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

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Light

Time allowed: 1 hour 20 minutes

Subject code **0625**

Physics

Questions from Paper 3, Paper 4 and Paper 6

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

Total marks

/ 78

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 78 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.

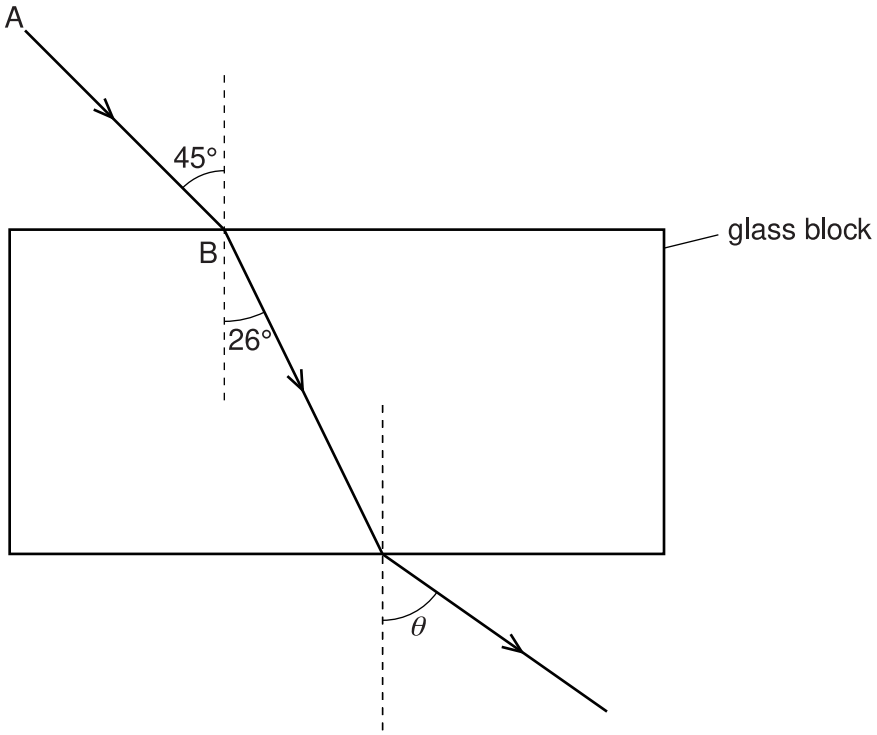


Fig. 6.1

(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.

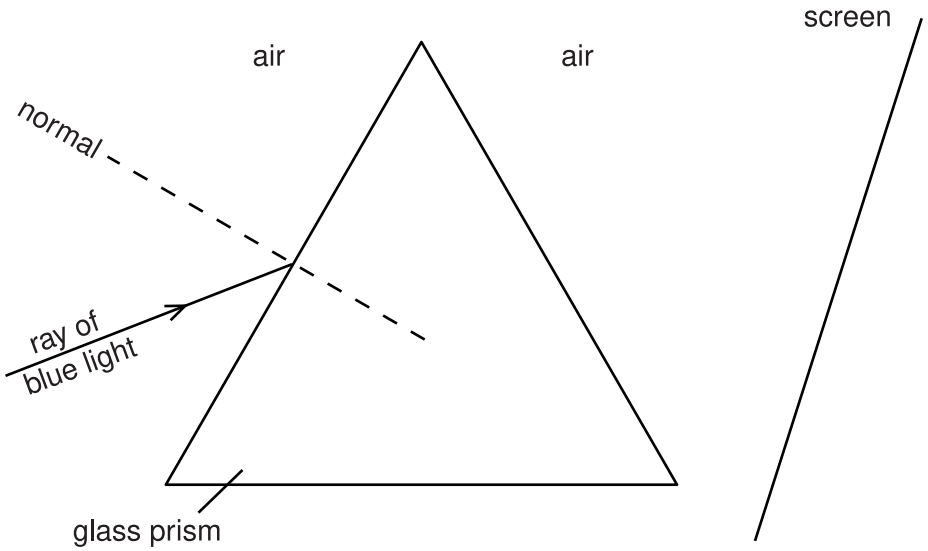


Fig. 6.2

(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]

Refraction and total internal reflection Click for more variations

1 **(a)** **(i)** refraction
accept refracted ray, ignore bends B1

(ii) 45 (°) condone no/incorrect unit B1

(b) **(i)** refracted down at first surface B1
refracted down at 2nd surface B1

(ii) X marked above point where candidate's blue light hits screen B1

[Total: 5]

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2 **(a)** Fig. 8.1 shows an incomplete ray diagram of a converging lens forming an image of the object, O.

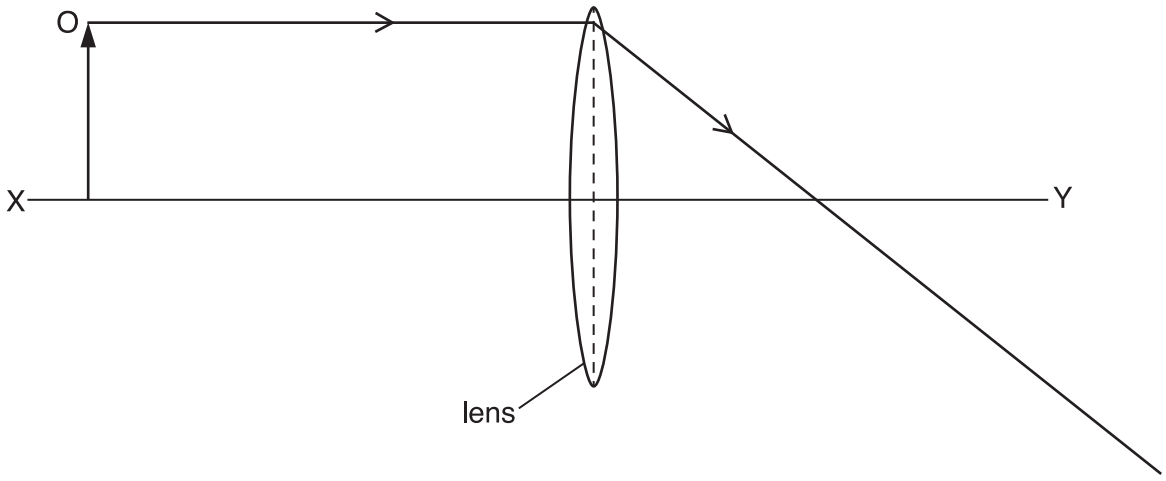


Fig. 8.1

(i) State the term given to the line XY.

..... [1]

(ii) On Fig. 8.1, indicate the position of one principal focus of the lens. Label the principal focus, F. [1]

(b) (i) On Fig. 8.1, draw a ray of light from the top of the object that passes through the lens to form the image. Use a ruler. [2]

(ii) On Fig. 8.1, draw the image formed by the lens. Label the image I. [1]

(iii) Choose words from the box that describe the image formed by the lens in Fig. 8.1.

diminished	enlarged	horizontal	inverted	same size	upright

Draw a ring around each correct word. [2]

[Total: 7]

Lenses and ray diagrams Click for more variations

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2(a)(i)	(principal) axis ignore X-axis	**B1**
2(a)(ii)	F marked near intersection of ray and principle axis	**B1**
2(b)(i)	Either: ray from top of object towards centre of lens	**B1**
	continues from centre and crosses initial ray	**B1**
	OR 1st ray through F on left of lens (needs to be added by candidate)	**(B1)**
	2nd ray parallel to principle axis and crosses initial ray	**(B1)**
2(b)(ii)	inverted arrow drawn from axis to point where rays cross	**B1**
2(b)(iii)	diminished circled	**B1**
	inverted circled	**B1**

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3 **(a)** A student shines a ray of red light towards a large glass prism, as shown in Fig. 5.1.
The angles of the prism are 45°, 90° and 45°.
The critical angle for the glass is 42°.

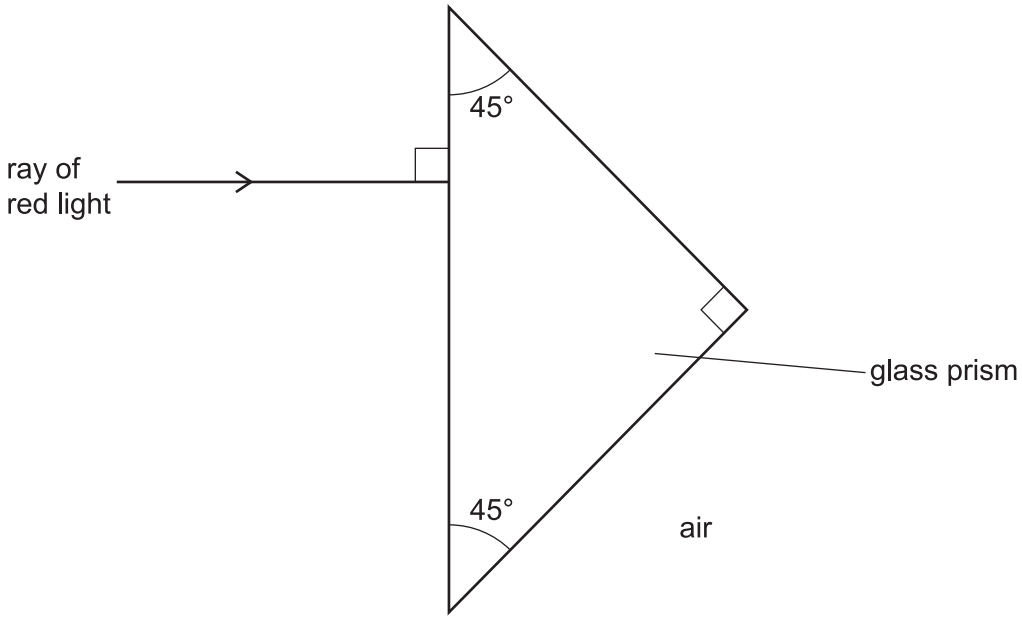


Fig. 5.1

On Fig. 5.1:

(i) continue the path of the ray in the glass prism to a boundary between glass and air [1]

(ii) draw and label the normal at the point your ray hits the boundary between glass and air [1]

(iii) continue your ray until it emerges into the air. [2]

(b) The spectrum of visible light is made up of seven colours.

Fig. 5.2 shows a partially completed spectrum for visible light.

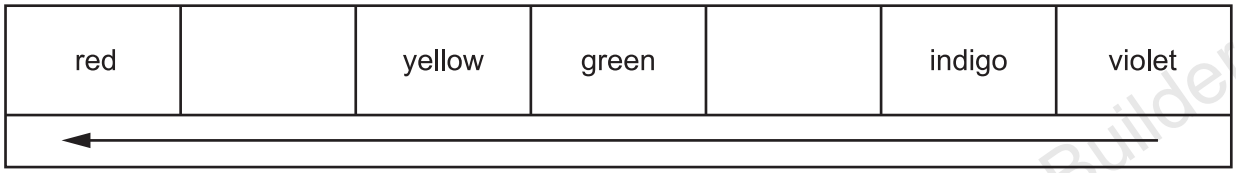


Fig. 5.2

(i) On Fig. 5.2, write the names of the missing colours. [2]

(ii) State the property of visible light that increases in the direction of the arrow in Fig. 5.2.

..... [1]

[Total: 7]

Dispersion and colour Click for more variations

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3(a)(i)	ray continues normally into glass	**B1**
3(a)(ii)	one correct normal seen	**B1**
3(a)(iii)	ray is totally internally reflected at a glass / air boundary	**B1**
	ray emerging from hypotenuse	**B1**
3(b)(i)	orange – between red and yellow	**B1**
	blue – between green and indigo	**B1**
3(b)(ii)	wavelength	**B1**

4 A student directs a ray of light towards a plane mirror, as shown in Fig. 8.1.

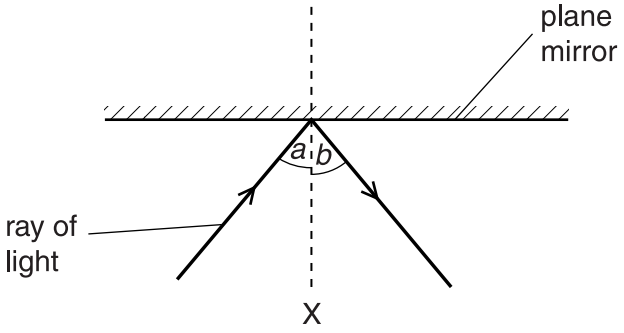


Fig. 8.1

(a) (i) Name the line labelled X.

.....[1]

(ii) When angle *a* is 45°, angle *b* is also 45°.

Angle *a* is changed to 20°.

What is the new value of angle *b*? Tick **one** box.

20° ☐ 25° ☐ 45° ☐ 65° ☐ 80° ☐ [1]

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(b) The student now makes the ray of light from Fig. 8.1 pass into a glass block, as shown in Fig. 8.2.

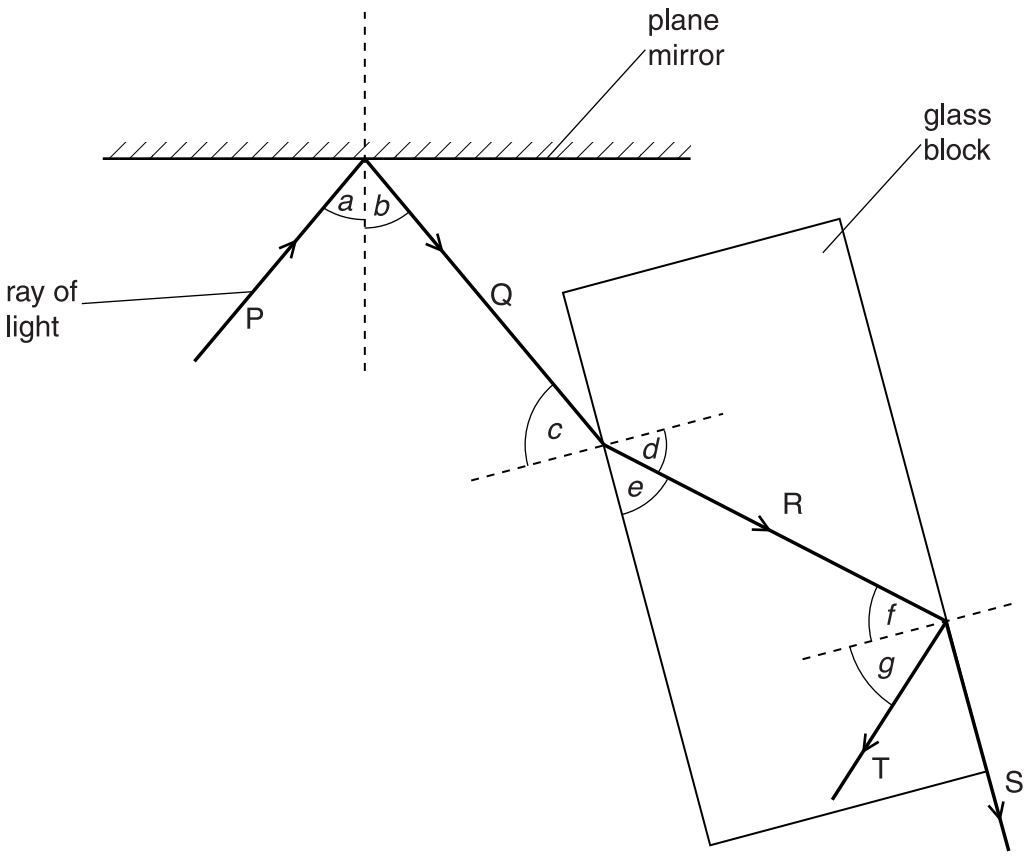


Fig. 8.2

Complete the table, using the labels from Fig. 8.2. The first label is done for you.

description	label
an angle of incidence	*a*
an angle of refraction	
an internally reflected angle	
a critical angle	
a refracted ray	

[4]

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(c) The student uses a converging lens to produce an image of an object. Fig. 8.3 shows the arrangement.

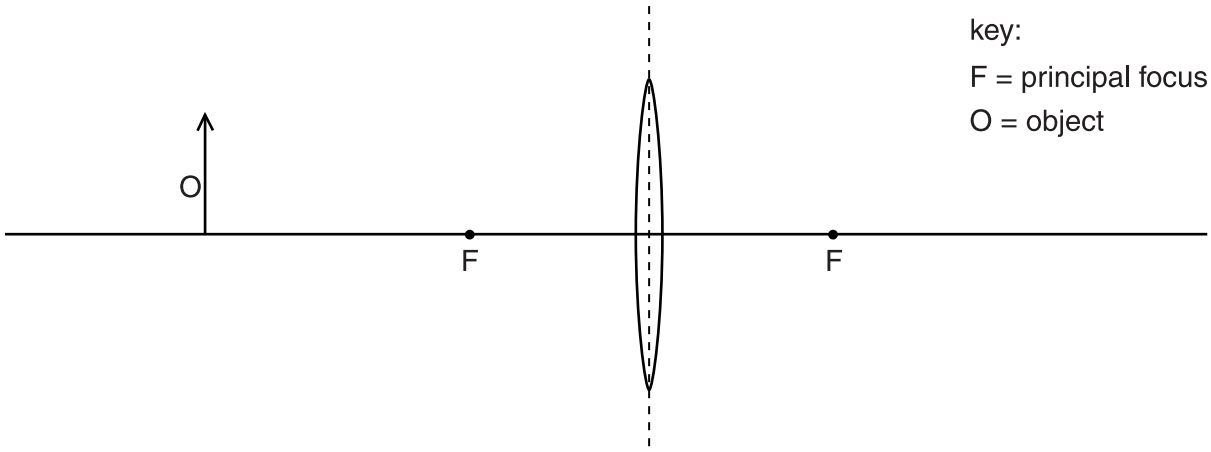


Fig. 8.3

On Fig. 8.3, using a ruler, carefully draw two rays from the object O to locate the position of the image. Use an arrow to represent the image. [3]

[Total: 9]

Lenses and ray diagrams Click for more variations

Reduced to 78% to fit the page (wider than A4).

4(a)(i)	normal	**B1**
4(a)(ii)	20°	**B1**
4(b)	d	**B1**
	g	**B1**
	f	**B1**
	R **OR** S	**B1**
4(c)	any two rays correctly drawn from top of O: ray parallel to axis, through lens, and beyond F ray undeviated through centre of lens and beyond ray through F, through lens, then parallel to axis	**M2**
	inverted image correctly drawn and positioned at intersection of two rays	**A1**
		Total: 9

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

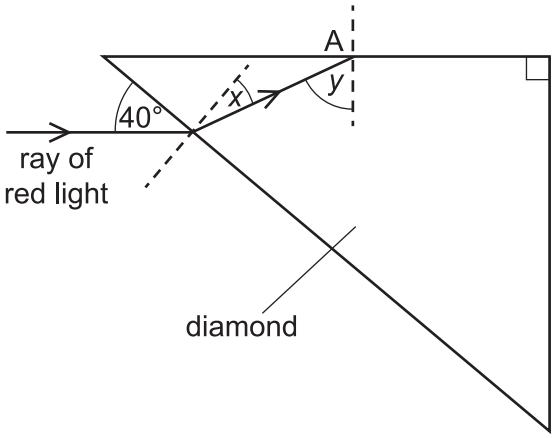


Fig. 7.1 (not to scale)

(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]

Refraction and total internal reflection Click for more variations

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5(a)	sin *i* / sin *r* = n in any form	**C1**
	r = 18°	**A1**
5(b)	light travelling from optically dense medium to optically less dense medium	**B1**
	all light reflected OR no light refracted	**B1**
	angle of incidence is greater than the critical angle	**B1**
5(c)	ray reflected at face AB with *i* = *r* by eye	**B1**
	ray refracted at face BC and bent away from the normal	**B1**

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6 **(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.

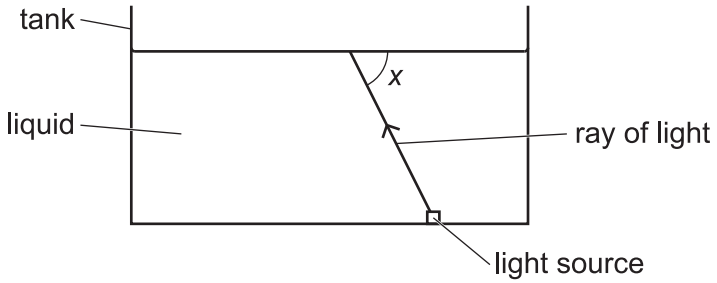


Fig. 7.1

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]

Refraction and total internal reflection Click for more variations

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6(a)	any **two** from: • all light is reflected • no light is refracted • (occurs) when light travels in a more dense medium towards a (boundary with a) less dense medium	**B2**
6(b)(i)	(x =) 48°	**A3**
	$n = 1 / \sin c$ **OR** $c = \sin^{-1}(1 / n)$ **OR** $\sin c = 1 / 1.5$ **OR** $c = \sin^{-1}(1 / 1.5)$	C1
	$c = 42(°)$	C1
6(b)(ii)	(speed =) 2.0×10^8 m / s	**A2**
	$n = \frac{\text{speed of light in vacuum}}{\text{speed of light in liquid}}$ **OR** $n = \frac{\text{(approx.) speed of light in air}}{\text{speed of light in liquid}}$ **OR** $n = c / v$ **OR** (v =) c / n **OR** $1.5 = \frac{3 \times 10^8}{\text{speed of light in liquid}}$	C1

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7 Fig. 6.1 is a full-scale diagram of a lens and an object O.

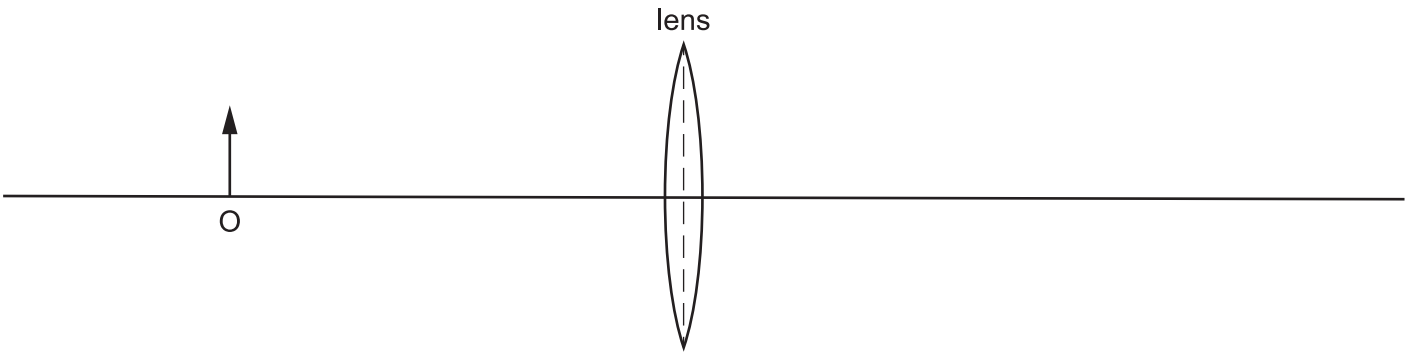


Fig. 6.1

(a) The focal length of the lens is 3.5 cm.

On Fig. 6.1, mark and label with the letter F the positions of the **two** principal focuses. [1]

(b) On Fig. 6.1, draw **three** rays to locate the image. Draw an arrow to represent the image and label the image I. [3]

(c) State **three** properties of the image I.

..... [2]

(d) A student incorrectly states that this lens is being used as a magnifying glass.

(i) State how the image produced by a magnifying glass is different from the image I.

..... [1]

(ii) The student moves the object O to a position P so that the lens shown in Fig. 6.1 acts as a magnifying glass.

On Fig. 6.1, mark a possible position for P. [1]

[Total: 8]

Lenses and ray diagrams Click for more variations

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7(a)	principal focuses marked in correct position	**B1**
7(b)	1 mark for each of: • 1 correct ray • 2nd correct ray • 3rd correct ray and image, labelled I, in correct position with arrow at bottom	**B3**
7(c)	real	**B1**
	inverted and enlarged	**B1**
7(d)(i)	(image produced by a magnifying glass is) upright OR NOT inverted OR virtual	**B1**
7(d)(ii)	position marked between principal focus and lens	**B1**

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8 Fig. 6.1 shows part of an optical fibre used in high-speed broadband communication.

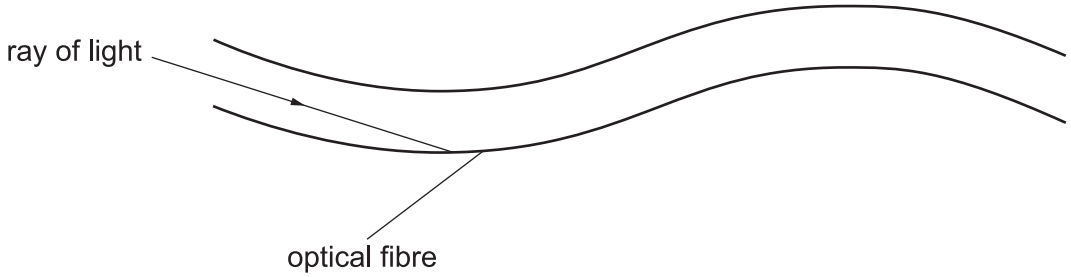


Fig. 6.1

(a) State **two** advantages of using optical fibres in high-speed data transmission compared to electrical signals sent on copper wires.

.....

..... [2]

(b) **(i)** The optical fibre is made of glass with a refractive index of 1.4.

Calculate the critical angle *c*.

c = ... [3]

(ii) State the meaning of critical angle.

.....

..... [1]

(iii) On Fig. 6.1, label the angle of incidence of the ray of light as it hits the wall of the glass fibre. Draw the continuation of the ray until it leaves the glass fibre. [2]

[Total: 8]

Refraction and total internal reflection Click for more variations

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8(a)	Any **two** from: • high rates (of data transmission) / faster (data transmission) • carry large amounts (of data / information) • secure • Little data / signal loss • glass is transparent to (some) infrared	**B2**
8(b)(i)	(c =) 46°	**A3**
	N = 1 / sin c, 1.4 = 1 / sin c **OR** (c =) $\sin^{-1}$ (1 / 1.4)	C1
	Equation in this form only (c =) $\sin^{-1}$ (1 / n) **OR** (c =) $\sin^{-1}$ (1 / 1.4) **OR** (c =) 46	C1
8(b)(ii)	angle of incidence (of light) at which the angle of refraction is (exactly) 90°	**B1**
8(b)(iii)	angle of incidence marked **AND** TIR of ray inside glass **AND** light ray leaves end of fibre after <u>two **or** three</u> reflections	**A2**
	angle of incidence marked **OR** TIR drawn until ray leaves end of fibre	C1

9 **(a)** Fig. 6.1 shows a converging lens and an object OX. The focuses of the lens are labelled F.

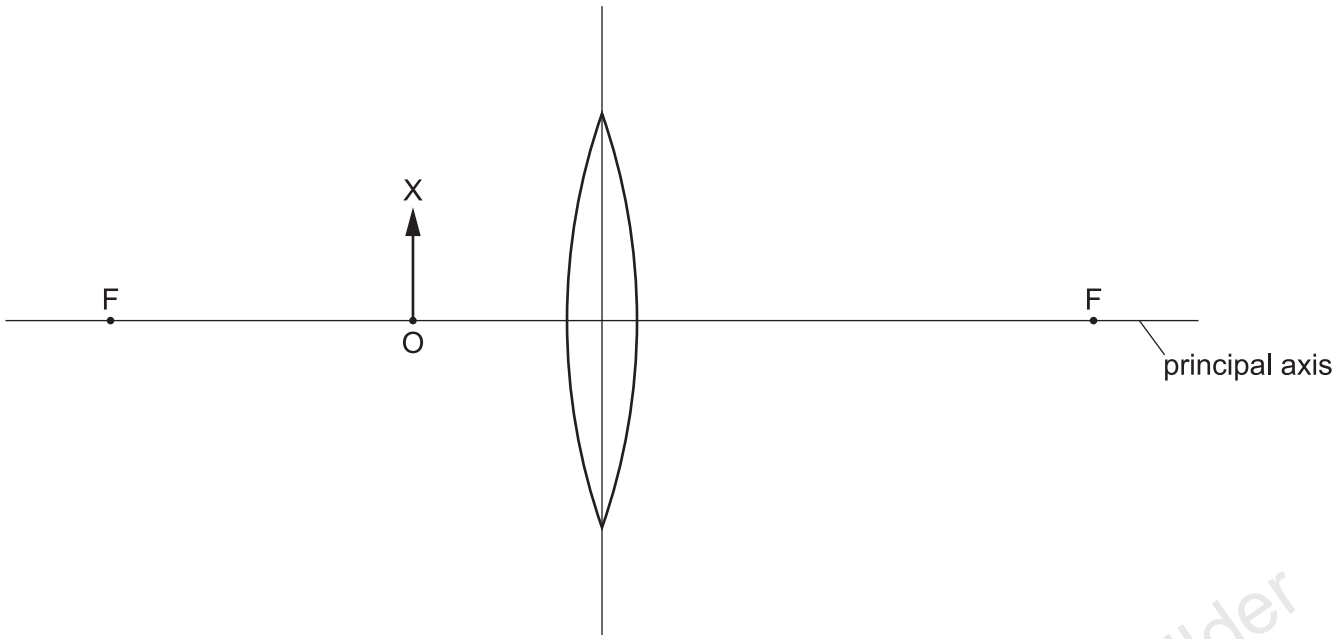


Fig. 6.1

(i) On Fig. 6.1, carefully draw **two** rays from X which locate the image of the object. Draw the image and label it IY.

Measure the distance from IY along the principal axis to the centre line of the lens.

distance = ...

[4]

(ii) State **two** reasons why the image IY is virtual.

1. .....

2. .....

[2]

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(b) Fig. 6.2 shows a ray of green light passing into, through and out of a glass prism.

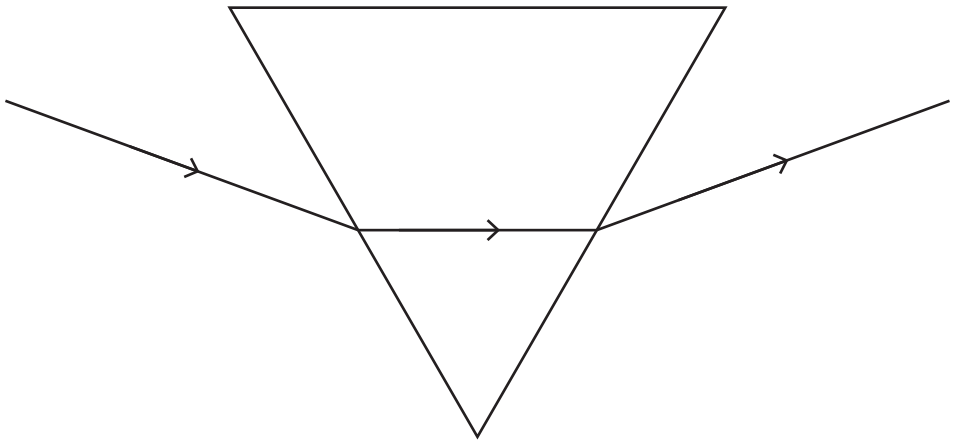


Fig. 6.2

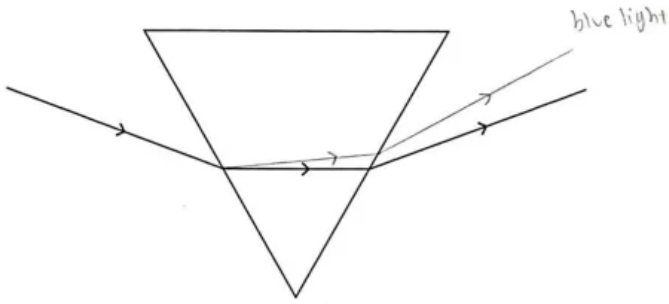
A ray of blue light is incident on the prism on the same path as the incident ray of green light.

On Fig. 6.2, draw the path of the blue light through and out of the prism. [3]

[Total: 9]

Lenses and ray diagrams Click for more variations

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9(a)(i)	*two correct rays from*: • ray from X through centre of lens • ray from X to lens, parallel to principal axis, refracted through RH focus F • ray from X (that would pass through LH focus) refracted parallel to principal axis.	**M2**
	two rays correctly extended back, intersecting to left of object and image labelled	**A1**
	IY drawn **AND** 36 mm ≤ distance ≤ 44 mm	**A1**
9(a)(ii)	*any two from:* • object closer to lens than (one) focal length • (actual) rays do not meet (at image) • image cannot be formed on a screen **OR** image only visible through lens • object and image on same side (of lens) **OR** image on LHS of lens/object.	**B2**
9(b)		**A3**
	blue ray refracted <u>closer</u> to the normal than the green ray as it enters the prism	C1
	blue ray refracted away from the normal as it leaves the prism	C1

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10 A student investigates the reflection of light by a plane mirror.
The student's ray-trace is shown full-size in Fig. 1.1.

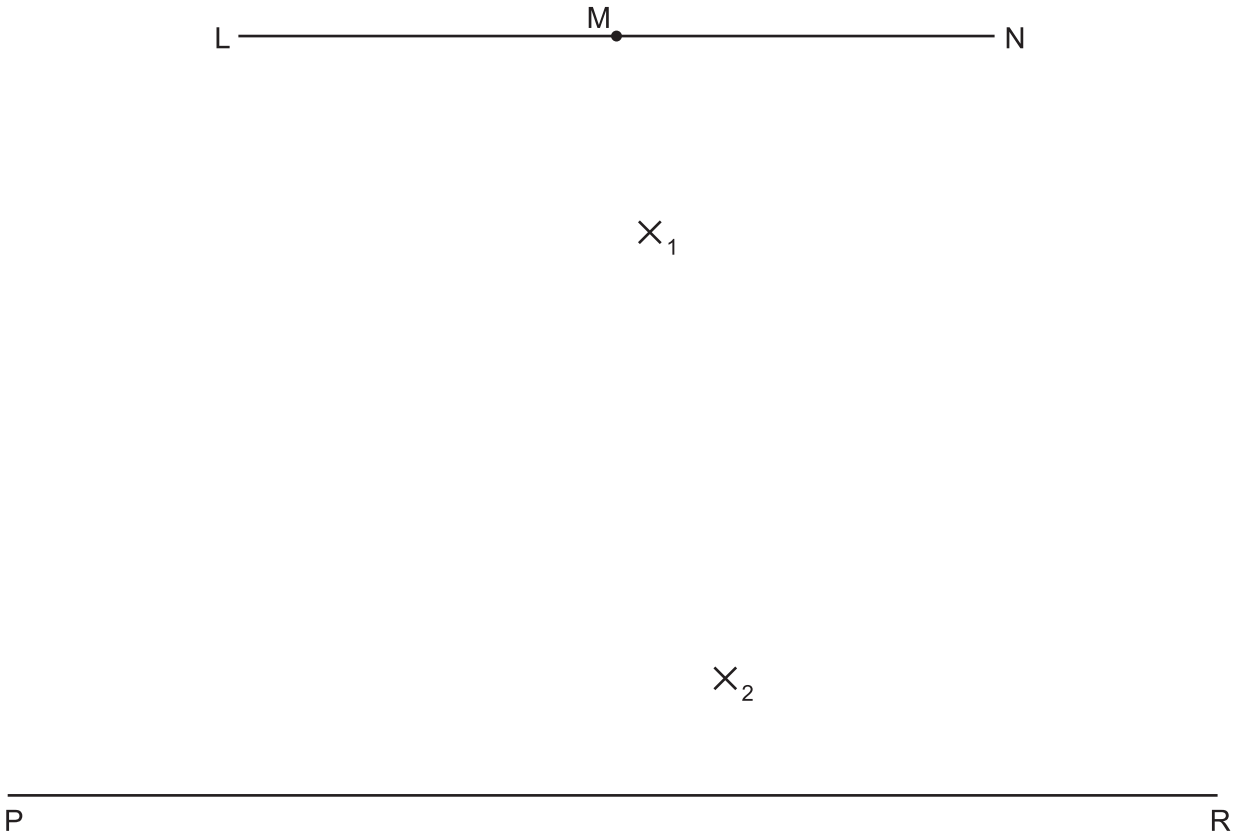


Fig. 1.1

(a) The student:

- draws line **LN**
- labels the mid-point of **LN** with the letter **M**
- draws a line **PR** parallel to **LN** and 10.0 cm below it

On Fig. 1.1, draw a normal to **LN** at the point **M**. Extend the normal downwards until it crosses the line **PR**. Label the point at which the normal crosses **PR** with the letter **Q**. [1]

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(b) On Fig. 1.1, draw a line 14.0 cm long from point **M** at an angle $\theta = 10°$, as shown in Fig. 1.2. Label the other end of the line **O**. [2]

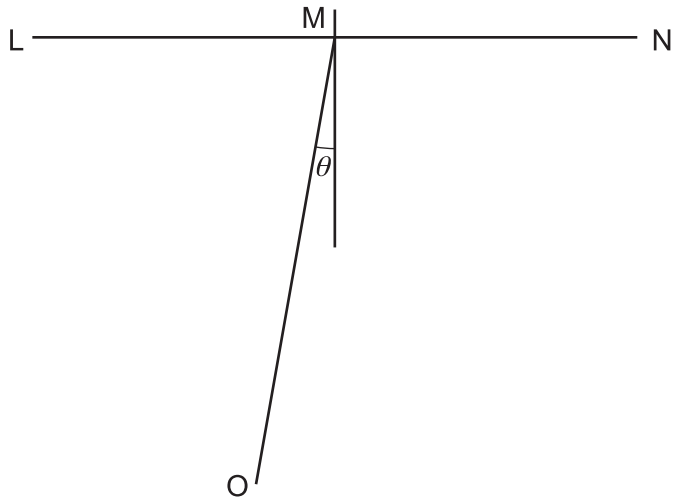


Fig. 1.2

(c) The student:

- places the reflecting surface of a mirror along the line **LN**, with its reflecting surface facing the bottom of the page, and with the centre of the mirror at **M**
- positions a light source and slit so that a ray of light passes along the line **OM** towards **M**
- marks two small crosses X_1 and X_2, a suitable distance apart on the ray reflected from the mirror
- removes the mirror and the illuminated slit.

(i) On Fig. 1.1, draw a line joining **M** to X_1 and X_2.

Continue the line until it crosses the line **PR** and label the point where it crosses **PR** with the letter **T**. [1]

(ii) Measure the length *a* of the line **QT** in centimetres to the nearest millimetre and the length *b* of the line **MT** in centimetres to the nearest millimetre. Record your measurements below and in Table 1.1.

a = ... cm

b = ... cm
[1]

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(d) Calculate the ratio $r = \frac{a}{b}$. Record your answer in Table 1.1.

Give your answer to 2 significant figures.

Table 1.1

θ / °	a / cm	b / cm	$r = \frac{a}{b}$
10			
20	4.2	12.8	0.33
30	6.8	13.7	0.50

[2]

(e) The student repeats the procedure in **(b)** and **(c)** for values of $\theta = 20°$ and $\theta = 30°$.

The student's results are recorded in Table 1.1.

The student states that r is directly proportional to θ.

State if you agree with the student.

Use values from Table 1.1 to justify your answer.

statement .....

justification .....

.....

.....

[2]

(f) Suggest what the student can do to have more confidence in their answer to part **(e)**.

.....

.....

..... [1]

(g) Suggest **one** source of inaccuracy in this experiment, even if it is carried out very carefully.

.....

..... [1]

[Total: 11]

Refraction and total internal reflection Click for more variations

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10(a)	normal correct (by eye), extended to cross PR and Q labelled	**1**
10(b)	$\theta = 10° \pm 1°$ and end of line labelled O MO = 14.0 ± 0.2 cm	**2**
10(c)(i)	line joining M to the crosses, continued to cross PR	**1**
10(c)(ii)	a = 1.7 ± 0.1 cm b = 10.3 ± 0.1 cm	**1**
10(d)	r correct answer to 2 significant figures	**2**
10(e)	statement to match results (expect YES) values from table used to justify statement	**2**
10(f)	extend the investigation for different values of θ	**1**
10(g)	reflecting surface of the mirror is at the back/thickness of mirror/small variations in protractor angle have a much larger effect on a and b/ thickness of light ray/difficult to locate centre of light ray/experiment not done in a dark room	**1**

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