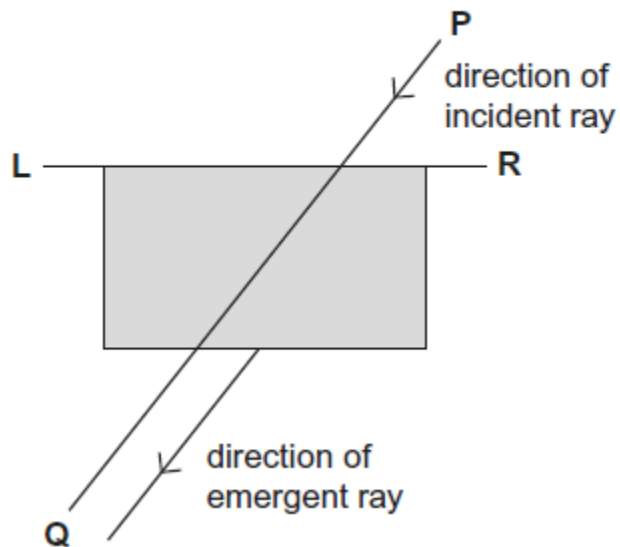


12

A student aligns the longer edge of a rectangular glass block along a line **LR**, as shown in **Figure 1**.

Figure 1

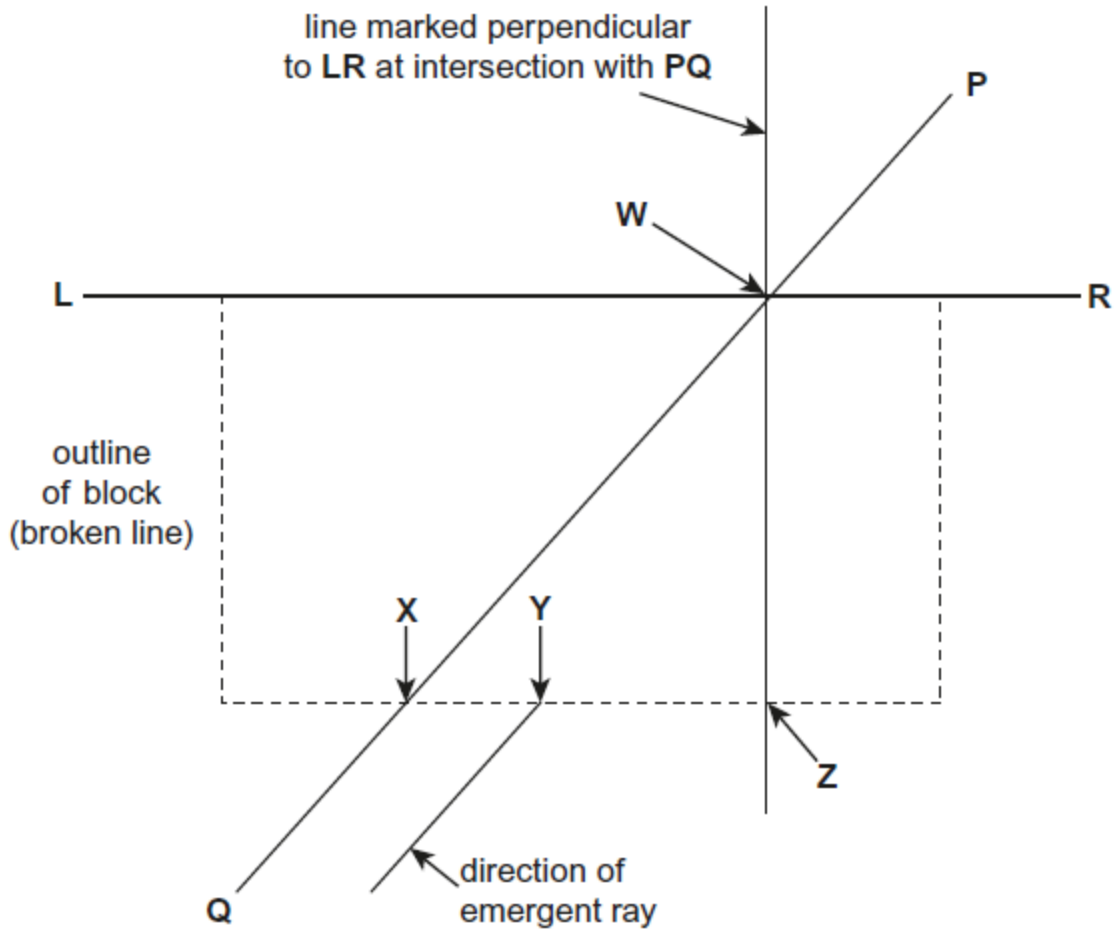


The student marks the outline of the block and directs a ray along **PQ**.

The student marks the direction of the emergent ray then removes the block and marks a line perpendicular to **LR** where **PQ** and **LR** intersect.

The student then marks the points **W**, **X**, **Y** and **Z** that are defined in **Figure 2**.

Figure 2



(a) Show that the refractive index n of the block is given by the equation

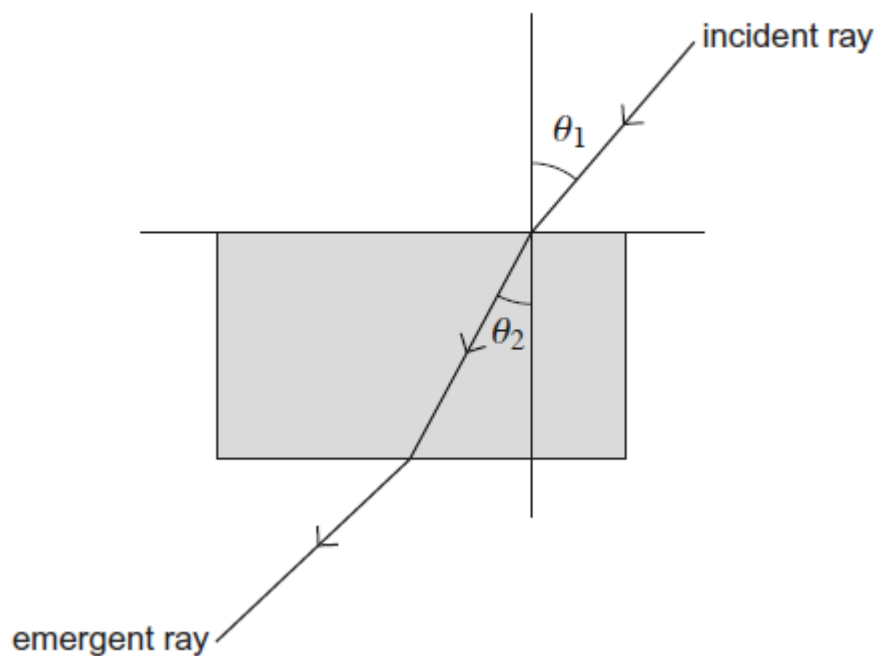
$$n = \frac{XZ \times WY}{YZ \times WX}$$

You may wish to use the equation $n = \frac{\sin \theta_1}{\sin \theta_2}$

where θ_1 and θ_2 are the angles shown in **Figure 3**.

You may also wish to illustrate your answer with a diagram.

Figure 3



(2)

- (b) The student repeats the procedure for different directions of the incident ray **PQ**. The student measures **XZ**, **WX**, **YZ** and **WY** for each direction of **PQ**. State and explain how the student can use these results to obtain a value of n by a graphical method.

(2)

- (c) The student used a block with dimensions 114 mm × 65 mm × 19 mm to perform the experiment.

The student's data are shown in the table below.

WX/mm	WY/mm	XZ/mm	YZ/mm
130	78	113	44
103	75	80	38
90	73	63	33
81	71	49	27
75	69	38	22
67	66	15	10

Explain whether the range of measurements made by the student is suitable.

(3)

(Total 7 marks)

13

A student uses a travelling microscope to investigate the perforation holes in a block of postage stamps.

The student positions the microscope to observe the line of perforation holes along the line XY shown in **Figure 1**.

Figure 1

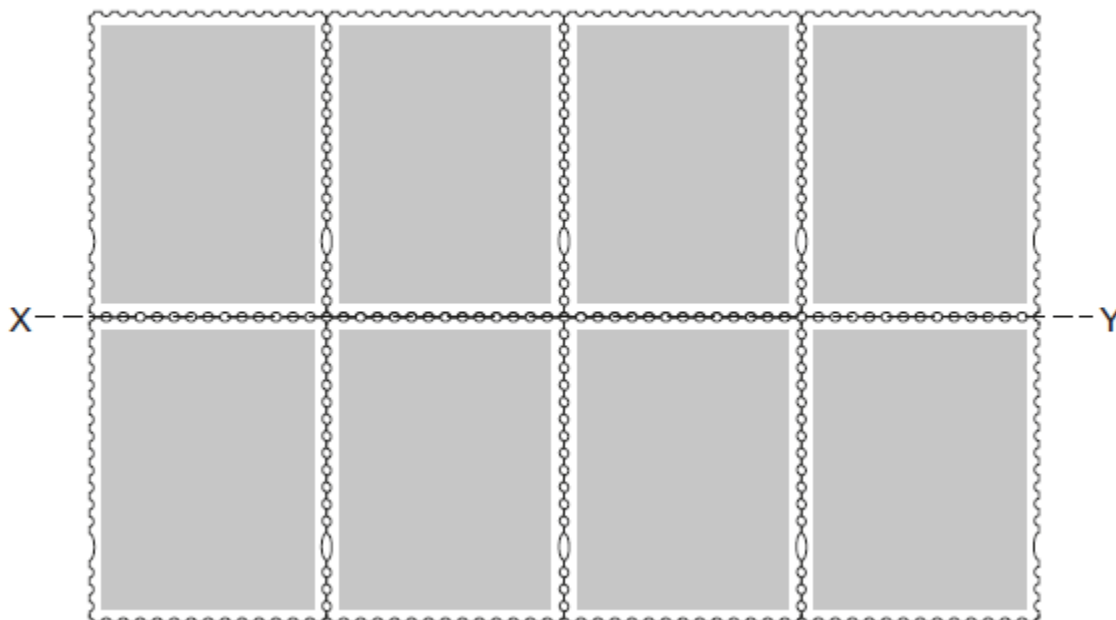
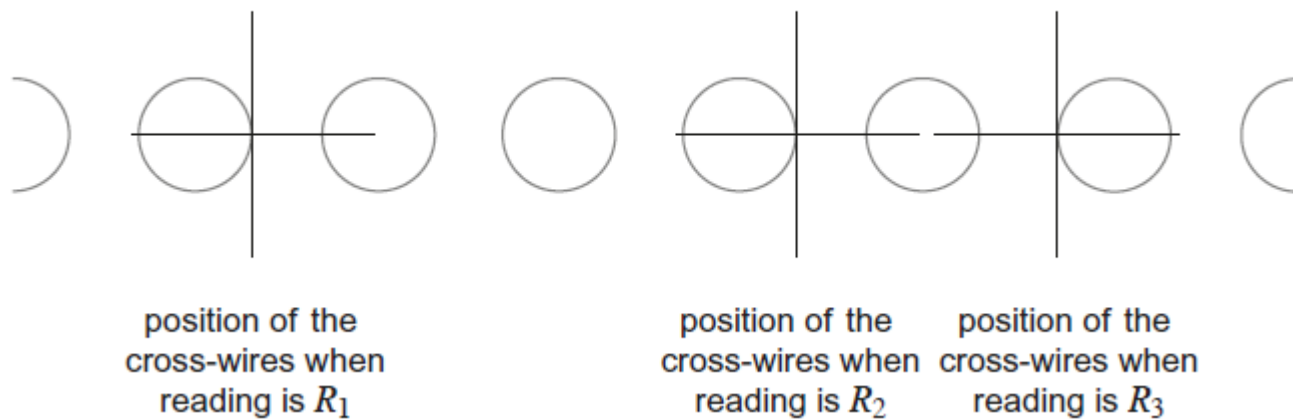


Figure 2 shows the positions of the cross-wires of the microscope when the student makes readings R_1 , R_2 and R_3 .

Figure 2



The student's readings are shown in the table below.

reading	position / mm
R_1	25.51
R_2	29.80
R_3	31.82

- (a) Determine the average separation s between the centres of adjacent perforation holes along line XY.

average separation $s =$ _____ mm

(1)

- (b) State the precision of the microscope readings.

precision = _____ mm

(1)

- (c) Determine the percentage uncertainty in your result for s .

percentage uncertainty = _____ %

(2)

(d) Determine the diameter d of a perforation hole.

diameter $d =$ _____ mm

(2)

(Total 6 marks)