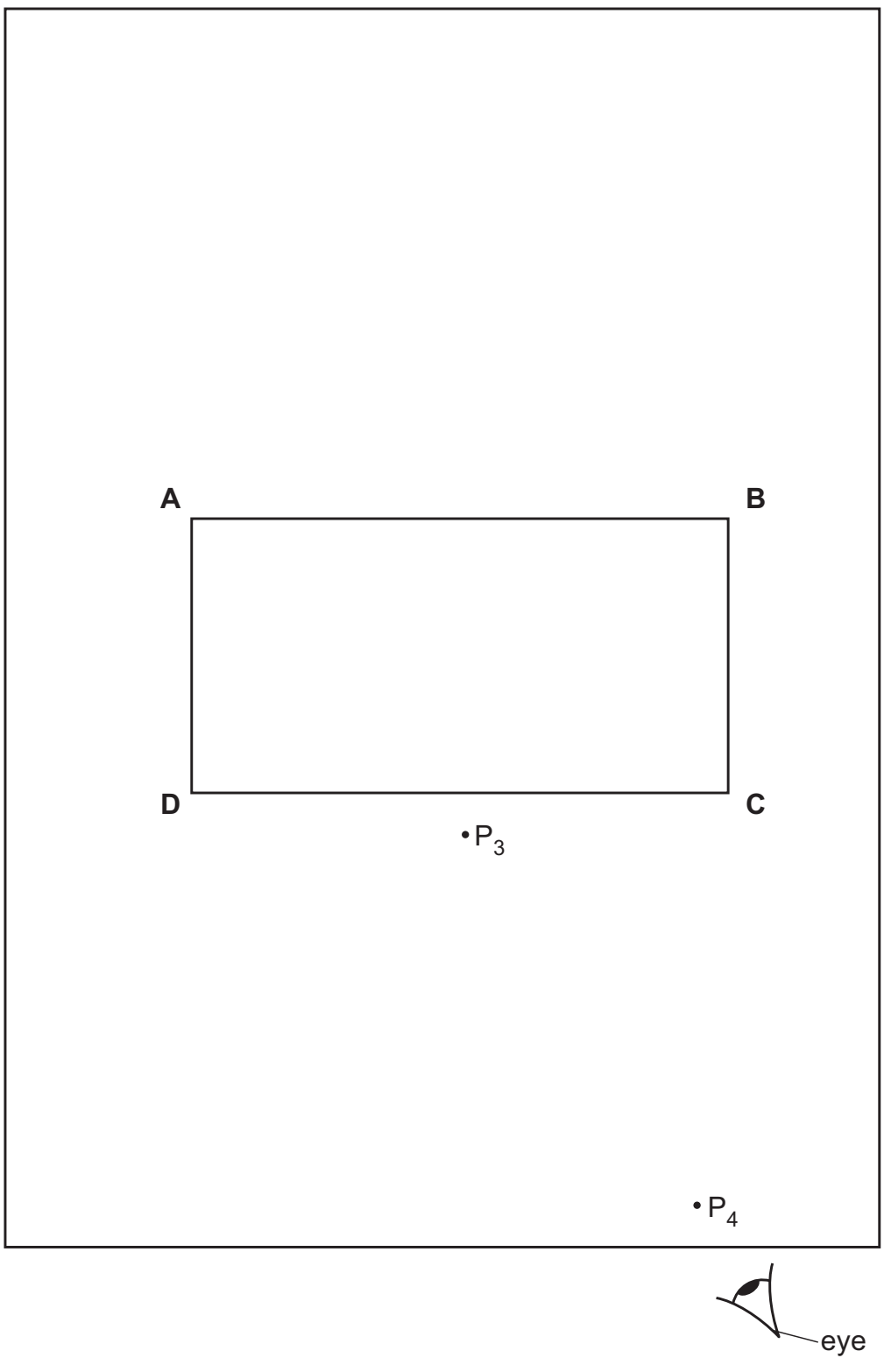

Fig. 3.1

(a) On Fig. 3.1, draw a normal **NL** to the side **AB** of the transparent block at a distance 2.0 cm from **A**. Continue the normal so that it passes through side **CD** of the block.

Label the point **S** where **NL** crosses **AB**.

[2]

(b) • Draw a line **RS** at an angle $i = 30°$ to the normal, above **AB** and to the left of the normal.

• The student places two pins P_1 and P_2 on line **RS**. Mark, with two crosses (X), on line **RS**, positions of the pins at a suitable distance apart for this experiment.

[2]

(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 **CD** of the block. He adjusts his line of sight until the images of P_1 and P_2 appear exactly one behind the other.

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

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

• Draw a line through the positions of P_3 and P_4. Continue the line until it meets the normal **NL** and label that point **E**.

• Label the other end of the line **F**.

• Measure the acute angle θ between **EF** and the normal. An acute angle is an angle less than 90°.

angle θ = ... [2]

(d) (i) Tick **one** box to complete the sentence.

To produce the most accurate ray-trace, a student places the pins P_1 and P_2

☐ exactly 5.0 cm apart.

☐ less than 5.0 cm apart.

☐ more than 5.0 cm apart.

[1]

(ii) Suggest **two** other techniques that the student can use to produce an accurate ray-trace.

1. .....

.....

2. .....

.....

[2]

(e) The student plans to investigate the relationship between angle i and angle θ. The student takes more sets of readings to test the relationship. List suitable values of angle i that the student can use.

.....

..... [2]

[Total: 11]