Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Refraction and total internal reflection

Time allowed: 1 hour 10 minutes

Subject code **0625**

Physics

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 70

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 70 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 **(a)** A ray of red light passes through a rectangular glass block, as shown in Fig. 6.1.

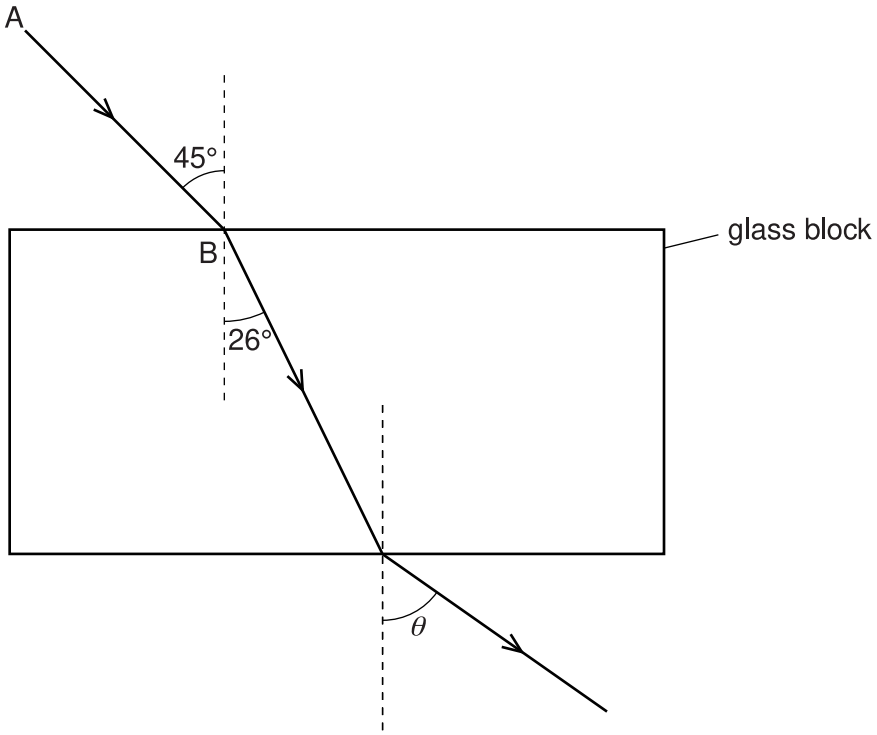


Fig. 6.1

(i) What name describes what happens to the ray of light at B?

.....

(ii) On Fig. 6.1, the emergent ray is not drawn at the correct angle θ to the normal.

State the correct value of the angle θ.

θ = ...
[2]

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(b) A ray of blue light is directed into a glass prism, as shown in Fig. 6.2.

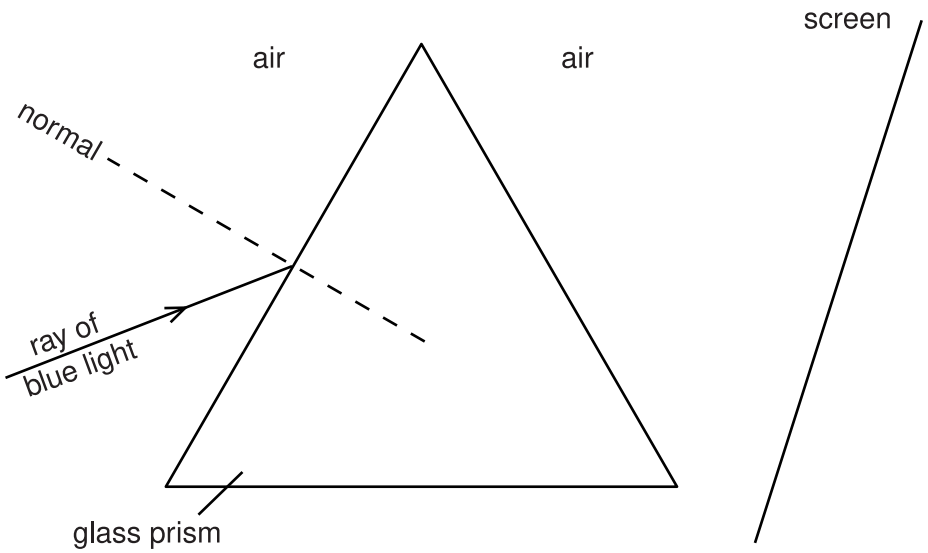


Fig. 6.2

(i) Using your ruler, draw a possible path for the blue light, until it reaches the screen.

(ii) The ray of blue light is replaced by a ray of red light.

On Fig. 6.2, mark an X to show where the red light might hit the screen.

[3]

[Total: 5]

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2 **(a)** In Fig. 7.1, a ray of light is shown passing into water from air. The angle of the refracted ray to the normal is 40°.

On Fig. 7.1, mark clearly the angle of incidence *i*. [1]

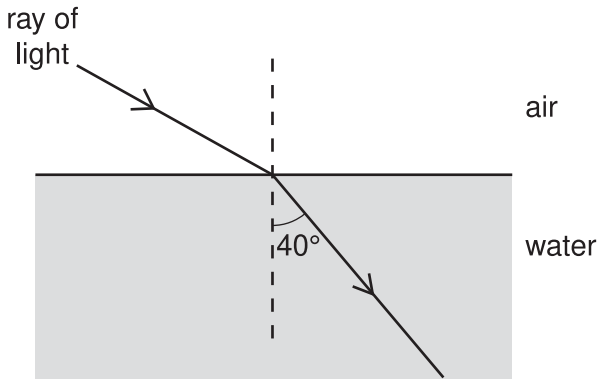


Fig. 7.1

(b) In Fig. 7.2, a ray of light is shown in water and reaching the surface with the air at an angle of 40° to the normal.

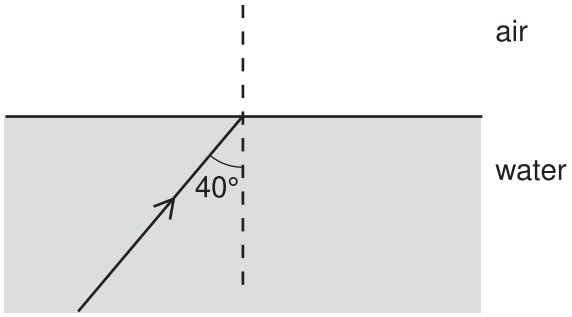


Fig. 7.2

(i) On Fig. 7.2, draw accurately the path of the ray in the air. [2]

(ii) The angle in the water in Fig. 7.2 is increased from 40° to 70°, and the ray no longer emerges into the air.

State what happens to the ray at the surface and explain why this happens.

.....

.....

.....

..... [2]

[Total: 5]

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3 **(a)** **(i)** Describe what is observed during *total internal reflection*.

.....

..... [1]

(ii) State **two** conditions required for light to be totally internally reflected.

1. .....

.....

2. .....

.....
[2]

(b) Describe and explain the action of optical fibres in communication technology. You may draw a diagram in your answer.

.....

.....

.....

..... [3]

[Total: 6]

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4 Fig. 7.1 shows red light travelling from air into a prism made of diamond. The path of the red light is incomplete.

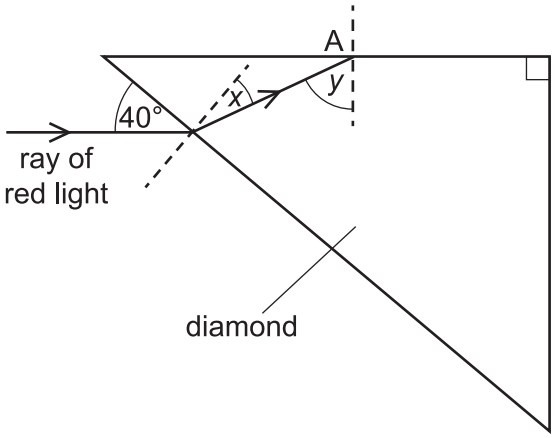


Fig. 7.1 (not to scale)

(a) The refractive index of diamond is 2.42.

Calculate angle *x*.

angle *x* = ... [2]

(b) Explain the term *total internal reflection*.

.....

.....

.....

.....

..... [3]

(c) The angle *y* is greater than the critical angle of diamond.

On Fig. 7.1, draw the path of the red light through and out of the prism after point A. [2]

[Total: 7]

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5 **(a)** State what is meant by total internal reflection.

.....

..... [2]

(b) Fig. 7.1 shows a ray of light from a light source in a tank containing a liquid.

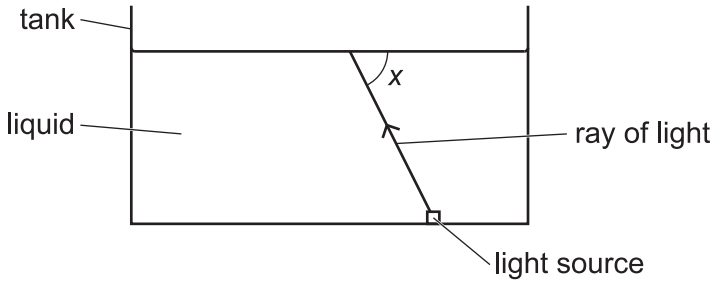


Fig. 7.1

The ray of light strikes the surface of the liquid at an angle x.

(i) The refractive index of the liquid is 1.5.

Calculate the largest value of x for which total internal reflection can occur.

x = ... [3]

(ii) The speed of light in air is 3.0×10^8 m/s.

Calculate the speed of light in the liquid.

speed = ... [2]

[Total: 7]

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6 Fig. 8.1 shows a section through the swimming pool in a hotel.

To make the pool more attractive at night, there are submerged lamps in the pool. Fig. 8.1 shows three rays coming from one of these lamps.

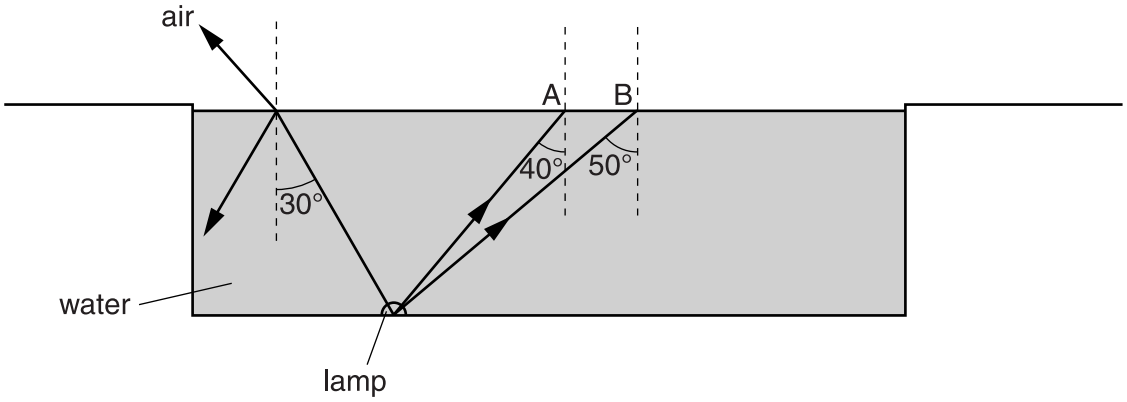


Fig. 8.1

The critical angle for the water/air boundary is 48°.

(a) State what is meant by the *critical angle* for a ray of light.

.....

.....

.....[3]

(b) On Fig. 8.1, use your ruler to draw approximate paths for the rays after they reach the surface at A and B. [4]

[Total: 7]

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7 Fig. 5.1 shows four rays of red light, P, Q, R and S, coming from a spotlight in a swimming pool.

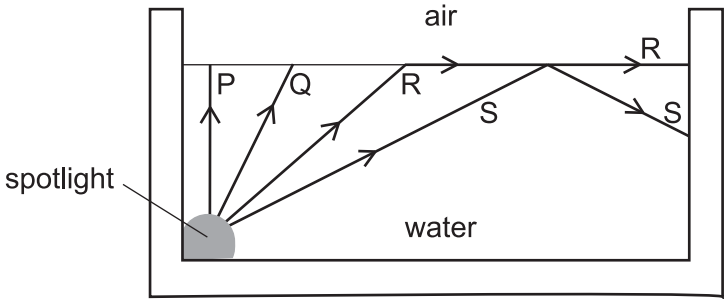


Fig. 5.1

(a) Define, in words, refractive index for a ray of light travelling from air to water.

..... [1]

(b) On Fig. 5.1, draw the path of rays P and Q at the water–air boundary. [2]

(c) The angle of incidence for ray R is 49°.

Calculate the refractive index of the water.

refractive index = ... [2]

(d) Explain why ray S is totally internally reflected at the water surface.

.....

..... [2]

[Total: 7]

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8 Fig. 5.1 shows a ray of yellow light incident on a glass prism ABC.

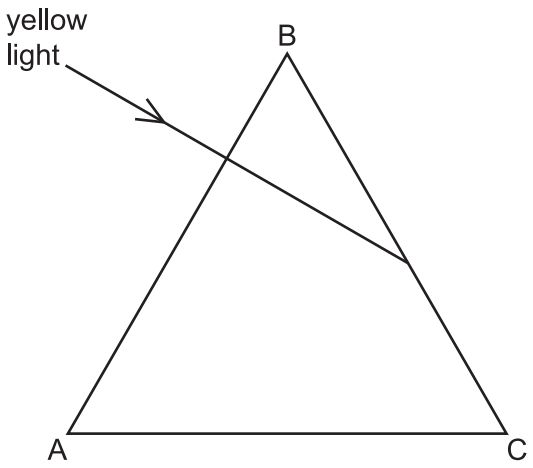


Fig. 5.1

(a) Explain why the ray does **not** change direction when it enters the prism at face AB.

.....

..... [1]

(b) The critical angle for the glass is 42°.

(i) Calculate the refractive index of the glass.

Show your working.

refractive index = ... [2]

(ii) On Fig. 5.1, continue the path of the light through the prism and after it leaves the prism. [3]

(c) Internet data can be transferred using infrared waves in optical fibres.

State **two** advantages of using optical fibres to transmit data.

1 .....

2 ..... [2]

[Total: 8]

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9 Fig. 7.1 shows a ray of light approaching face AB of a glass prism of refractive index 1.5.

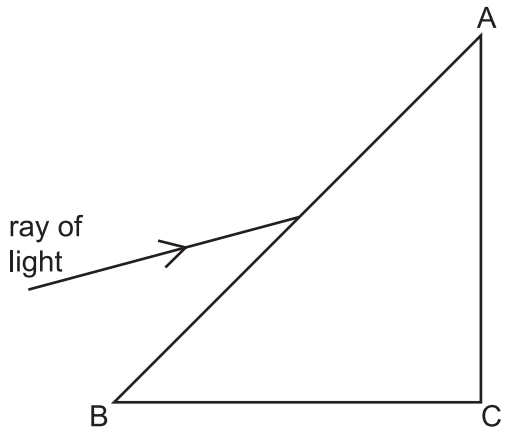


Fig. 7.1

(a) **(i)** On Fig. 7.1, accurately draw the path of the ray within the prism from face AB to face AC. You will need to make a measurement from Fig. 7.1 and carry out a calculation.

[4]

(ii) Determine the angle of incidence of this ray when it strikes face AC.

angle = ... [1]

(b) Without further measurement or calculation, sketch on Fig. 7.1 the approximate path of the ray after passing through the face AC. [1]

(c) Fig. 7.2 shows a ray of light travelling within an optical fibre.

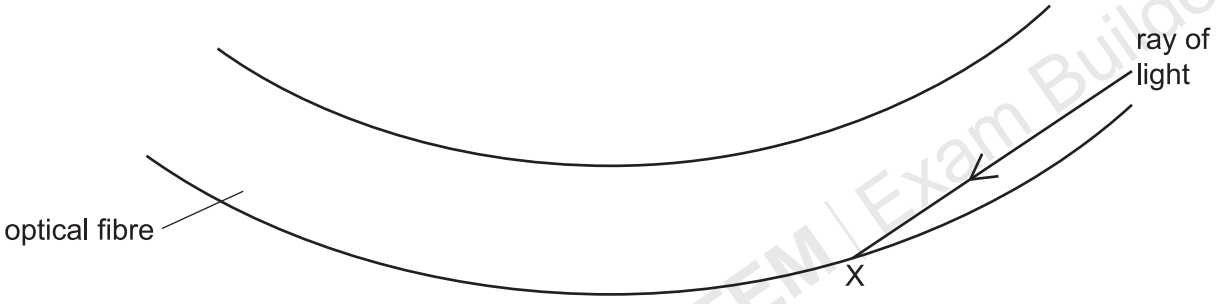


Fig. 7.2

(i) Complete the path of the ray of light to the left-hand end of the fibre. [2]

(ii) Name the process taking place at X. ..... [1]

[Total: 9]

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10 **(a)** Fig. 4.1 shows a ray of light as it enters the side of a plastic block. The ray of light passes from air into the plastic.

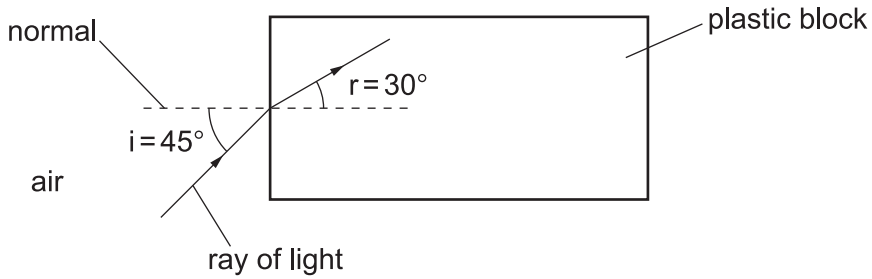


Fig. 4.1

(i) State how the speed, wavelength and frequency of the wave in the plastic block compare with their values in the air.

speed: .....

wavelength: .....

frequency: .....

[2]

(ii) Show that the refractive index of the plastic is 1.4.

Show your working.

[1]

(iii) Calculate the critical angle for the plastic.

critical angle = ... [2]

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(b) Fig. 4.2 shows the same plastic as in **(a)** used to make an optical fibre. A ray of light is passing along the fibre.

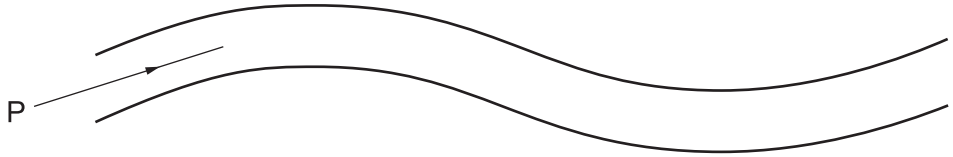


Fig. 4.2

(i) Carefully continue the ray of light P until it reaches the other end of the fibre. [2]

(ii) State **two** uses for optical fibres.

1 .....

2 .....
[2]

[Total: 9]

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