www.megalecture.com · www.youtube.com/@megalecture

Online tutoring for Cambridge IGCSE, O Level & A Level Physics

IGCSE PHYSICS 0625 · TOPICAL PAST PAPERS

Light

Paper 2 — Theory / Structured Questions (topical compilation)

Fahad H. Ahmad

Contact: +92 323 509 4443

M.Eng NUS Singapore · B.Eng NUST · 15+ years of teaching experience in Singapore, UAE & Pakistan · 60,000+ subscribers and 20 million+ video lecture views.

1 Fig. 2.1 shows the lens of a simple camera being used to photograph an object.

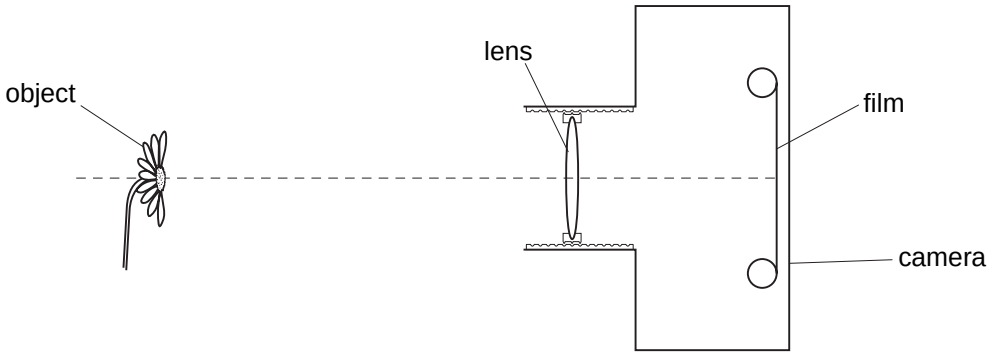

Fig. 2.1

The lens forms a focused image of the object on the film.

(a) Draw two rays from the top of the object to show how the lens forms the image. [2]

(b) The object moves closer to the camera. State how the lens is adjusted to keep the image in focus.

.....

.....

..... [1]

(c) Complete Fig. 2.2 to show how white light is split into a spectrum when it passes through a glass prism. [3]

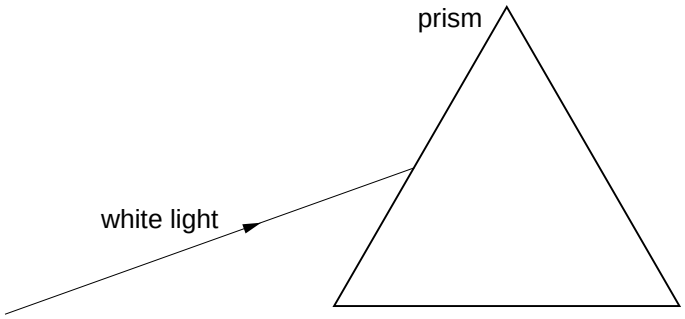

Fig. 2.2

5054/02/M/J/05/Q2

2 Fig. 4.1 and Fig. 4.2 show rays of light passing through the same semi-circular block of plastic.

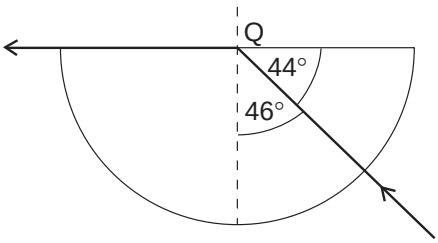

Fig. 4.1

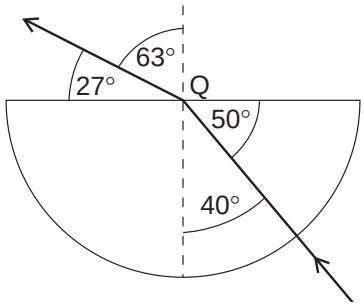

Fig. 4.2

Q is the centre of the straight side of the block.

(a) State the value of the critical angle in the plastic.

critical angle = ... [1]

(b) Explain what is meant by the *critical angle*.

.....

.....

.....

..... [2]

(c) Calculate the refractive index of the plastic. State the formula that you use.

refractive index = ... [3]

(d) Some light reflects back into the plastic at Q.

On Fig. 4.1, draw the reflected ray at Q. [1]

5054/02/M/J/06/Q4

3 Fig. 4.1 shows part of an optical fibre.

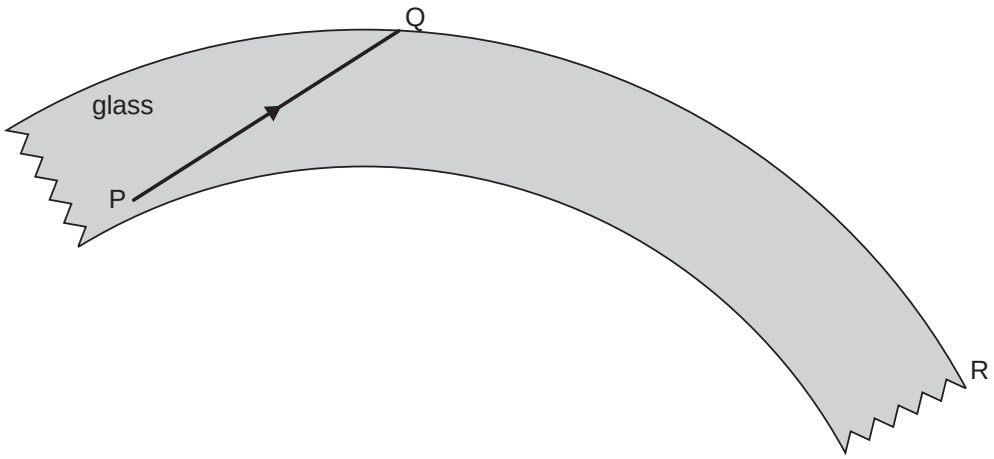

Fig. 4.1

The ray PQ undergoes total internal reflection in the optical fibre.

(a) On Fig. 4.1, continue the path of ray PQ until it reaches end R. [1]

(b) Explain what is meant by *total internal reflection*.

.....

.....

..... [1]

(c) Optical fibres are cheaper and lighter than copper wires. State one other advantage of using optical fibres rather than copper wires for telephone communications.

.....

.....

..... [1]

(d) The light in the optical fibre is travelling at a speed of 2.1×10^{8} m/s and has a wavelength of 6.4×10^{-7} m.

Calculate the frequency of the light.

frequency = ... [2]

5054/02/M/J/07/Q4

4 Fig. 5.1 is drawn full scale. The focal length of the lens is 3.0 cm.

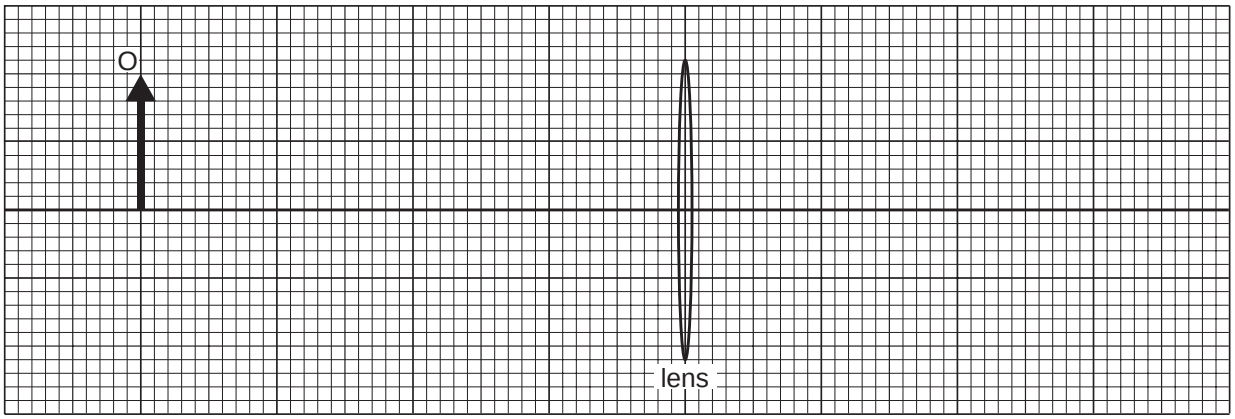

Fig. 5.1

(a) On Fig. 5.1, draw two rays from the top of the object O that meet at the image. [2]

(b) **(i)** Define the term *linear magnification*.

.....

.....

..... [1]

(ii) Determine the magnification produced by the lens in Fig. 5.1.

magnification = ... [1]

(c) Fig. 5.2 shows a normal eye viewing an object close to it. Fig. 5.3 is a long-sighted eye viewing an object at the same distance.

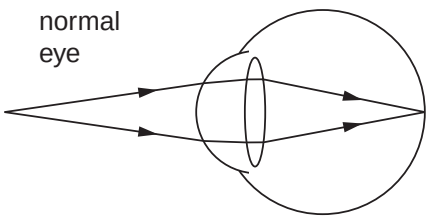

Fig. 5.2

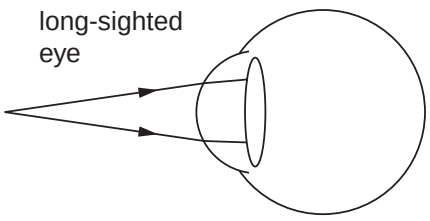

Fig. 5.3

Complete Fig. 5.3 to show the rays travelling through the eye. [1]

5054/02/M/J/07/Q5

5 Fig. 5.1 shows a man looking at his reflection in a rectangular plane mirror.

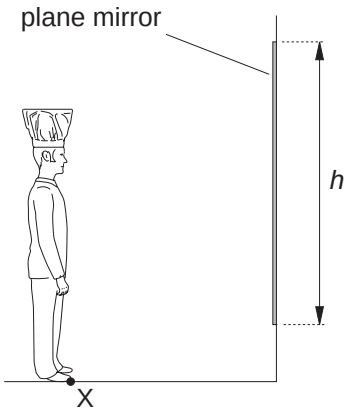

Fig. 5.1

The vertical side of the mirror has length *h*.

(a) **(i)** On Fig. 5.1, draw a ray of light from point X that is reflected by the mirror to the man's eye. [1]

(ii) On Fig. 5.1, mark the angle of incidence of your ray at the mirror.

Label this angle *i*. [1]

(iii) Define the *angle of incidence*.

.....

.....

..... [1]

(b) On Fig. 5.1, draw a ray of light from the top of the man's hat that is reflected by the mirror to his eye.

Use your rays to determine the smallest value of *h* that allows the man to see all of the image in the mirror, from the top of his hat to his toes.

On the diagram, 1 cm represents 0.5 m.

h = ... [2]

5054/02/M/J/09/Q5

6 Fig. 5.1 shows a ray of white light incident on a glass prism.

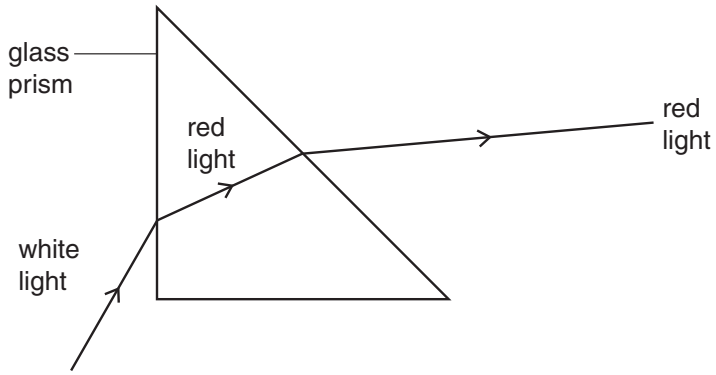

Fig. 5.1

Fig. 5.1 is not complete; it shows only the ray of red light produced from the white light.

(a) **(i)** On Fig. 5.1, draw the ray of blue light produced in, and beyond, the prism. [2]

(ii) State **two** colours of the spectrum found between the red and blue rays.

.....[1]

(b) Fig. 5.2 shows the same prism with the ray of white light incident at a different angle.

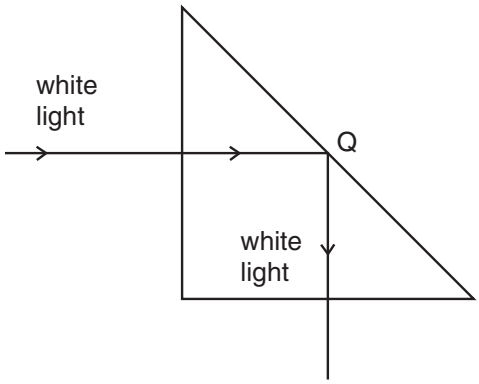

Fig. 5.2

Fig. 5.2 is complete; no spectrum is produced.

(i) Explain why no light emerges from the prism at Q.

.....

.....[1]

(ii) Explain why no spectrum is produced.

.....

.....[1]

5054/21/M/J/10/Q5

7 Fig. 5.1 shows a ray of light entering a semi-circular glass block and striking the glass surface at M, the mid-point of the straight face.

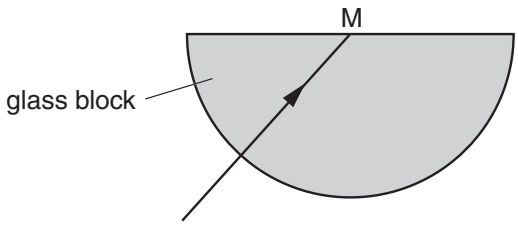

Fig. 5.1

(a) The ray of light strikes the glass surface at M with an angle of incidence *C* equal to the critical angle of light in glass.

(i) State what is meant by *critical angle*.

.....

..... [1]

(ii) On Fig. 5.1, mark and label the angle *C*. [1]

(iii) On Fig. 5.1, continue the ray of light after it strikes the glass surface at M. [1]

(b) Fig. 5.2 shows a second ray of light striking M.

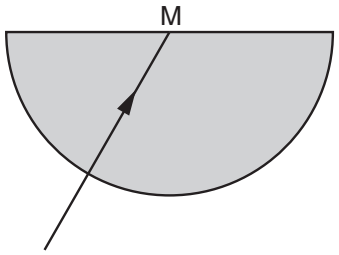

Fig. 5.2

This ray has an angle of incidence at M smaller than the critical angle.
On Fig. 5.2, continue this ray of light after it strikes the glass surface at M. [1]

(c) The refractive index of this glass is 1.5. A third ray of light enters the block from air with an angle of incidence of 50°. Calculate the angle of refraction.

angle= ..... [2]

5054/22/M/J/10/Q5

12

8 **(a)** Describe an experiment to measure the critical angle for light in glass or perspex.

Your answer should include a labelled diagram.

.....

.....

.....

.....

.....

.....

.....

.....[5]

(b) Fig. 10.1 represents a simple camera.

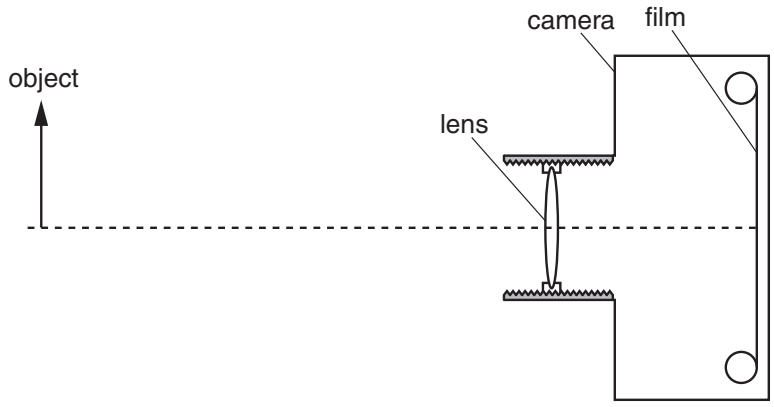

Fig. 10.1 (to scale)

(i) State the type of lens used in this simple camera.

.....[1]

(ii) Draw two rays from the top of the object to show how the image is formed on the film. Mark and label the image on the film. [3]

(iii) Define the term *linear magnification*.

.....

.....[1]

(iv) Fig. 10.1 is drawn to scale. Determine the linear magnification of the object shown in Fig. 10.1.

magnification = ...[1]

(v) Apart from its size, state one other property of the image formed by the lens.

.....[1]

(vi) Explain why, when taking photographs of other objects, it may be necessary to move the lens towards the film.

.....

.....

.....

.....[3]

5054/22/M/J/11/Q10

9 (a) Fig. 10.1 shows the path of a ray of blue light as it passes through a glass prism.

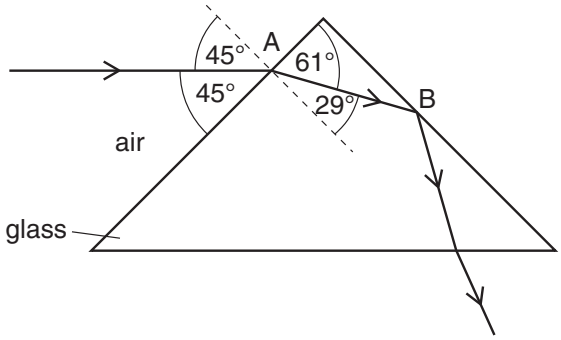

Fig. 10.1

(i) State the wave term used to describe what happens to the ray of light at A.

.....[1]

(ii) Using angles from Fig. 10.1, calculate the refractive index of the glass.

refractive index = ...[3]

(iii) Explain why the ray does not emerge from the prism at B.

.....

.....[2]

(iv) Fig. 10.2 shows a second, horizontal, ray of blue light striking the prism at point C.

On Fig. 10.2, continue the path of the second ray through and out of the glass prism. [2]

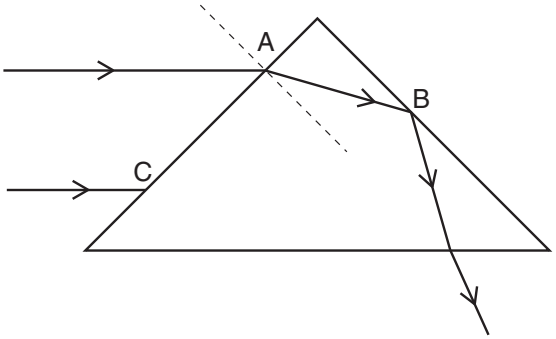

Fig. 10.2

(b) The camera lens shown in Fig. 10.3 is used to photograph the object O.

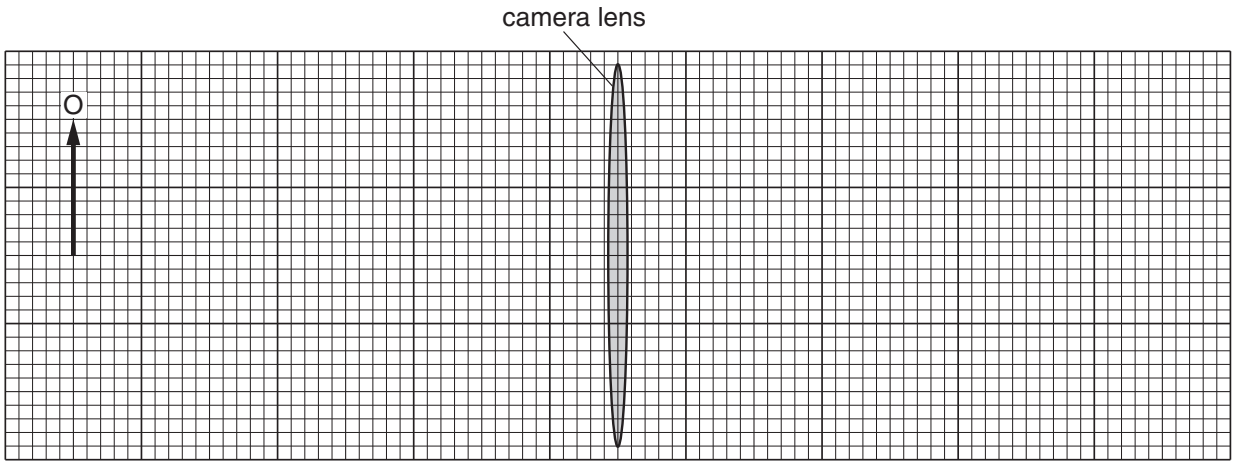

Fig. 10.3 (full scale)

The object O is 2.0 cm high and is placed 8.0 cm from the centre of the lens. The lens has a focal length of 3.0 cm.

(i) Draw rays on Fig. 10.3 to find the position and height of the image formed by the lens. Label the image I. [3]

(ii) Determine the height of the image.

.....[1]

(iii) The image formed by the lens is a real image.

1. Explain the difference between a real image and a virtual image.

.....

.....

.....[1]

2. Explain how a converging lens is used to produce and view a virtual image.

.....

.....

.....

.....[2]

5054/21/M/J/12/Q10

10 Optical fibres are used to transmit telephone signals. Fig. 5.1 shows a ray of light that strikes the inside surface of an optical fibre at P.

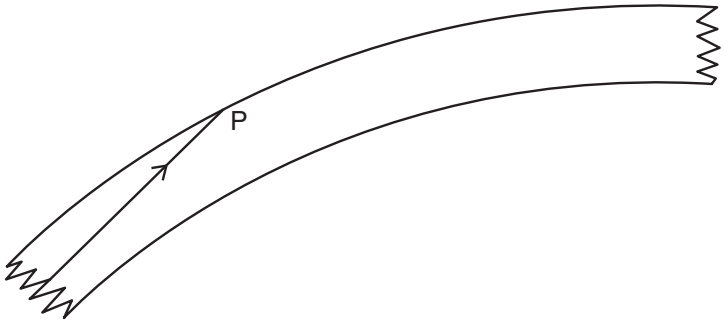

Fig. 5.1

(a) State one advantage of using optical fibres to transmit telephone signals.

.....

.....[1]

(b) **(i)** On Fig. 5.1, draw a normal at P and mark the angle of incidence with the letter *i*. [1]

(ii) State and explain what happens to the ray at P. Use the term *critical angle* in your answer.

.....

.....

.....[2]

(c) The optical fibre is made of glass of refractive index 1.5.
At the start of the optical fibre, the ray enters the glass from air.
The angle of incidence in the air is 60°.

Calculate the angle of refraction in the glass.

angle = ...[2]

5054/22/M/J/12/Q5

11 Fig. 5.1 shows a ray of light that enters a semicircular glass block at A.
At B, some of the light is reflected and some light leaves the glass and travels along the surface.

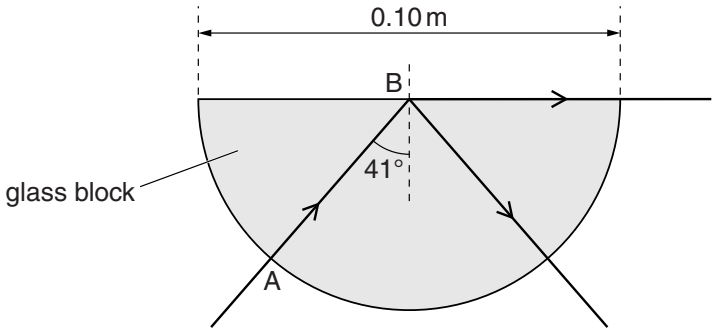

Fig. 5.1

(a) State the name of the angle of incidence marked 41°.

.....[1]

(b) Rays of light are incident at B with different angles of incidence.

(i) On Fig. 5.2a, the angle i_1 is less than 41°.
Draw the path taken by the ray of light after B.

(ii) On Fig. 5.2b, the angle i_2 is greater than 41°.
Draw the path taken by the ray of light after B.

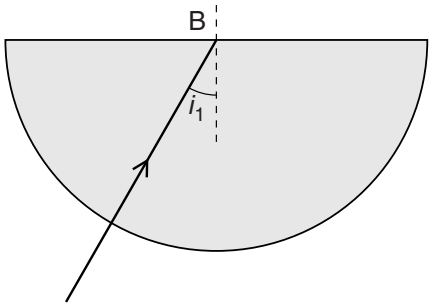

Fig. 5.2a

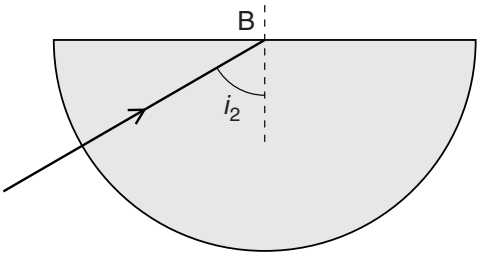

Fig. 5.2b [2]

(c) The speed of light in the glass block is 2.0×10^8 m/s.
The diameter of the glass block is 0.10 m.

Calculate the time taken for the light to travel from A to B.

time = ...[2]

5054/21/M/J/13/Q5

12 A student traces the path of a ray of blue light as it enters and as it leaves a glass prism. Fig. 10.1 shows the trace obtained by the student.

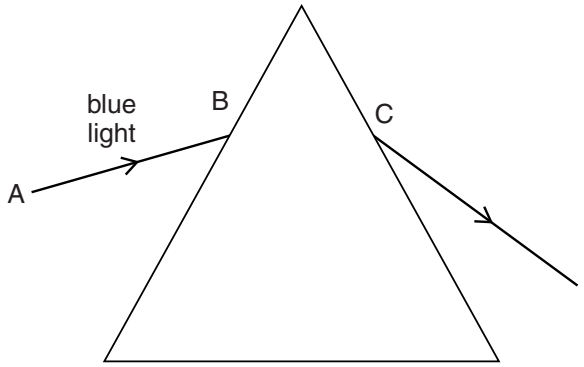

Fig. 10.1

(a) On Fig. 10.1, draw and label, at the point B, the normal, the angle of incidence *i* and the angle of refraction *r*. [3]

(b) State, in terms of the properties of light waves, why the light refracts at B.

.....

..... [1]

(c) The angle of incidence for the ray of blue light at B is 45°. The refractive index of the glass is 1.5. Calculate the angle of refraction at B.

angle of refraction = ... [3]

(d) The student performs another experiment with a ray of red light along the line AB.

On Fig. 10.1, show the path taken by this ray of light as it passes through and leaves the prism. [2]

(e) The student performs another experiment with a semicircular glass block and a ray of white light. Fig. 10.2 shows the path taken by this ray of light as it enters the glass at P until it hits the straight edge at Q.

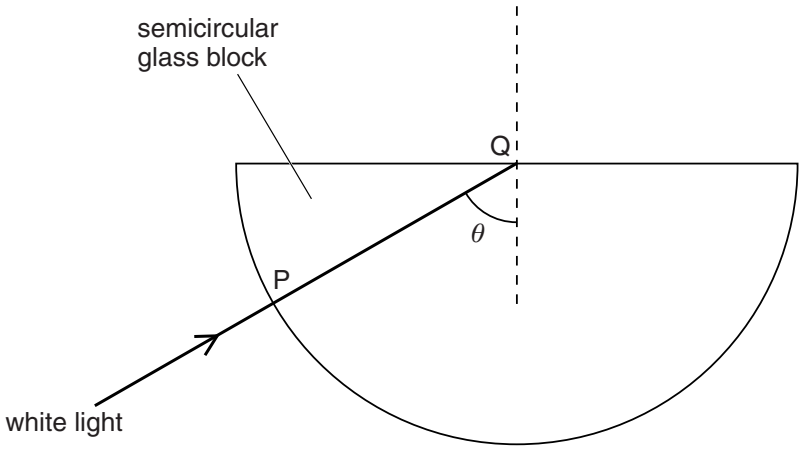

Fig. 10.2

The student finds that there is no change in direction as the ray enters the glass at P and that no light passes out of the glass at Q.

(i) Explain why the ray does not change direction at P.

.....

..... [1]

(ii) Explain why no light passes out of the glass at Q.

.....

.....

..... [2]

(iii) On Fig. 10.2, draw the complete path followed by this ray. [1]

(iv) The student directs the ray of white light into the glass along different paths, so that the angle θ is slowly reduced.

Describe what happens to the ray at Q.

.....

.....

..... [2]

5054/22/M/J/13/Q10

13 A collector views a postage stamp of height 1.5 cm through a lens. The lens is 2.0 cm from the stamp. The image has a linear magnification of 3.0.

The stamp, the image of the stamp and the position of the lens are shown full scale in Fig. 3.1.

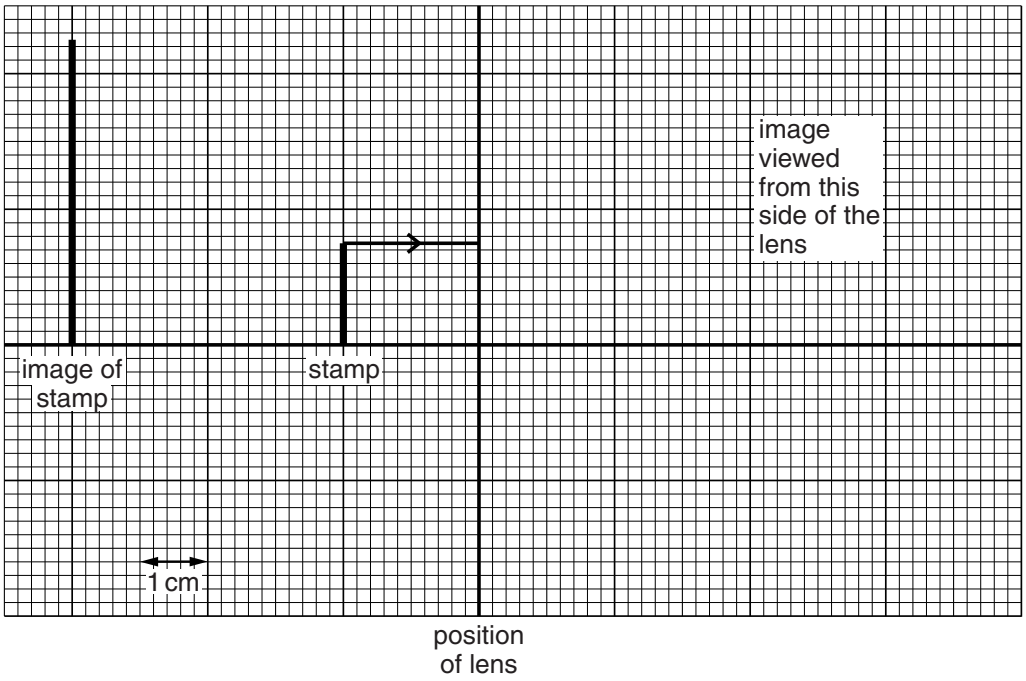

Fig. 3.1 (full scale)

A ray of light from the top of the stamp to the lens is shown on Fig. 3.1.

(a) State the type of lens used.

..... [1]

(b) State what is meant by *linear magnification*.

.....

..... [1]

(c) **(i)** On Fig. 3.1, complete the path of the ray from the top of the stamp after it passes through the lens. [1]

(ii) Use your drawing to determine the focal length of the lens.

..... [1]

(iii) On Fig. 3.1, draw two additional rays from the top of the stamp to show how the image is formed. [1]

5054/21/M/J/14/Q3

14 Visible light, radio waves, X-rays, gamma rays and microwaves are some of the components of the electromagnetic spectrum.

(a) State two other components of the electromagnetic spectrum.

1. .....

2. .....
[1]

(b) White light is a mixture of different colours.

Fig. 5.1 shows a ray of white light entering a glass prism.

The white light separates into a number of colours. Only the blue light and the red light are shown.

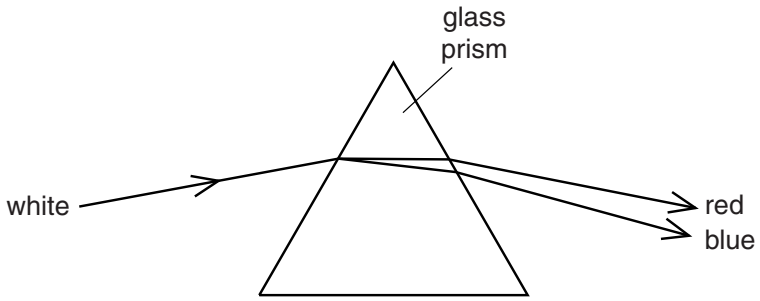

Fig. 5.1

Explain why the blue light and the red light separate as shown.

Use the term *refractive index* in your answer.

.....

.....

.....

.....

..... [3]

5054/22/M/J/14/Q5

15 **(a)** A beam of parallel light strikes a converging lens of focal length 2.8 cm.

The width of the beam before it reaches the lens is 1.0 cm. The width changes on the other side of the lens.

State a distance from the lens where the width of the beam is

(i) less than 1.0 cm,

..... [1]

(ii) more than 1.0 cm.

..... [1]

(b) An object is placed 3.0 cm from a converging lens of focal length of 2.8 cm. Fig. 6.1 is an incomplete, full-scale ray diagram for this arrangement.

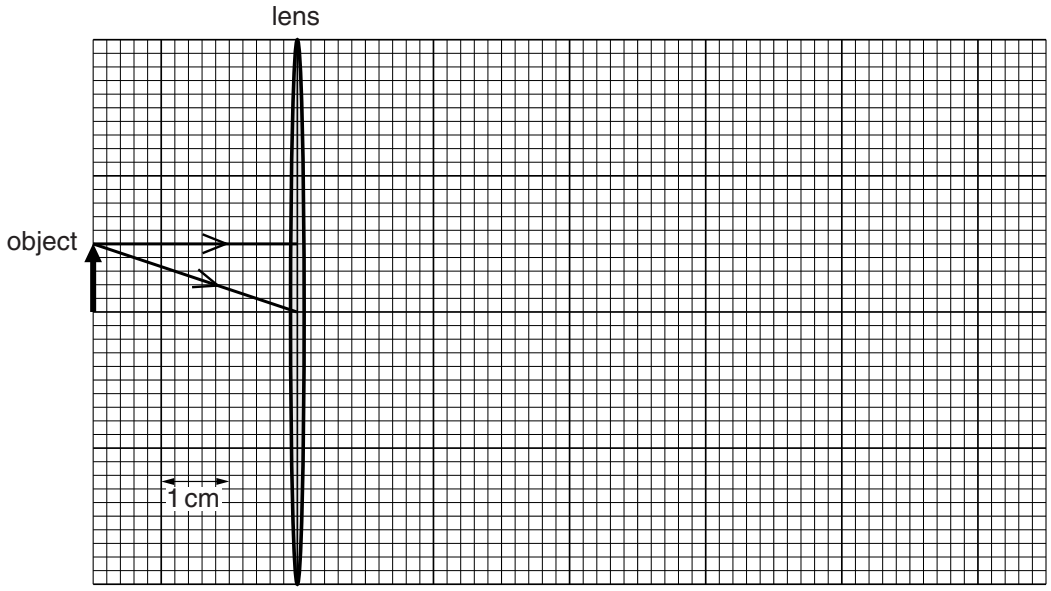

Fig. 6.1 (full scale)

(i) On Fig. 6.1, draw the paths of the two rays after they pass through the lens. [2]

(ii) Explain how your ray diagram shows that the image is more than 11 cm from the lens.

.....

..... [1]

(iii) Underline **three** of the following words which describe the image.

diminished inverted magnified real upright virtual [1]

5054/22/M/J/14/Q6

16 Fig. 5.1 shows a ray of light entering and passing along an optical fibre.

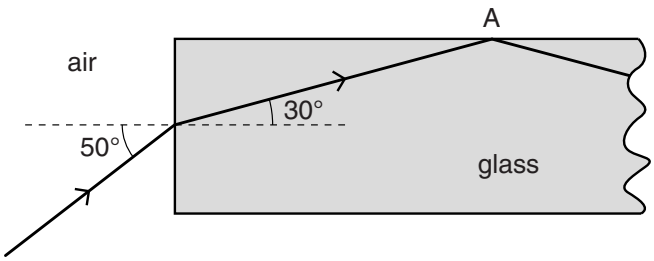

Fig. 5.1

(a) Calculate the refractive index of the glass in the optical fibre.

refractive index = ...[2]

(b) Explain why the ray of light is totally internally reflected at A.

.....

.....

.....[2]

(c) Both optical fibre and copper wire are used to transmit data.

Optical fibre is cheaper and can carry more data per second than copper wire.

State one other advantage of using optical fibre rather than copper wire to transmit data.

.....

.....[1]

5054/21/M/J/15/Q5

17 **(a)** Explain what is meant by *critical angle*.

.....

.....

.....

.....[2]

(b) Diamonds are attractive because of their ability to reflect light. The critical angle for diamond in air is 24°.

(i) Calculate the refractive index of diamond.

refractive index = ...[2]

(ii) Fig. 6.1 shows two diamonds of different shapes. A ray of light enters each diamond, as shown.

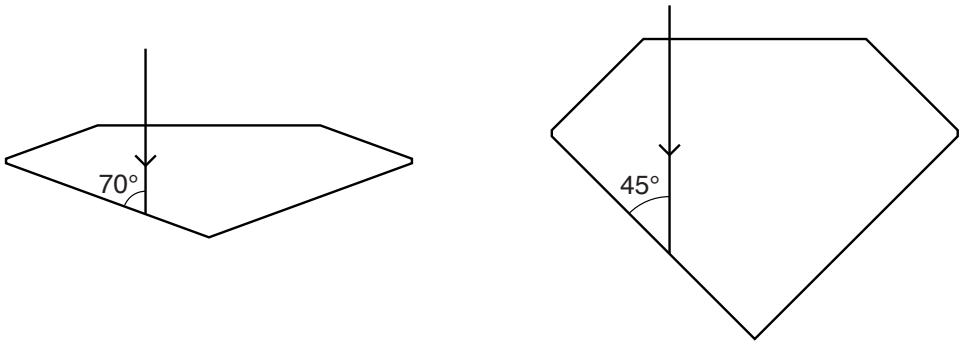

Fig. 6.1

On Fig. 6.1 continue the path of each ray of light until it emerges into the air. [3]

5054/21/M/J/16/Q6

18 A person can focus clearly on objects that are far away, but near objects appear blurred.

Fig. 5.1 shows three rays from a point on a near object as they pass through the person's eye. The refraction of the light as it enters the eye is ignored.

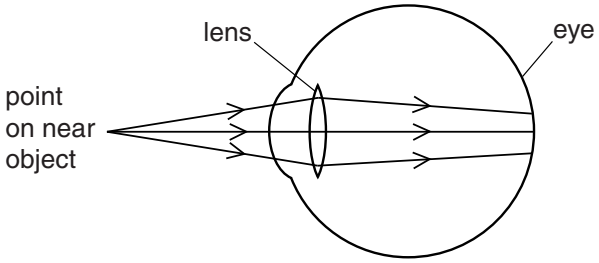

Fig. 5.1

(a) (i) State the name of the eye defect shown in Fig. 5.1.

.....[1]

(ii) Explain what causes the image of the near object to appear blurred.

.....

.....

.....[2]

(b) A lens is used to correct the defect.

(i) On Fig. 5.2, draw a suitable lens placed in front of the eye and continue the path of the three rays to the back of the eye.

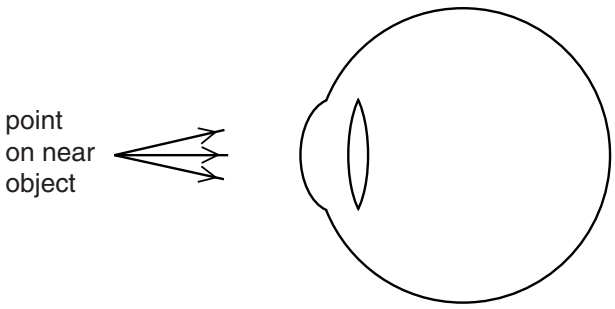

Fig. 5.2 [2]

(ii) State what type of lens is used.

.....[1]

5054/22/M/J/16/Q5

19 Fig. 4.1 shows a converging lens, an object O and the image I produced by the lens.

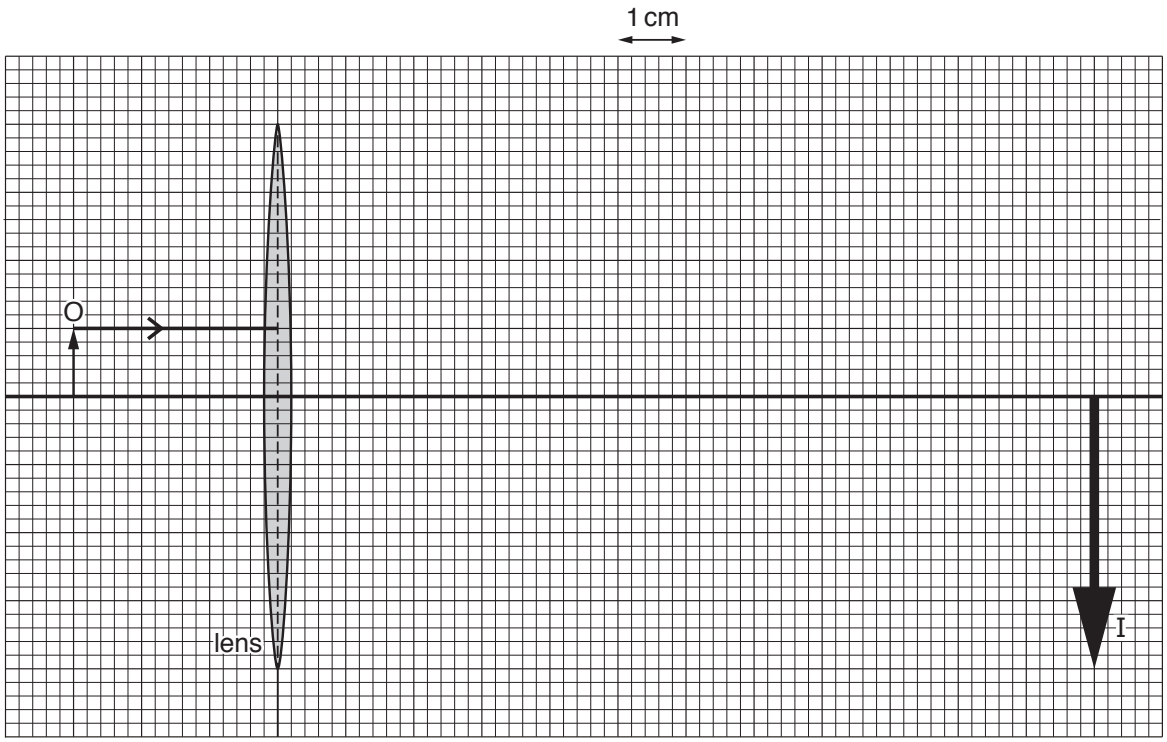

Fig. 4.1

(a) The image formed is real and has a linear magnification of 4.0.

(i) Define the term *linear magnification*.

.....

.....[1]

(ii) Explain what is meant by *real image*.

.....

.....[1]

(b) On Fig. 4.1 a horizontal ray has been drawn from the top of the object to the lens.

(i) Continue this ray until it meets the image.

(ii) Using Fig. 4.1, determine the focal length of the lens.

focal length = ...

(iii) Draw another two rays from the top of the object to show how the image is formed.

[3]

5054/21/M/J/17/Q4

20 **(a)** Fig. 10.1 shows two rays from an object that is placed in front of a plane mirror.

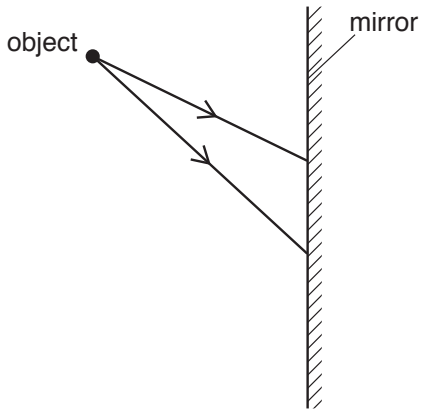

Fig. 10.1

(i) On Fig. 10.1, draw the two reflected rays and locate the position of the image. [2]

(ii) Apart from its position, state one characteristic of the image.

.....[1]

5054/21/M/J/17/Q10

21 Fig. 9.1 shows a man in a room looking into a mirror, as viewed from above.

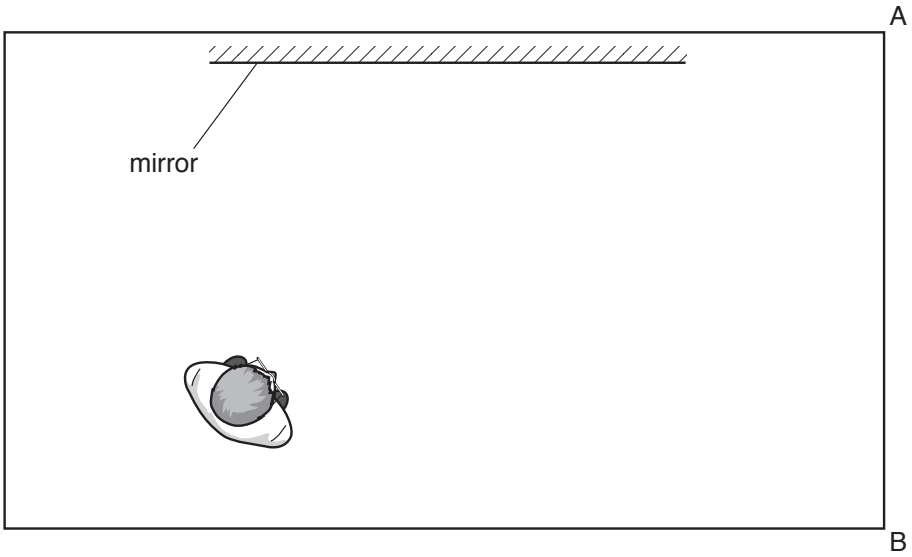

Fig. 9.1

(a) The man can see an image of part of the wall AB in the mirror.

Point C is the point on the wall closest to A that the man can see by reflection in the mirror. This point is not marked on Fig. 9.1.

(i) On Fig. 9.1, find point C and draw a ray of light from C which enables the man to see the image of C. [2]

(ii) On the ray that you have drawn on Fig. 9.1, label the angle of incidence *i* and the angle of reflection *r*. [2]

(iii) One characteristic of the image formed by the mirror is that it is virtual.

1. Explain what is meant by a *virtual* image.

.....

.....

.....[2]

2. State one other characteristic of an image formed by a plane mirror.

.....

.....[1]

(b) Light travels along optical fibres by total internal reflection.

(i) State two differences between total internal reflection and reflection in a mirror.

1. .....

.....

2. .....

.....
[2]

(ii) The critical angle for light travelling from the material of the fibre to air is 44°.

Calculate the refractive index of the material in the fibre.

refractive index = ...[2]

(iii) Light enters the optical fibre from air with an angle of incidence of 50°.

Calculate the angle of refraction.

angle of refraction = ...[2]

(iv) Optical fibres are used in telecommunications to send large amounts of data.

Pulses of light travel at almost the same speed along a fibre as electrical pulses travel along a metal wire.

State two advantages of using optical fibres rather than wires for transmitting data.

1. .....

.....

2. .....

.....
[2]

5054/22/M/J/17/Q9

22 **(b)** The glass prism in Fig. 9.1 is used to split white light from the Sun into different colours.

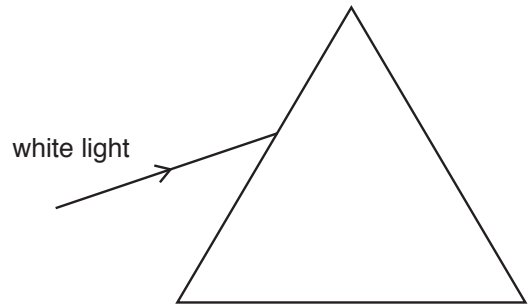

Fig. 9.1

(i) Draw, on Fig. 9.1, to show the action of the prism on the light as it passes through the prism. [3]

(ii) Explain why the prism splits white light into different colours.

.....

.....

.....

.....[2]

(c) The Earth is 1.5×10^8 km from the Sun.

(i) State the speed of light in a vacuum.

.....[1]

(ii) Calculate the time taken for light to travel from the Sun to the Earth.

time = ...[2]

5054/21/M/J/18/Q9

23 A converging lens has a focal length of 3.0 cm. An object of height 2.0 cm is placed 5.0 cm from the centre of the lens. Fig. 6.1 shows the arrangement of the object and the lens.

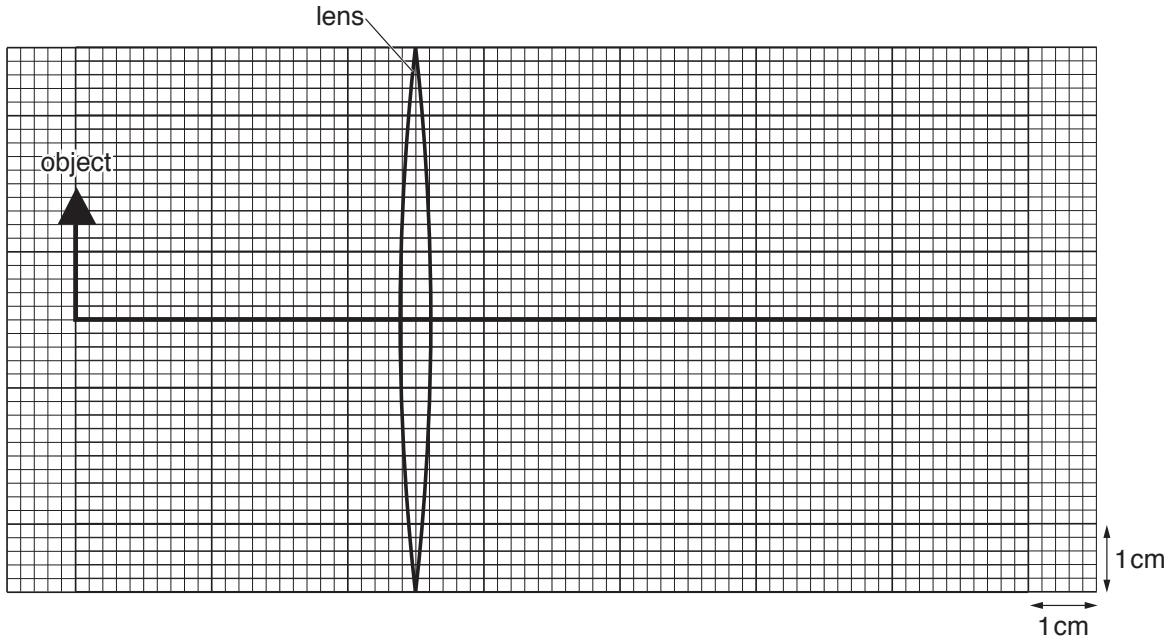

Fig. 6.1 (to scale)

(a) On Fig. 6.1, draw rays from the top of the object to show how the lens forms an image of the object. Mark the image clearly. [2]

(b) The image is magnified. State **one** other feature of the image.

.....[1]

(c) Calculate the linear magnification produced by the lens in this case.

magnification = ... [2]

(d) State the name of **one** optical device that produces a magnified image as shown by Fig. 6.1.

.....[1]

5054/22/M/J/18/Q6

24 Fig. 3.1 shows three rays of light travelling in water from a light source S.

One ray of light is totally internally reflected at the boundary between water and air.

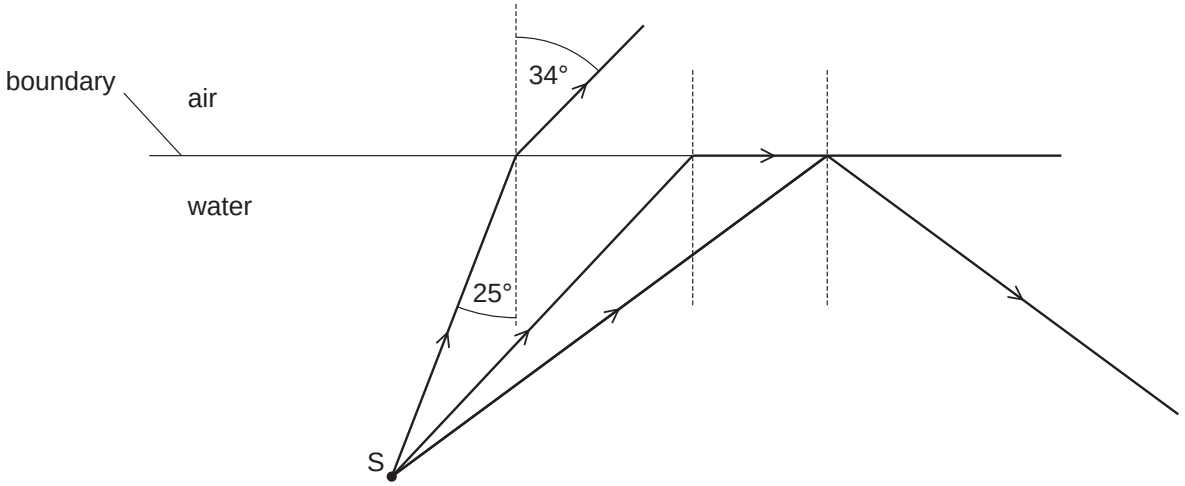

Fig. 3.1 (not to scale)

(a) On Fig. 3.1, mark the critical angle and label it *c*. [1]

(b) State why only one of the three rays is totally internally reflected.

.....

..... [1]

(c) Calculate:

(i) the refractive index for water

refractive index = ... [2]

(ii) the critical angle for the boundary between water and air.

critical angle = ... [2]

5054/22/M/J/19/Q3

25 A dentist uses a plane mirror to see the back of a tooth.

(a) A plane mirror produces an image of an object.

Describe the position of this image.

.....

.....

..... [2]

(b) Fig. 6.1 shows the plane mirror used by the dentist to see the point labelled X on the tooth.

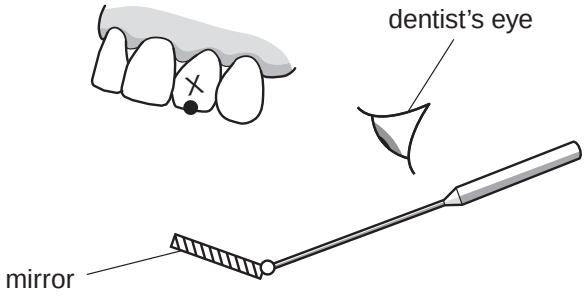

Fig. 6.1

On Fig. 6.1:

(i) mark the position of the image of X formed by the mirror [1]

(ii) draw a ray of light from X to show how the dentist can see the tooth. [2]

(c) State **one** characteristic of the image formed by the plane mirror other than its position.

.....

..... [1]

5054/21/M/J/20/Q6

26 **(a)** Two mirrors, A and B, are inclined at an angle of 60° to each other.

Light strikes mirror A at an angle of 30°, as shown in Fig. 4.1.

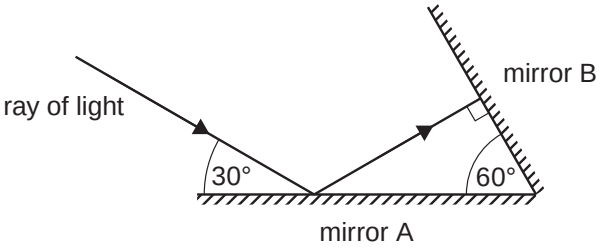

Fig. 4.1

(i) Determine the angle of incidence at mirror A.

angle of incidence at A = ... [1]

(ii) Determine the angle of incidence at mirror B.

angle of incidence at B = ... [1]

(iii) Describe the path of the reflected ray after it leaves mirror B.

.....

..... [1]

(b) A plane mirror hanging on a wall is used to form the image of an object.

State **three** characteristics of the image formed.

1. .....

2. .....

3. .....

[3]

5054/22/M/J/20/Q4

27 Fig. 5.1 shows part of the ray diagram of a lens being used as a magnifying glass.

Three rays are shown coming from the top of an object O.

The points labelled F are one focal length from the lens.

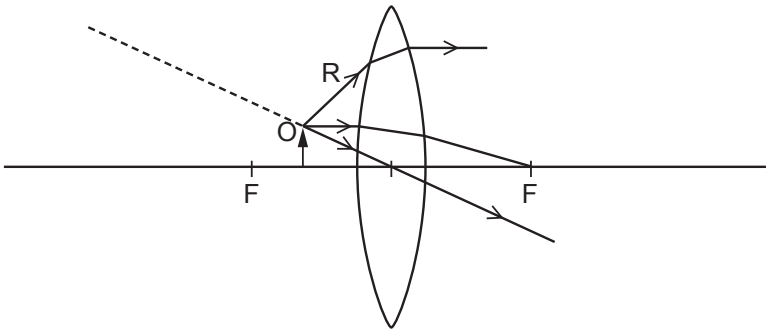

Fig. 5.1

(a) State the name of the type of lens shown in Fig. 5.1.

..... [1]

(b) Describe what happens to the ray of light R:

• as it enters the lens .....

.....

• as it leaves the lens. .....

.....

[2]

(c) Using all three rays from O, complete Fig. 5.1 to show the image formed. [2]

(d) Underline **all** of the words in the list that describe the image formed in **(c)**.

inverted upright real virtual

[1]

5054/21/M/J/21/Q5

28 **(b)** White light is made up of different colours.

(i) State the name of four of the colours in the visible spectrum and place them in order from the smallest wavelength to the largest wavelength.

smallest wavelength .....

.....

.....

largest wavelength .....

[2]

(ii) A narrow beam of white light can be split into different colours.

Fig. 10.4 shows rays of white light emitted from a lamp.

Complete Fig. 10.4 to show how a narrow beam is produced from these rays and how a spectrum is shown on the screen. Label your diagram.

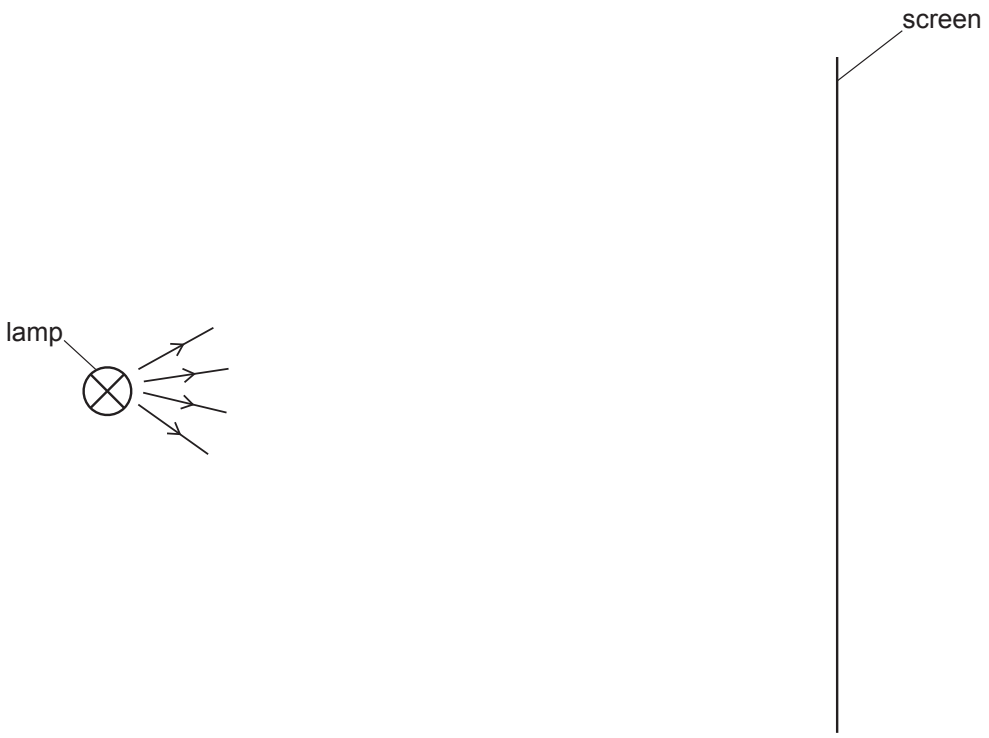

Fig. 10.4

[4]

5054/22/M/J/21/Q10

29 Two parallel rays of light, one red and one blue, enter a glass prism.

Fig. 4.1 shows both rays of light before they enter the prism. The blue ray is also shown incident on a different side of the prism after passing through the prism.

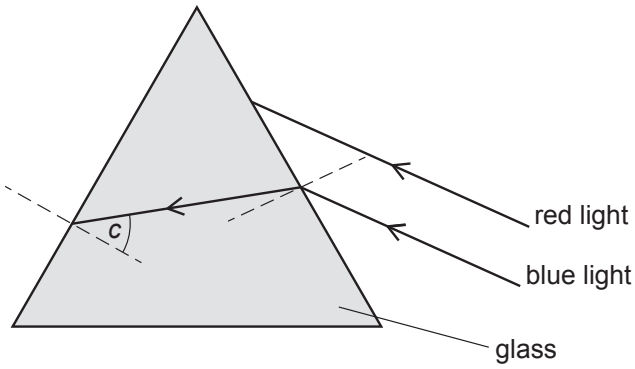

Fig. 4.1 (not to scale)

The ray of blue light strikes the left side of the prism at an angle equal to its critical angle *c*.

(a) (i) On Fig. 4.1, mark and label the angle of incidence *i* and the angle of refraction *r* for the blue light as it enters the prism. [1]

(ii) On Fig. 4.1, continue the path of the blue light after it strikes the left side of the prism. [1]

(iii) The refractive index of glass for red light is smaller than the refractive index for blue light.

On Fig. 4.1, draw the path of the red light as it travels in the prism and after it strikes the left side of the prism. [2]

(b) (i) State what is meant by the critical angle.

.....

..... [2]

(ii) The refractive index of glass for blue light is 1.5.

Calculate the critical angle *c* for blue light in glass. Show your working.

c = ... [2]

5054/21/M/J/22/Q4

30 Fig. 4.1 shows a ray of white light incident on a glass prism.

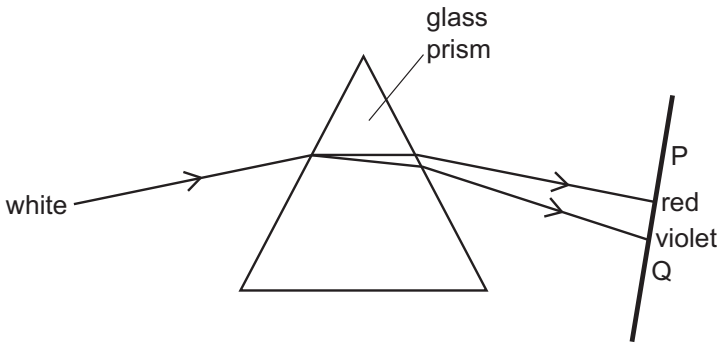

Fig. 4.1 (not to scale)

Refraction causes the white light to separate into different colours.

(a) Define the term 'angle of refraction'.

.....

..... [2]

(b) The angle of incidence of the white light as it enters the prism is 40° and the angle of refraction for the red light is 25°.

Calculate the refractive index of the glass for red light. Show your working.

refractive index = ... [2]

(c) Using Fig. 4.1, state and explain how the refractive index for red light differs from the refractive index for violet light.

.....

.....

.....

..... [2]

(d) The source of white light used in Fig. 4.1 produces other types of electromagnetic radiation as well as visible light.

State the name of the invisible radiation found at P and the invisible radiation found at Q.

at P ..... at Q ..... [1]

5054/22/M/J/22/Q4

31 Fig. 2.1 shows a ray of light **PQR** passing along a simple optical fibre to its end at **R**.

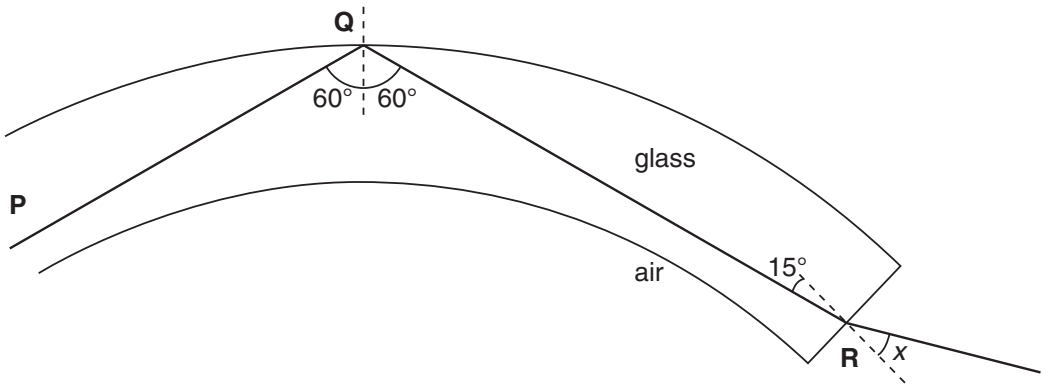

Fig. 2.1

(a) **(i)** Explain why the ray **PQ** does not leave the optical fibre at **Q**.

.....

.....

.....

(ii) Explain why the ray **QR** changes direction at **R**.

.....

.....
[3]

(b) The refractive index of glass is 1.5. The ray **QR** makes an angle of 15° with the normal to the glass surface at **R**. Calculate the angle *x*, shown on Fig. 2.1.

angle *x* = ... [2]

(c) State one advantage of optical fibres rather than copper wires for carrying telephone communications.

.....

.....

.....[1]

5054/2/O/N/02/Q2

32 Fig. 3.1 shows words seen through a lens. Fig. 3.2 shows the same words without the lens.

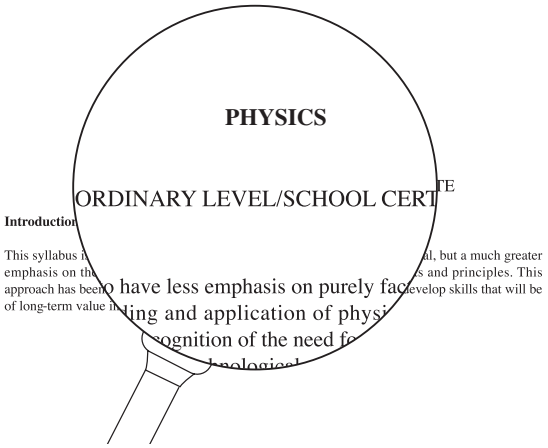

Fig. 3.1

PHYSICS

GCE ORDINARY LEVEL/SCHOOL CERTIFICATE

Introduction

This syllabus is designed to have less emphasis on purely factual material, but a much greater emphasis on the understanding and application of physical concepts and principles. This approach has been adopted in recognition of the need for students to develop skills that will be of long-term value in an increasing technological world.

Fig. 3.2

(a) State two properties of the image formed by the lens.

1 .....

.....

2 .....

..... [2]

(b) On Fig. 3.3, sketch a ray diagram to show how the image in Fig. 3.1 was formed by the lens. Mark clearly the focal length of the lens and the image formed.

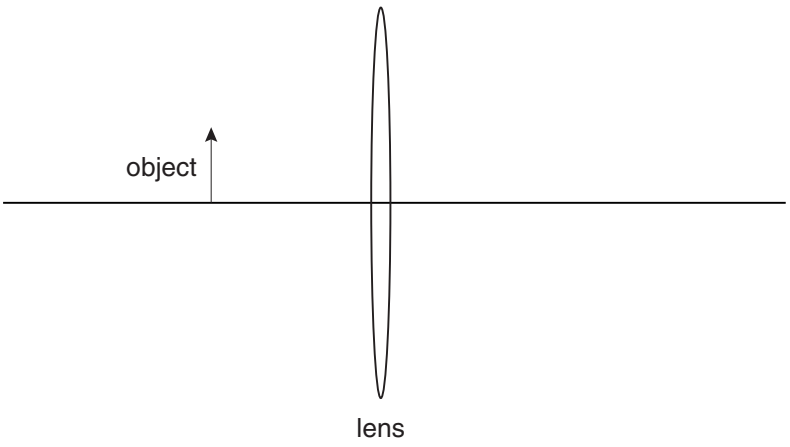

Fig. 3.3

[3]

5054/02/O/N/03/Q3

33 Fig. 4.1 shows an air bubble in water. The rays of light are incident on the air bubble.

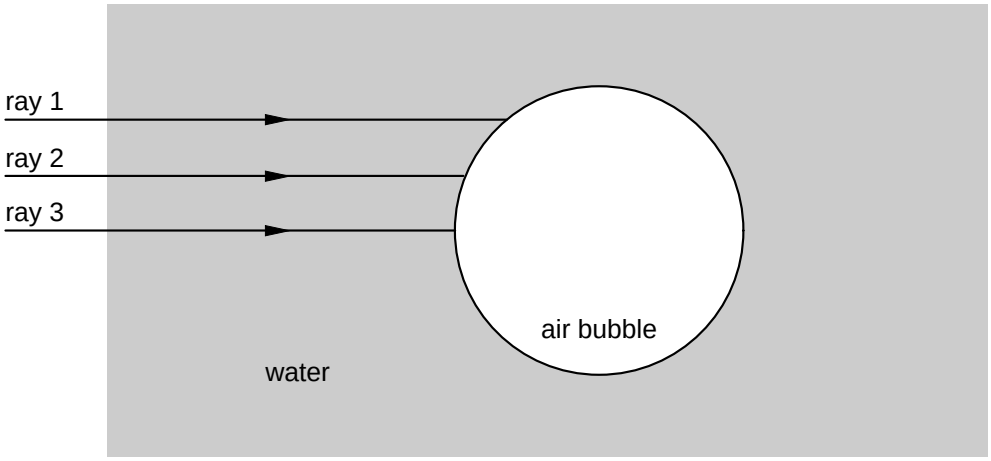

Fig. 4.1

The angle of incidence of ray 1 on the air bubble is greater than the critical angle.
The angle of incidence of ray 2 on the air bubble is less than the critical angle.
Ray 3 is perpendicular to the surface of the bubble.

The angle of incidence of ray 2 on the air bubble is 27° and the angle of refraction of ray 2 inside the air bubble is 37°.

(a) On Fig. 4.1, at the point where ray 1 meets the air bubble, mark

(i) the normal to the surface,

(ii) the angle of incidence.

[2]

(b) Complete Fig. 4.1 to show how all three rays continue after they meet the air bubble. [3]

(c) **(i)** Define what is meant by the *refractive index* of water.

.....

.....

.....

(ii) Calculate the refractive index of water.

refractive index = …….

054/02 O/N/04/Q4

34 **(a)** Fig. 4.1 shows a ray of light incident on a mirror at X. The incident ray makes an angle of 50° with the surface of the mirror.

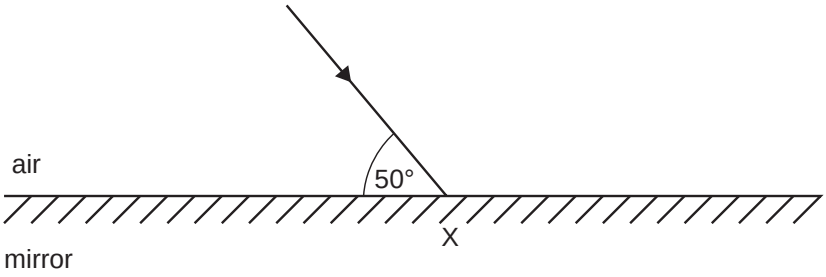

Fig. 4.1

(i) Complete Fig. 4.1 to show the normal and the reflected ray at X. [1]

(ii) State the values of

1. the angle of incidence, ... [1]

2. the angle of reflection. ..... [1]

(b) Describe with the help of a diagram how you would find the position of the image produced by a plane mirror.

.....

.....

.....

.....

.....

.....

.....

..... [3]

5054/02/O/N/06/Q4

35 **(a)** Fig. 11.1 shows a ray of light passing through the edge of a converging lens.

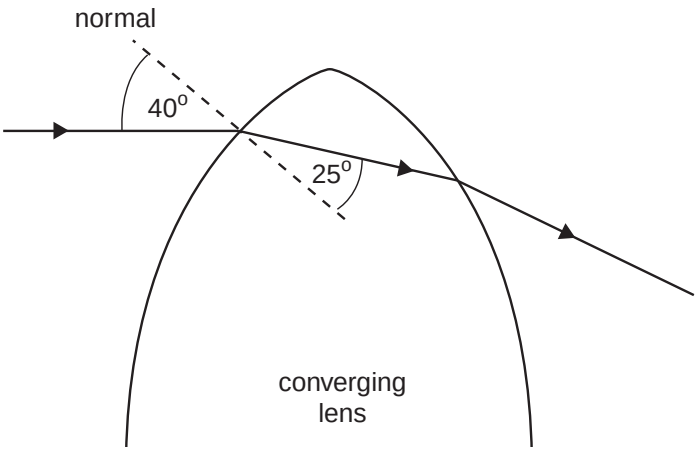

Fig. 11.1

(i) Describe what happens to the direction of the ray of light as it enters and leaves the lens. [2]

(ii) State what happens to the speed, frequency and wavelength of the light as it enters the lens. [3]

(iii) Calculate the refractive index of the glass used in the lens. [3]

(b) The focal length of the lens is 20 cm. An object is placed 50 cm from the lens and an image is formed on a screen.

(i) Explain what is meant by the *focal length* of a lens. You may draw a diagram if you wish. [2]

(ii) Draw a ray diagram to scale to show the formation of the image. [3]

(iii) The image is real. State **two** other properties of the image. [2]

5054/02/O/N/07/Q11

36 Fig. 6.1 shows a ray of white light from a ray-box passing into a glass prism. A spectrum is formed between P and Q on the screen.

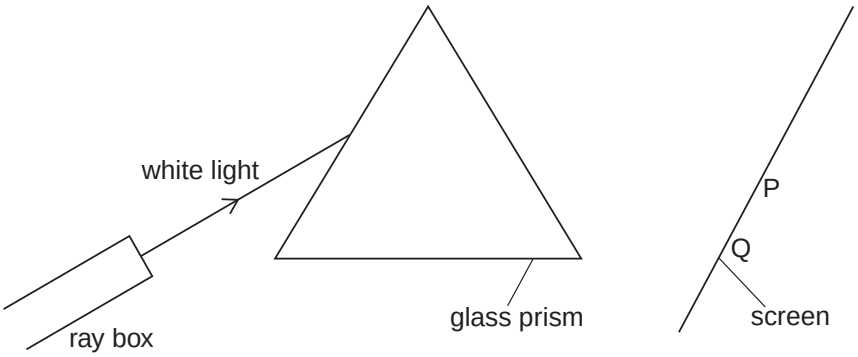

Fig. 6.1

(a) State the colour of the light at end P of the spectrum.

..... [1]

(b) State whether the value of each of these properties for blue light is greater than, equal to or less than the value for red light.

(i) speed in a vacuum ..... [1]

(ii) wavelength ..... [1]

(c) Fig. 6.2 shows the ray passing through a red filter before it reaches the prism.

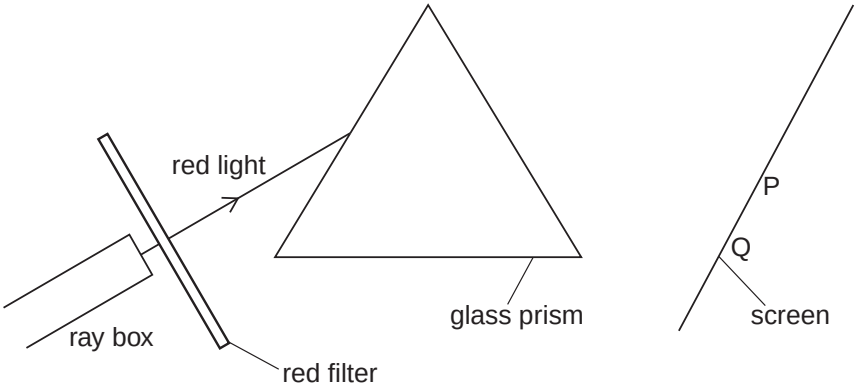

Fig. 6.2

Complete Fig. 6.2 to show the ray of red light passing through and emerging from the prism. [2]

5054/02/O/N/08/Q6

37 Fig. 4.1 shows an old coin displayed in a museum.

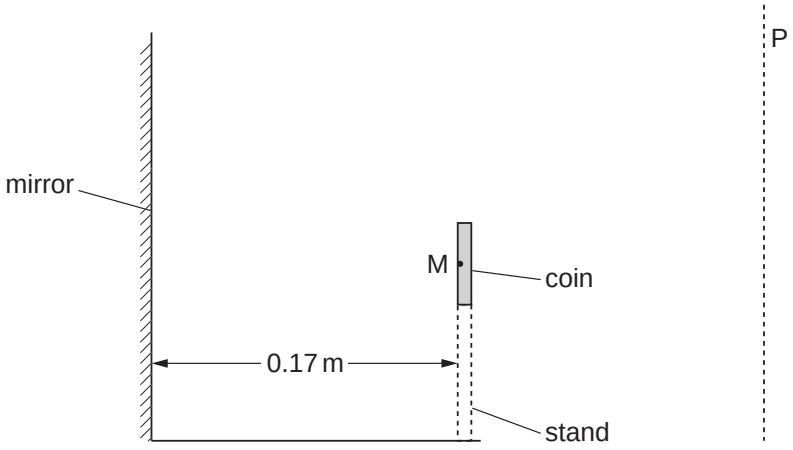

Fig. 4.1

The coin is vertical and is supported by a transparent stand. A vertical mirror 0.17 m behind the coin ensures that the back of the coin can be seen by a visitor looking from the line P.

M is a point on the back of the coin.

(a) On Fig. 4.1,

(i) draw **two** rays of light from M to show how its image is produced, [2]

(ii) label the image I. [1]

(b) State the distance from point M on the coin to its image.

distance = ...[1]

5054/02/O/N/09/Q4

38 **(a)** Fig. 9.1 shows a young boy lying on his back on the bottom of a swimming pool. He is holding his breath and his eyes are open. A red light is positioned on the ground at Q.

At first the boy's head is touching the pool wall. He notices that, as he slides away from the pool wall, his eye reaches a point P where he first sees the light at Q. Fig. 9.1 shows the boy in this position.

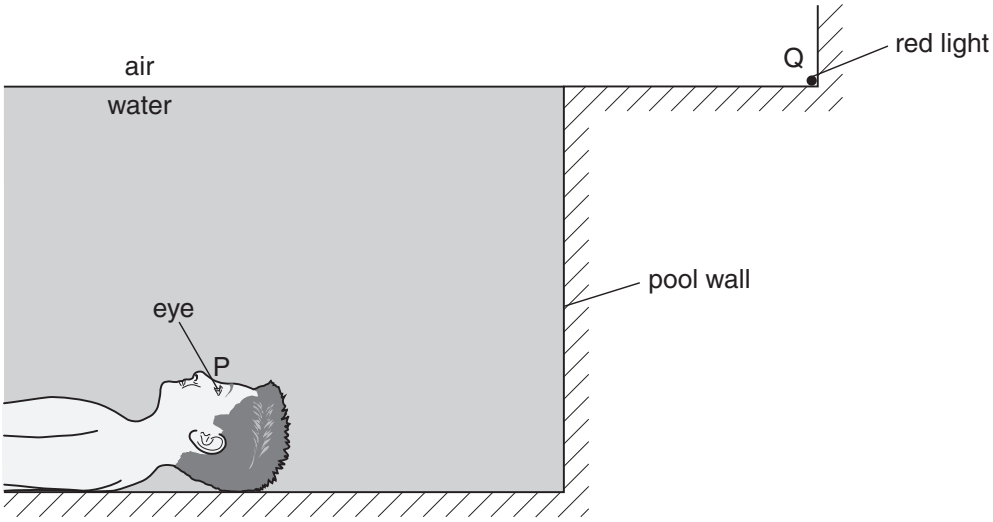

Fig. 9.1

(i) On Fig. 9.1, draw the ray of light travelling from Q to P. Mark the critical angle for light in water and label it C. [2]

(ii) Explain why the boy is unable to see the red light at Q when his eye is closer to the pool wall than P.

.....

.....

..... [2]

(iii) The critical angle is 49°. Calculate the refractive index of water.

refractive index = ... [2]

(iv) The red light is now replaced with a blue light. State the effect of this on the wavelength of the light in the air.

..... [1]

(b) A small, very brightly illuminated display is located at the back of a projector. The projector lens produces an inverted and magnified image of the display on a white classroom wall.

Fig. 9.2 is a scale diagram showing the position and size of both the display and the image on the wall. R is a point on the display.

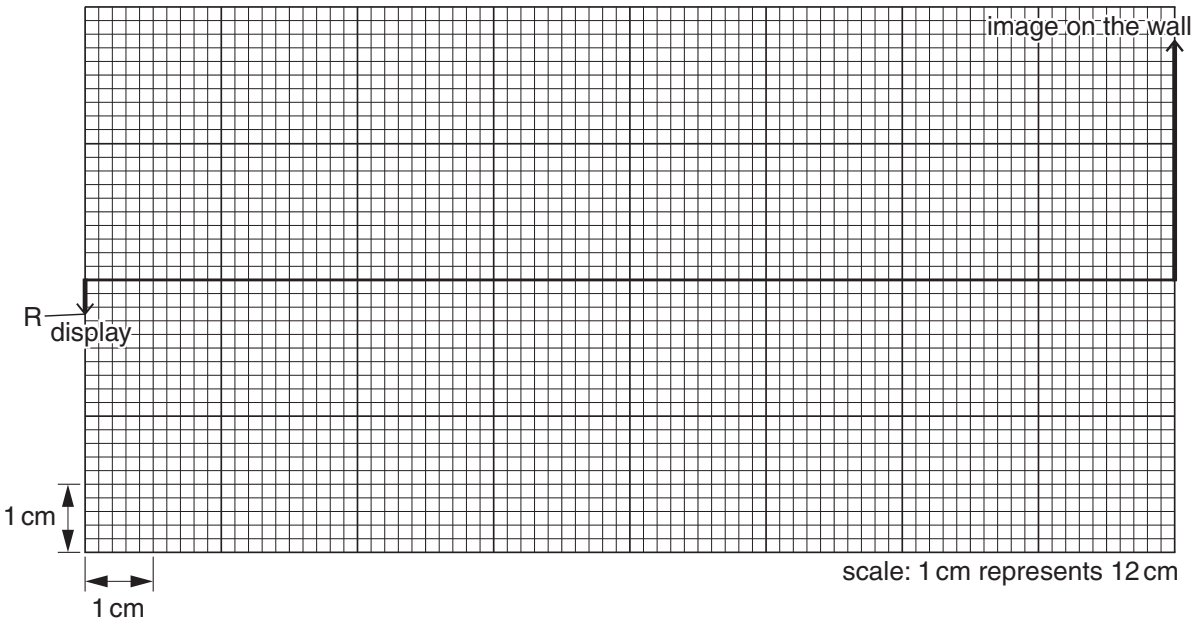

Fig. 9.2

(i) The image is inverted and magnified. State two other properties of the image.

1. .....

2. .....
[2]

(ii) On Fig. 9.2, draw the straight-line ray from R to the image. [1]

(iii) On Fig. 9.2, draw a vertical line representing the lens and label it L. [1]

(iv) A second ray from R to the image passes through a focal point (principal focus) of the lens. On Fig. 9.2, draw this ray and use it to mark this focal point. Label this focal point F. [2]

(v) Determine the focal length of the lens.

focal length = ... [2]

5054/21/O/N/10/Q9

39 Fig. 9.1 shows a very large plane mirror, inclined at 45° to the horizontal, beneath a pattern on the high ceiling of a hall.

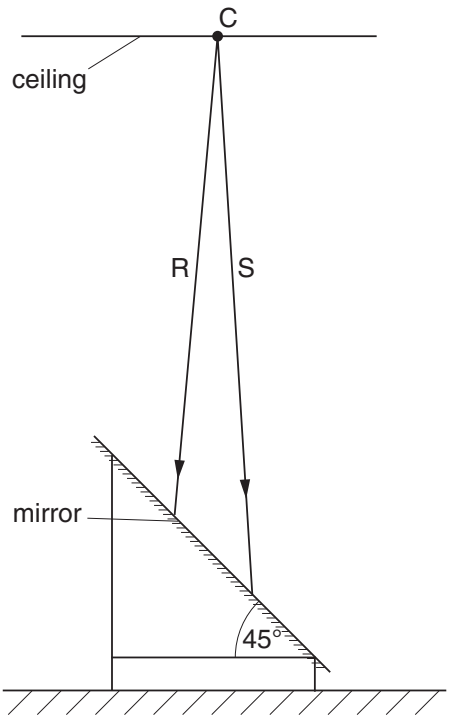

Fig. 9.1

The mirror is set on a stand at head-height immediately below the centre C of the pattern. R and S are two rays of light from C that strike the mirror.

(a) (i) On Fig. 9.1, continue the rays R and S after they strike the mirror. [1]

(ii) On Fig. 9.1, show how these rays are used to locate the image of C and mark and label the position of this image with the letter I. [2]

(iii) State two characteristics of this image.

1. .....

2. .....
[2]

(iv) Suggest how the mirror helps visitors to the hall to see the pattern on the ceiling.

.....

.....[1]

(b) Violet light from C has a wavelength of 4.0×10^{-7} m.

(i) Calculate the frequency of this light, clearly stating the value of any constant used in the calculation.

frequency = ... [3]

5054/22/O/N/10/Q9

40 Fig. 4.1 shows a glass lens in air and its two focal points F_1 and F_2.

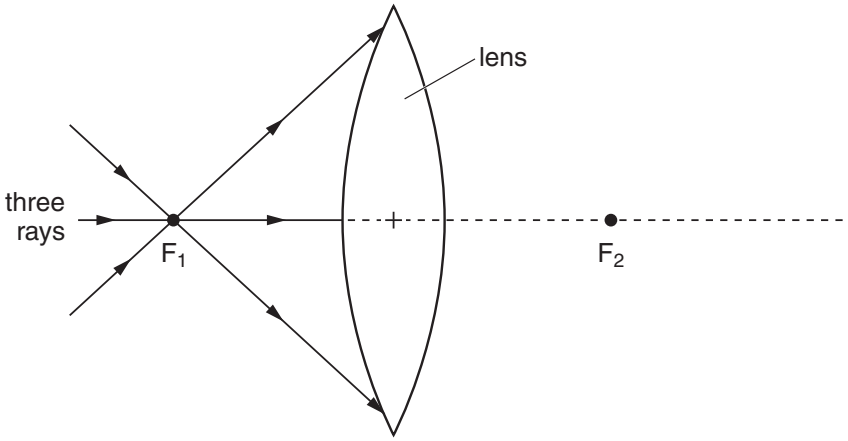

Fig. 4.1

Three rays of light pass through F_1 to the lens.

(a) On Fig. 4.1, continue the three rays through the lens and into the air. [2]

(b) State what happens to the speed of light on

(i) entering the glass lens from air,

.....[1]

(ii) leaving the lens and returning to the air.

.....[1]

(c) Light of wavelength 6.0×10^{-7} m travels in air at a speed of 3.0×10^{8} m/s.

(i) Calculate the frequency of this light.

frequency = ...[2]

(ii) State the effect, if any, on the frequency as the light enters the glass from air.

.....[1]

5054/21/O/N/11/Q4

41 Fig. 8.1 shows a short-sighted eye.

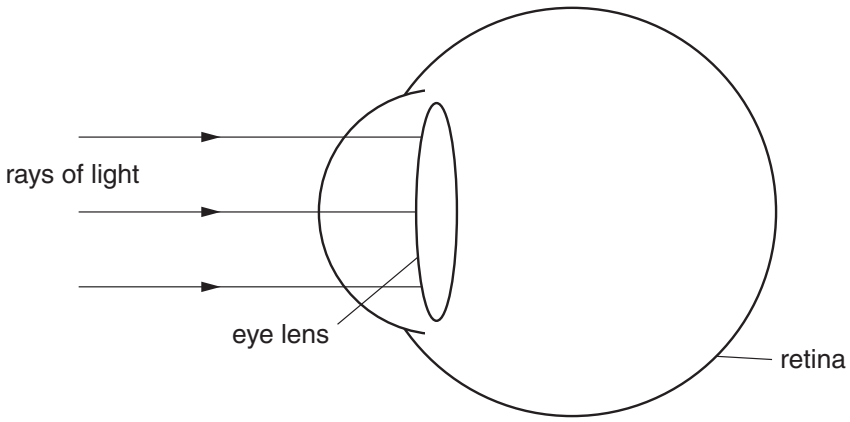

Fig. 8.1

Rays of light from a distant star are parallel as they reach the lens of the eye. Refraction of light as it enters the eye has been ignored in Fig. 8.1.

(a) **(i)** On Fig. 8.1, continue the rays to show their paths inside the short-sighted eye until they strike the retina. [2]

(ii) Explain how your diagram shows that the image of the star seen by the observer is blurred.

.....

.....[1]

(b) Fig. 8.2 shows three parallel rays of light.

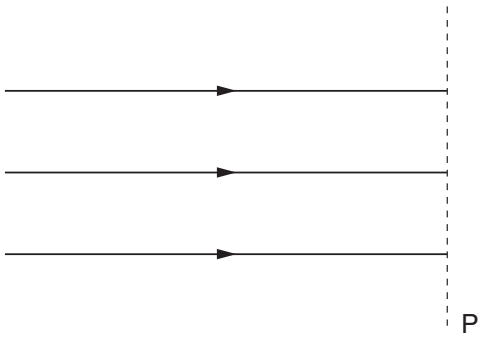

Fig. 8.2

(i) On the line P in Fig. 8.2, draw the shape of a lens that is used to correct short sight. [1]

(ii) On Fig. 8.2, continue the three rays through the lens that you have drawn. [1]

5054/22/O/N/11/Q8

42 A laser produces red light of frequency 4.7×10^{14} Hz. The speed of light in glass is 2.0×10^{8} m/s.

(a) Calculate the wavelength in glass of light from this laser.

wavelength = ...[2]

(b) Describe an experiment to verify *the law of reflection* for light. You may include a diagram in your answer.

.....

.....

.....

.....

.....

.....

.....[5]

(c) Fig. 10.1 shows a ray of light travelling in an optical fibre. The ray strikes the side of the fibre at P.

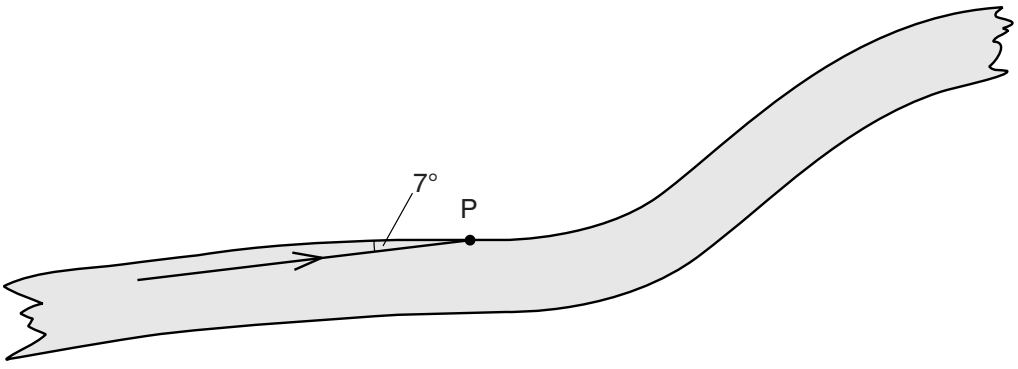

Fig. 10.1

The angle between the ray and the side of the fibre is 7°.

(i) Determine the angle of incidence of the ray at P.

angle = ...[1]

(ii) State and explain what happens to the ray at P.

.....

.....

.....[2]

(d) A room is illuminated by wall lamps. Fig. 10.2 shows a mirror on the wall behind one of the lamps.

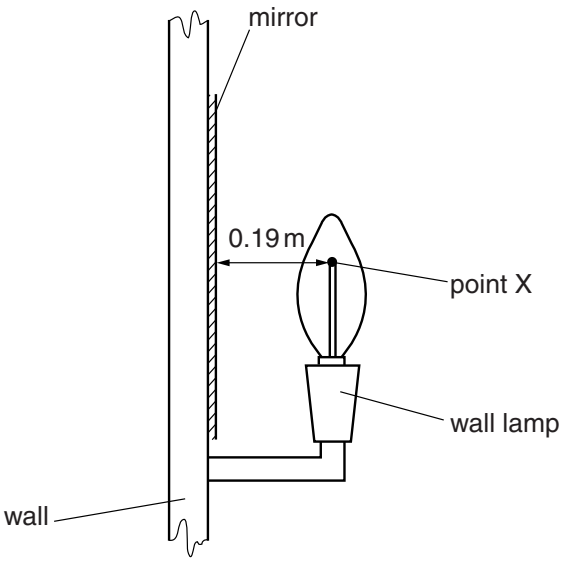

Fig. 10.2 (not to scale)

X is a point on the filament of the lamp. It is 0.19 m in front of the mirror.

(i) On Fig. 10.2, draw rays from X and locate the image of X. Label the image I. [3]

(ii) State the distance between I and the mirror.

distance = ...[1]

(iii) Suggest one advantage of placing a mirror behind the lamp in the room.

.....

.....[1]

5054/22/O/N/12/Q10

43 A student goes for a walk in the mountains. During a storm, she sees lightning strike a hillside in the distance. Several seconds later, she hears the thunder caused by the lightning.

(b) After the storm, the student sees a rainbow.

(i) State the speed of light in air.

speed = ...[1]

(ii) Calculate the wavelength in air of light of frequency 7.5×10^{14} Hz.

wavelength = ...[2]

(iii) State the colours of the spectrum in order of increasing wavelength.

.....

.....[2]

(c) In the laboratory, the student sends blue light into a glass prism placed on a sheet of paper. The arrangement is shown in Fig. 10.1.

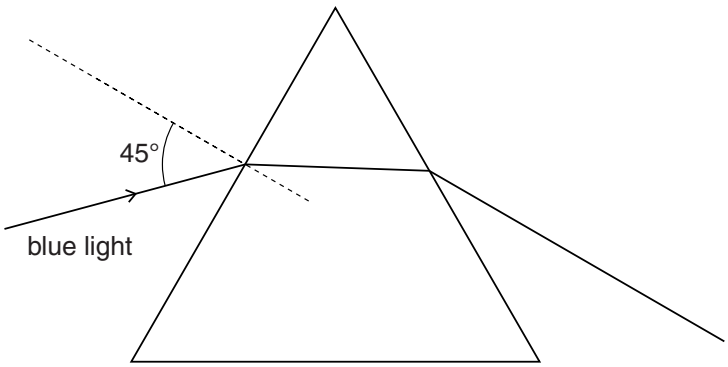

Fig. 10.1

The blue light enters the prism with an angle of incidence of 45°.

(i) On Fig. 10.1, mark the angle of refraction in the glass and label it *r*. [1]

(ii) The student wishes to determine the angle of refraction. On the sheet of paper, she draws the path the ray takes in the glass. Describe how she could do this.

.....

.....

.....[2]

(iii) **1.** State the formula that relates the angle of incidence *i*, the angle of refraction *r* and the refractive index *n*.

.....

.....[1]

2. The angle of refraction in the glass is 28°.

Calculate the refractive index of the glass.

refractive index = ...[1]

(iv) The student sends a ray of red light to the glass prism along the same path as the blue light.

On Fig. 10.1, mark the path taken by the red light after it enters the prism. [2]

5054/21/O/N/13/Q10

44 **(a)** State the speed of light in air.

.....[1]

(b) Fig. 10.1 shows a ray of blue light passing from air into a glass block and refracting at the surface.

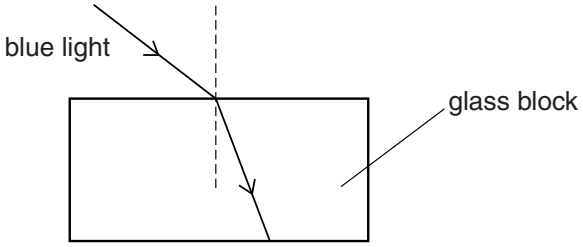

Fig. 10.1 (not to scale)

(i) As the light enters the glass, state what happens to

1. the speed of the light,

.....[1]

2. the frequency of the light,

.....[1]

3. the wavelength of the light.

.....[1]

(ii) On Fig. 10.1, mark and label the angle of incidence *i* and the angle of refraction *r*. [2]

(c) The refractive index of glass for blue light is 1.5.

(i) A ray of blue light strikes the surface of a glass block at an angle of incidence of 89°.

Calculate the angle of refraction of the light in the block.

angle of refraction = ...[3]

(ii) Explain why the angle of refraction of blue light in glass is always less than 45°.

.....

.....

.....

.....[2]

(d) Blue light, travelling in air, strikes the side of a different glass block and continues in the same direction as it enters the glass block. Fig. 10.2 shows the ray of light and the shape of the glass block. The critical angle for this glass is 42°.

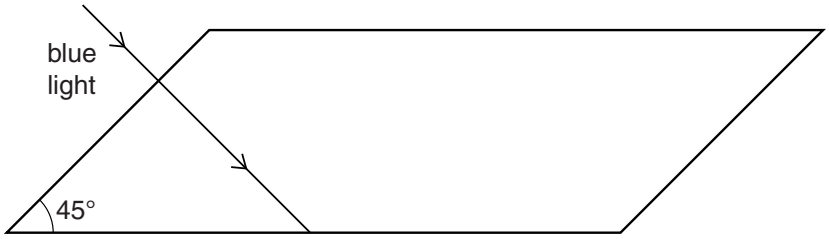

Fig. 10.2

(i) Explain why the light continues in the same direction as it enters the glass block.

.....

.....

.....[2]

(ii) On Fig. 10.2, complete the path of the light until it leaves the glass. [2]

5054/22/O/N/14/Q10

45 A burning candle is placed close to a thin converging lens. The candle acts as the object.

A white, vertical screen is moved to a position on the other side of the lens from the candle.

Fig. 6.1 is a full-scale diagram, on graph paper, of the lens and the screen.

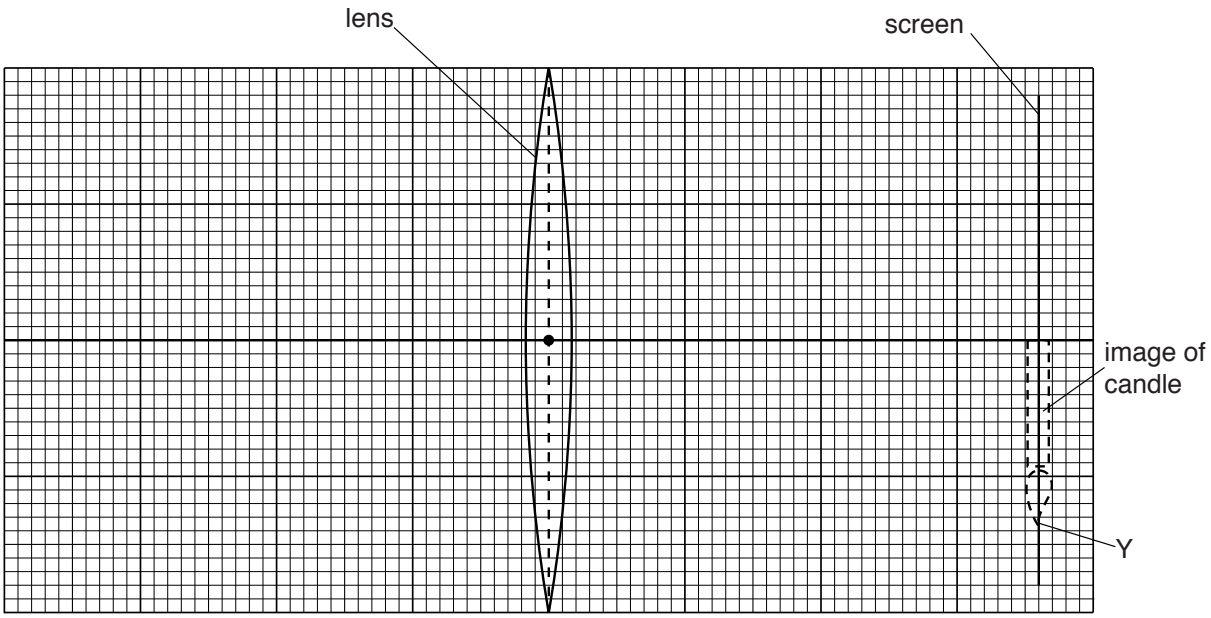

Fig. 6.1

The focal length of the lens is 2.4 cm. The screen is 7.2 cm from the centre of the lens. A sharply focused, inverted image of the candle is produced on the screen, as shown in Fig. 6.1.

(a) Define the term *focal length*.

.....

.....

..... [1]

(b) **(i)** On Fig. 6.1, mark and label with an F, each of the two focal points (principal foci) of the lens. [1]

(ii) The point Y is the tip of the image.

On Fig. 6.1, draw a ray diagram to locate the position of the top of the object.
Label this point X. [3]

(iii) Using Fig. 6.1, determine the distance of the candle from the centre of the lens.

distance = ... [1]

5054/21/O/N/15/Q6

46 Light enters a parallel-sided glass block at A. The angle between the side of the block and the ray of light in air is 35°.

The light then strikes the edge of the block at B. Fig. 7.1 shows the ray of light and the glass block.

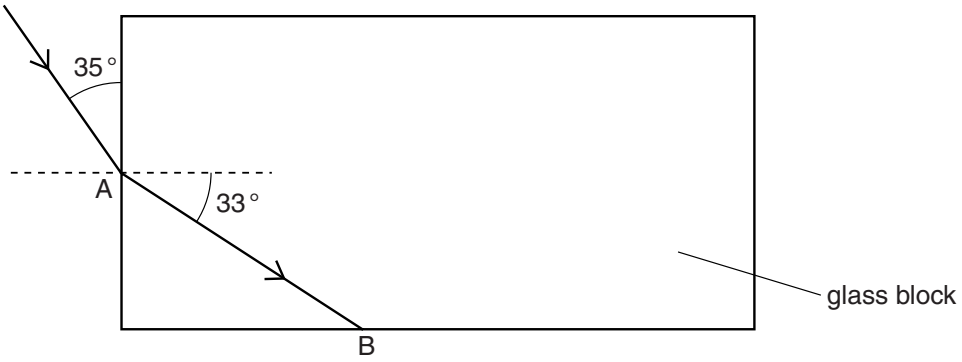

Fig. 7.1

The angle of refraction in the glass at A is 33°.

(a) Calculate the refractive index for light in the glass.

refractive index = ... [2]

(b) The light undergoes total internal reflection at B.

(i) State one condition necessary for total internal reflection to occur.

.....

.....

..... [1]

(ii) On Fig. 7.1, continue the ray to show the path of the light after total internal reflection at B and until it leaves the block. [1]

5054/22/O/N/15/Q7

47 A lamp is positioned at the bottom of a small pool of water. The critical angle for light passing from water into air is 49°.

(a) Explain what is meant by the term *critical angle*.

.....

.....

.....

.....[2]

(b) The lamp sends light towards the surface of the pool.

Fig. 4.1 shows three rays of light that are at 30°, 60° and 90° to the horizontal.

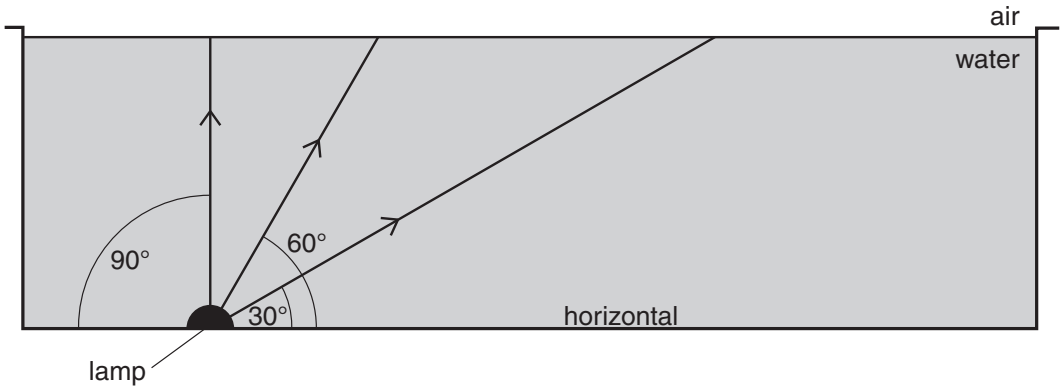

Fig. 4.1

On Fig. 4.1, draw the path taken by each of the three rays after they strike the surface of the water. [3]

5054/21/O/N/16/Q4

48 A laser produces a beam of red light.

(a) The red light from the laser has a frequency of 4.3×10^{14} Hz.

(i) State the speed of light in air.

.....[1]

(ii) Calculate the wavelength of this red light in air.

wavelength = ...[2]

(b) Red light from the laser strikes one side of a glass prism at an angle of incidence *i*. The light refracts towards the normal as it enters the prism.

Fig. 10.1 shows the prism, the light and a screen.

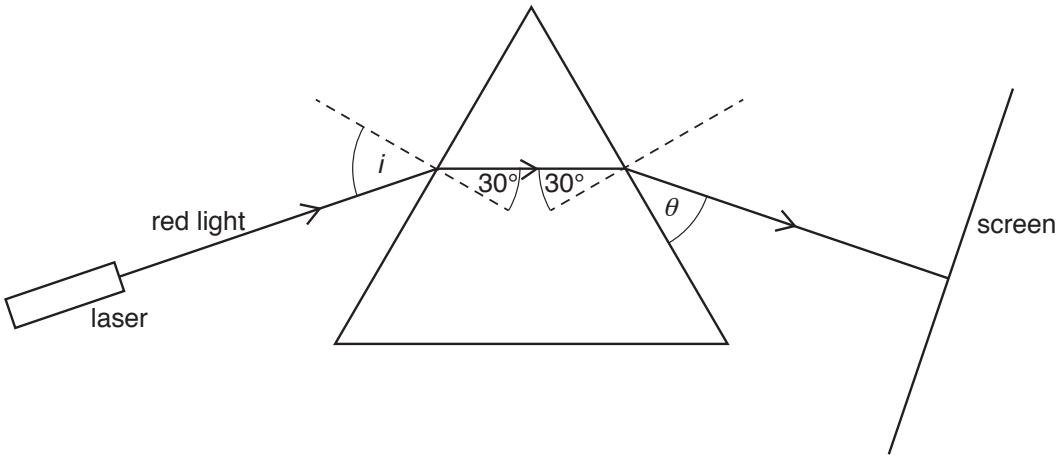

Fig. 10.1 (not to scale)

(i) State what happens to the speed of light as it enters the glass.

.....[1]

(ii) The refractive index of the glass is 1.5. The angle of refraction in the glass, where the light enters the prism, is 30°.

Calculate the angle of incidence *i*.

i = ...[2]

(iii) The light then passes back into the air and strikes the front of the white screen, as shown in Fig. 10.1.

Calculate θ, the angle between the ray in air and the side of the prism.

θ = ...[1]

(c) The laser in **(b)** is replaced with a filament lamp and a slit, as shown in Fig. 10.2.

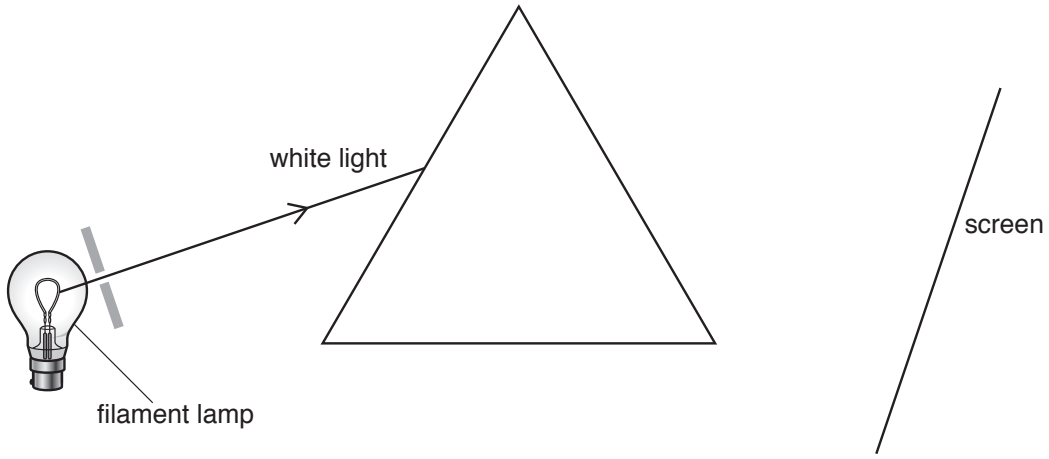

Fig. 10.2 (not to scale)

A ray of white light now strikes the prism.

(i) On Fig. 10.2, draw what happens to the light as it passes through the prism and strikes the screen. [2]

(ii) Describe what is seen on the screen.

.....

.....

.....

.....[2]

(iii) In addition to visible light, the filament lamp also emits some infra-red radiation. This infra-red radiation is able to pass through glass.

1. On the screen in Fig. 10.2, mark an X to indicate a place where infra-red radiation strikes the screen. [1]

5054/22/O/N/16/Q10

49 **(d)** Fig. 10.2 shows a ray of green light in air striking the side of a glass prism.

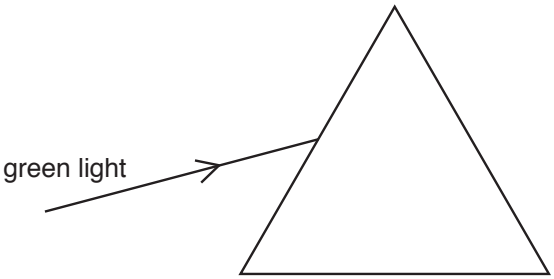

Fig. 10.2 (not to scale)

The refractive index of the glass for green light is 1.5.

(i) On Fig. 10.2,

1. draw the normal for this ray,

2. mark the angle of incidence with a letter *i*.

[1]

(ii) This angle of incidence is 57°.

Calculate the angle of refraction in the glass.

angle of refraction = ... [2]

(iii) State what happens, as the light enters the glass, to the light's

1. frequency,

.....

2. speed,

.....

3. wavelength.

.....

[2]

(iv) On Fig. 10.2, draw the path taken by the light as it passes through the glass and into the air. [2]

5054/21/O/N/17/Q10

50 **(c)** Fig. 9.2 shows light, in air, striking the vertical side of a rectangular glass block at an angle of incidence of 60°.

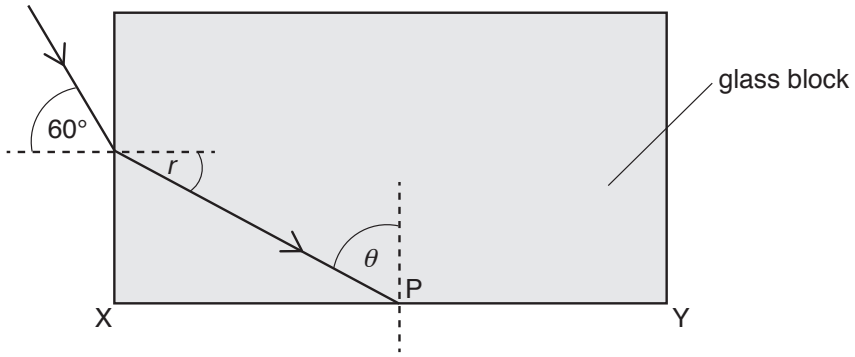

Fig. 9.2

The refractive index of the glass is 1.6. The light travels in the glass and strikes side XY at P.

(i) Underline all the terms that describe a light wave.

electromagnetic **longitudinal** **transverse**

[1]

(ii) At the point where the light enters the glass, the angle of refraction is *r*.

Calculate angle *r*.

r = ... [2]

(iii) **1.** Calculate the critical angle *c* for light travelling in the block.

c = ... [2]

2. At P, the angle θ between the ray and the normal is given by $\theta = 90° - r$.

State and explain what happens to the light when it strikes side XY.

.....

.....

..... [2]

3. On Fig. 9.2, draw the path of the light after it strikes side XY at P and the path of the light when it is again travelling in the air. [2]

5054/21/O/N/18/Q9

51 Visible light is one component of the electromagnetic spectrum.

(a) State the speed of light in a vacuum.

..... [1]

(b) State the colours of the visible spectrum.

..... [1]

(c) An object O of height 3.0 cm is placed 4.0 cm from the centre of a diverging lens.

Fig. 10.1 shows the object O, the diverging lens and the two focal points (principal focuses), F_1 and F_2, of the lens.

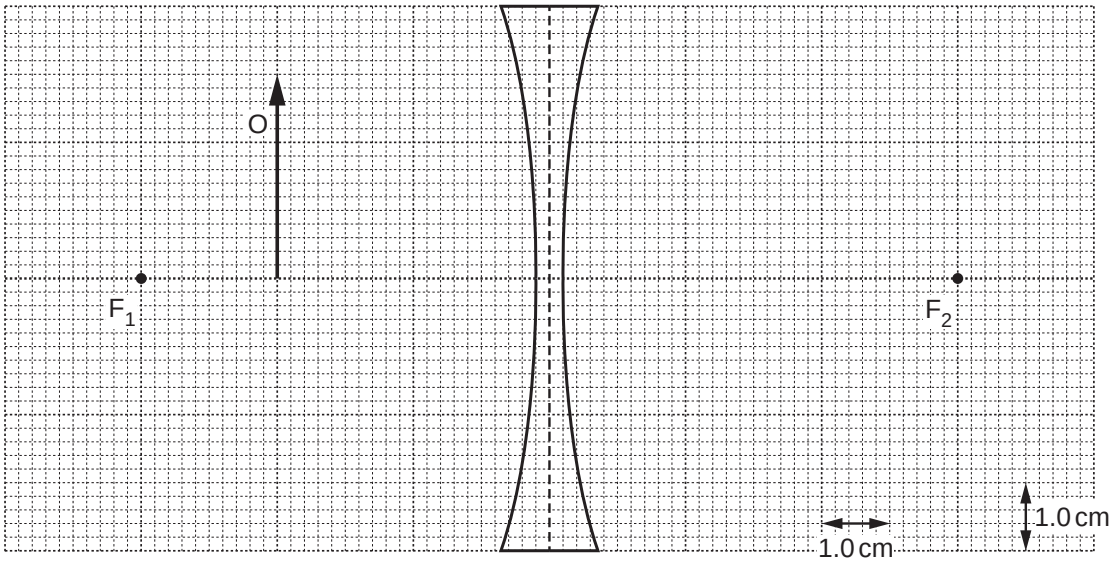

Fig. 10.1

(i) Determine the focal length of this lens.

focal length = ... [1]

(ii) The diverging lens produces an image of object O.

On Fig. 10.1, by drawing rays from the tip of O, locate this image and label it I. [4]

(iii) Determine the height of the image.

height = ... [1]

(iv) Determine the magnification of the image.

magnification = ... [1]

(v) State **two** ways in which a virtual image differs from a real image.

1. .....

.....

2. .....

..... [2]

(vi) State one use for a diverging lens.

.....

..... [1]

(d) Light passing from air into glass refracts in a similar way to a water wave passing from deep water into shallow water.

Fig. 10.2 represents light passing from air into glass at an angle to the surface.

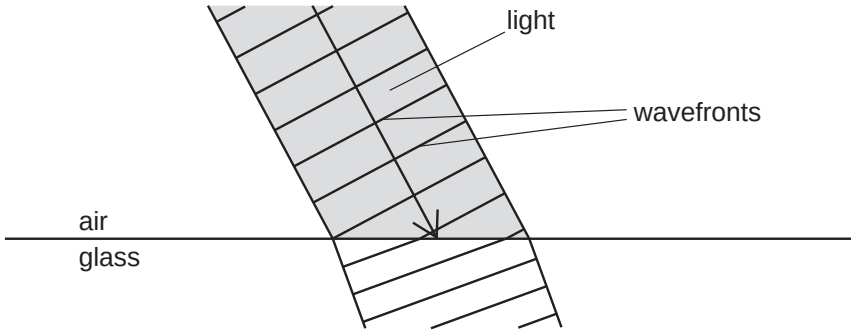

Fig. 10.2

One side of a wavefront strikes the glass before the other side.

Explain why the wavefronts change direction as the light enters the glass.

.....

.....

.....

..... [3]

5054/21/O/N/19/Q10

52 The three angles of a glass prism are 45°, 45° and 90° as shown in Fig. 4.1.

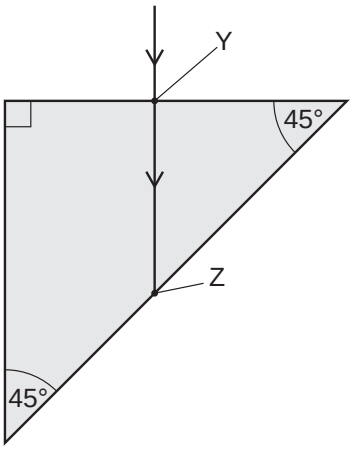

Fig. 4.1

At point Y, a ray of light of a single frequency travels in air and strikes the side of the prism at 90°. The ray passes into the glass prism.

(a) Light travels more slowly in glass than in air.

(i) State what happens to the wavelength of the light in the ray as it enters the glass.

..... [1]

(ii) State what happens to the frequency of the light in the ray as it enters the glass.

..... [1]

(b) The refractive index of glass is 1.6.

(i) Calculate the critical angle for light in glass.

critical angle = ... [2]

(ii) On Fig. 4.1, sketch the path of the light after it strikes the side of the prism at Z and after it returns to the air. [2]

5054/21/O/N/20/Q4

53 A thin converging lens is made of a transparent material of refractive index 1.4.

(a) A ray of light travelling in air strikes the surface of the lens at an angle of incidence of 55°.

(i) Calculate the angle of refraction.

angle of refraction = ... [2]

(ii) Place a tick (✓) in **one** of the boxes in the third column of Table 8.1 to indicate how the light ray deviates and what happens to the speed of the light in the ray as it enters the lens.

Table 8.1

direction of deviation	speed of light	
away from the normal	decreases	
away from the normal	does not change	
away from the normal	increases	
towards the normal	decreases	
towards the normal	does not change	
towards the normal	increases	

[1]

(iii) State what happens to the frequency of the light in the ray as it enters the glass.

..... [1]

(b) The focal length of the lens is 2.5 cm.

(i) State what is meant by *focal length*.

.....

..... [1]

(ii) Fig. 8.1 is a full-scale diagram that shows an object O of height 3.0 cm and the lens.

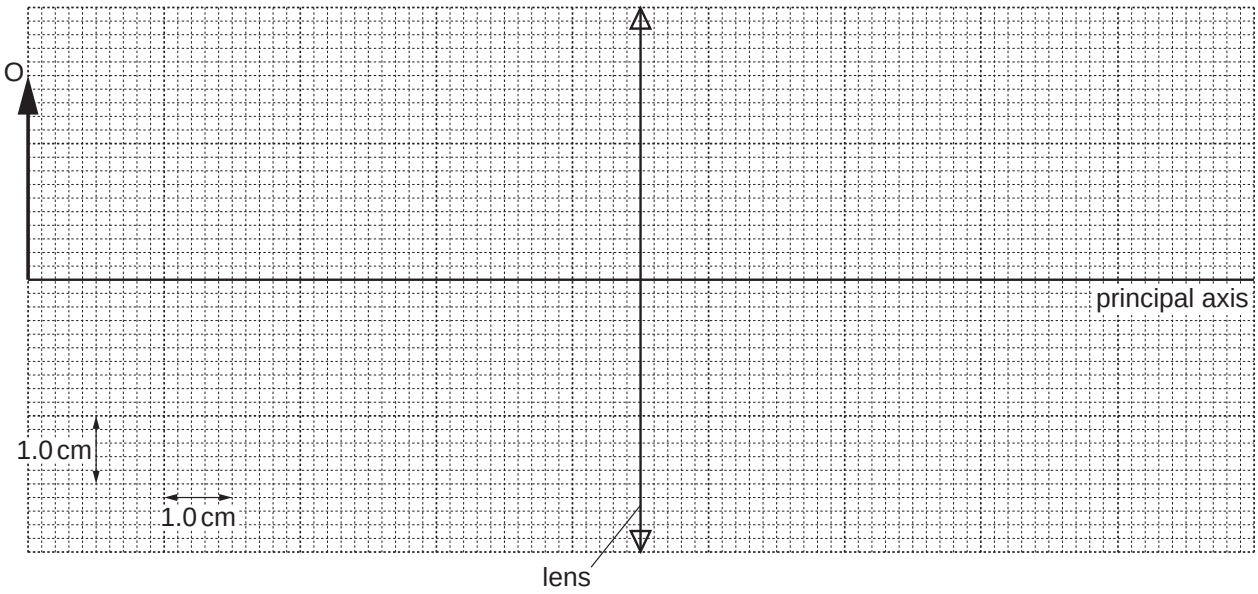

Fig. 8.1 (full scale)

By drawing on Fig. 8.1, locate and mark the image I of O. [4]

(iii) Determine the distance of I from the lens and calculate the magnification of O produced by the lens.

distance = ...

magnification = ...
[3]

(c) Describe how a converging lens is used in a camera.

.....

.....

.....

.....

..... [3]

5054/22/O/N/20/Q8

54 Fig. 3.1 shows light entering a transparent block.

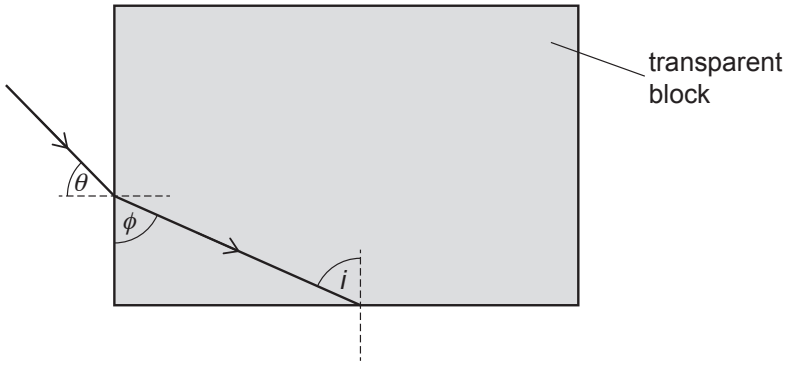

Fig. 3.1 (not to scale)

The light enters the block at an angle θ to the normal and travels through the block until it meets the bottom surface.

The angle between the ray in the block and the vertical side of the block is ϕ.

(a) Light travels more slowly in the block than in air.

(i) Explain how Fig. 3.1 shows this.

.....

.....

..... [2]

(ii) State what happens to the wavelength of the light and what happens to the frequency of the light as it enters the block.

wavelength .....

frequency .....
[2]

(b) The refractive index of the transparent material is 1.6. Angle θ is 45°.

(i) Determine angle ϕ.

ϕ = ... [3]

(ii) The angle of incidence i at the bottom surface is equal to ϕ and the critical angle for the material of the block in air is 39°.

Explain what happens to the light after it meets the bottom surface.

.....

.....

..... [2]

5054/22/O/N/21/Q3