3.2 Light

01. 0625_m23_qp_42 Q: 5

(a) Fig. 5.1 shows a semicircular transparent plastic block.

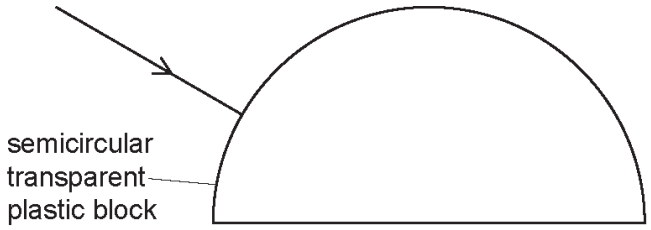

Fig. 5.1

A ray of light is incident normally on the curved surface of the block. The refractive index of the plastic is 1.5.

(i) Calculate the critical angle for the plastic.

critical angle = ... [2]

(ii) On Fig. 5.1, draw the path of the ray in the block and after the ray emerges from the block. [2]

(b) Fig. 5.2 is a full-scale diagram of a lens and an object O.

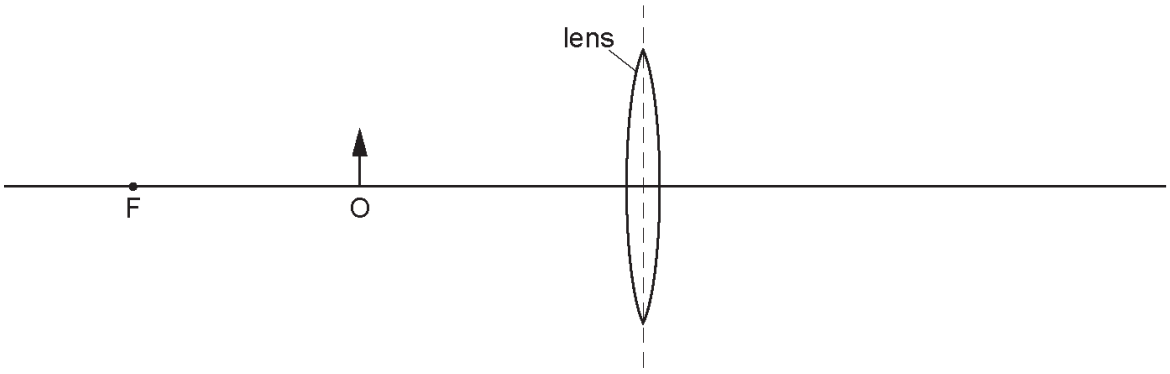

Fig. 5.2

The point marked F shows the position of a principal focus of the lens.

(i) Determine the focal length of the lens.

focal length = ... [1]

(ii) On Fig. 5.2, draw **two** rays from the object to locate the image. Label the image I. [3]

(c) Fig. 5.3 shows a simplified diagram of an eye with rays from a distant object and the path of the rays inside the eye of a person with short sight.

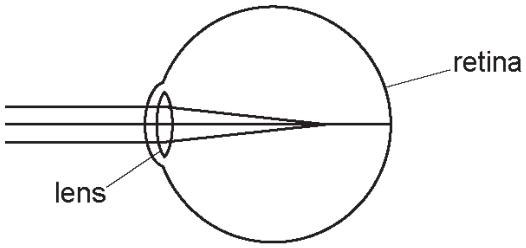

Fig. 5.3

On Fig. 5.4, draw an additional lens outside the eye to correct short-sightedness and show the path of the rays inside the eye.

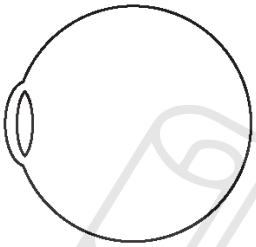

Fig. 5.4

[2]

02. 0625_s23_qp_41 Q: 5

Fig. 5.1 shows a block ABCD made of glass that has a refractive index of 1.5. The block has one curved side AB and three straight sides, BC, CD and DA.

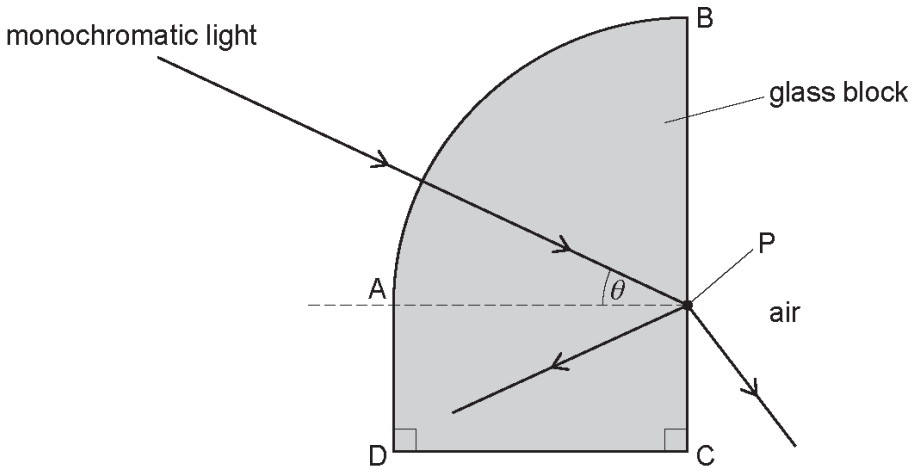

Fig. 5.1

There are right angles at C and D. The curved side AB is one quarter of the circumference of a circle that has its centre at point P.

A ray of monochromatic light enters the block through the curved side AB and strikes side BC at P. Some light emerges into the air and some is reflected.

(a) State what is meant by monochromatic.

.....

..... [1]

(b) Explain why the ray of light does **not** change direction when it enters the block through side AB.

.....

.....

..... [2]

(c) Show that the critical angle *c* for glass of refractive index 1.5 is 42°.

[2]

(d) Fig. 5.1 shows that the angle between the ray of light and line AP is θ, where line AP is at right angles to side BC.

Angle θ increases to 45°.

(i) State and explain what happens to the light that strikes P.

.....

.....

..... [2]

(ii) When $\theta = 45°$, the reflected light strikes side CD.

Describe what happens when this reflected light strikes side CD.

.....

..... [1]

03. 0625_s23_qp_42 Q: 7

Fig. 7.1 shows a container of oil.

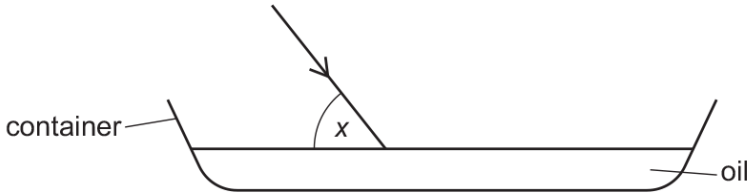

Fig. 7.1

A ray of light shines on the surface of the oil. The refractive index of the oil is 1.47.

(a) On Fig. 7.1, draw the normal at the point where the ray enters the oil. [1]

(b) The angle *x* is 56°.

Calculate the value of the angle of refraction.

angle of refraction = ... [3]

(c) State the approximate speed of light in air.

..... [1]

(d) Calculate the speed of light in the oil.

Give your answer to three significant figures.

speed = ... [2]

04. 0625_s23_qp_43 Q: 4

(a) Fig. 4.1 is an incomplete ray diagram showing an object O, a converging lens and the principal axis. The focal points of the lens are each labelled F.

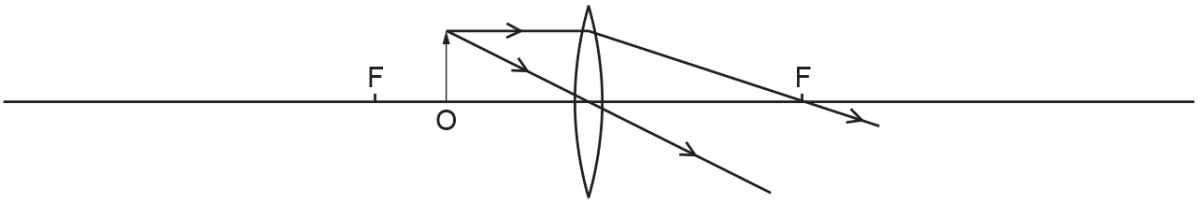

Fig. 4.1

(i) Complete the ray diagram to draw the image formed by the lens. Label your image I. [3]

(ii) Circle **three** descriptions in the list which describe the image formed in **(i)**.

diminished **enlarged** **inverted** **same size**

real **upright** **virtual**

[3]

(b) **(i)** State the name for the defect of vision that can be corrected by a converging lens.

..... [1]

(ii) Describe how a converging lens corrects the defect in **(i)**.
You may find it helpful to sketch a ray diagram.

.....

.....

..... [2]

05. 0625_w23_qp_41 Q: 6

A page of printed text is placed 18 cm from a converging lens of focal length 35 cm.

Fig. 6.1 is a scale diagram of the arrangement with each of the two principal focuses (focal points) of the lens labelled F.

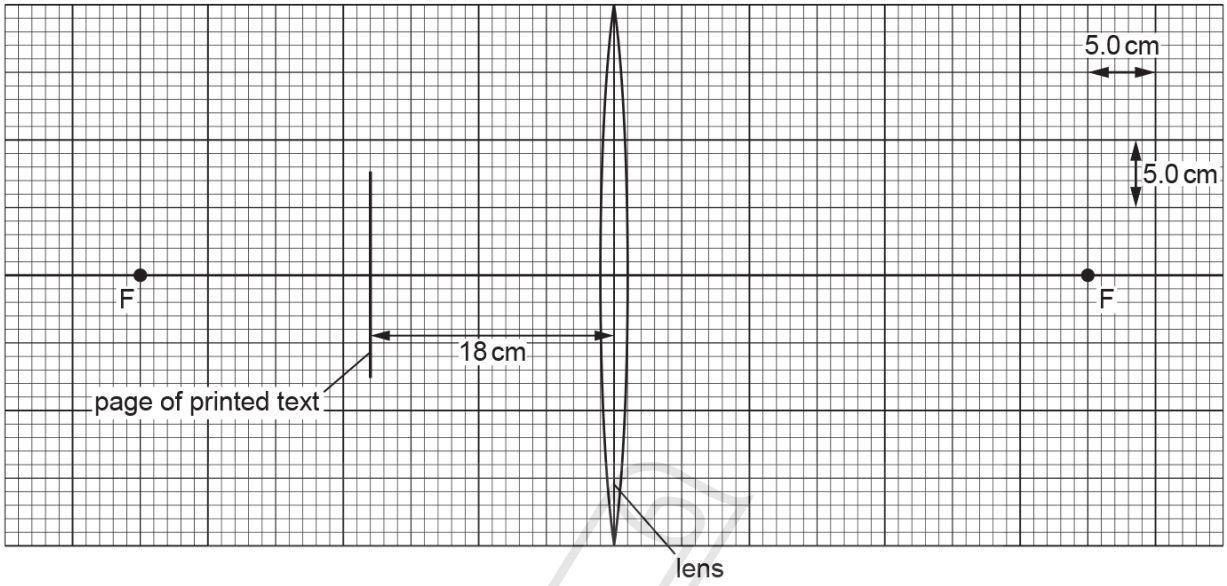

Fig. 6.1

(a) A length of 1.0 cm on the scale diagram represents an actual length of 5.0 cm.

(i) By drawing on Fig. 6.1, locate the image of the page produced by the lens and label it I. [3]

(ii) Using Fig. 6.1, determine the actual distance of image I from the lens.

actual distance from lens = ... [2]

(b) Converging lenses can be used as magnifying glasses.

State whether the image produced when a lens is used as a magnifying glass is real or virtual. Explain why.

.....

..... [1]

(c) Suggest how someone who is long-sighted may benefit from using a converging lens.

.....

.....

..... [2]

06. 0625_w23_qp_42 Q: 5

Fig. 5.1 shows a road junction, a moving car and a stationary truck. The road has high walls on each side.

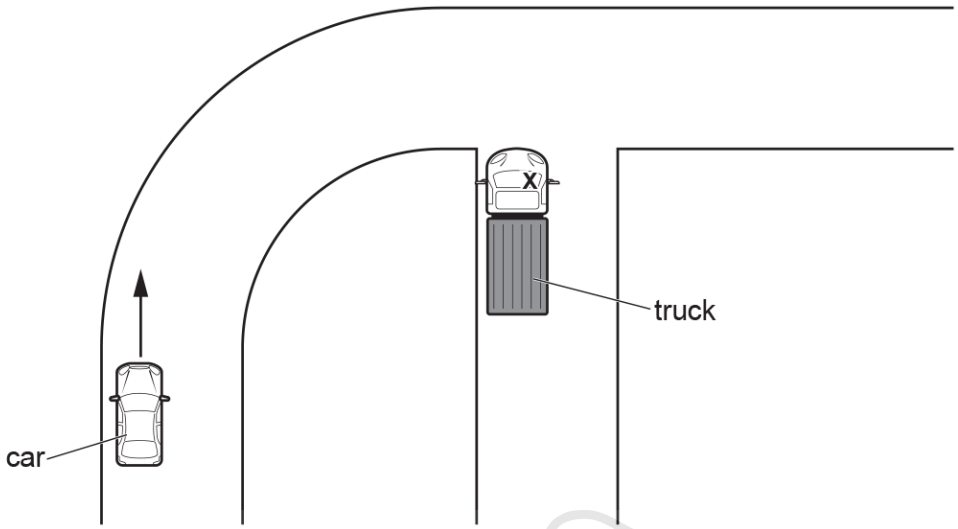

Fig. 5.1

(a) The driver of the truck is at position **X**. The car moves around the corner.

On Fig. 5.1, label a point Y on the road where the truck driver first sees the car. [1]

(b) A plane mirror is placed at the road junction as shown in Fig. 5.2.

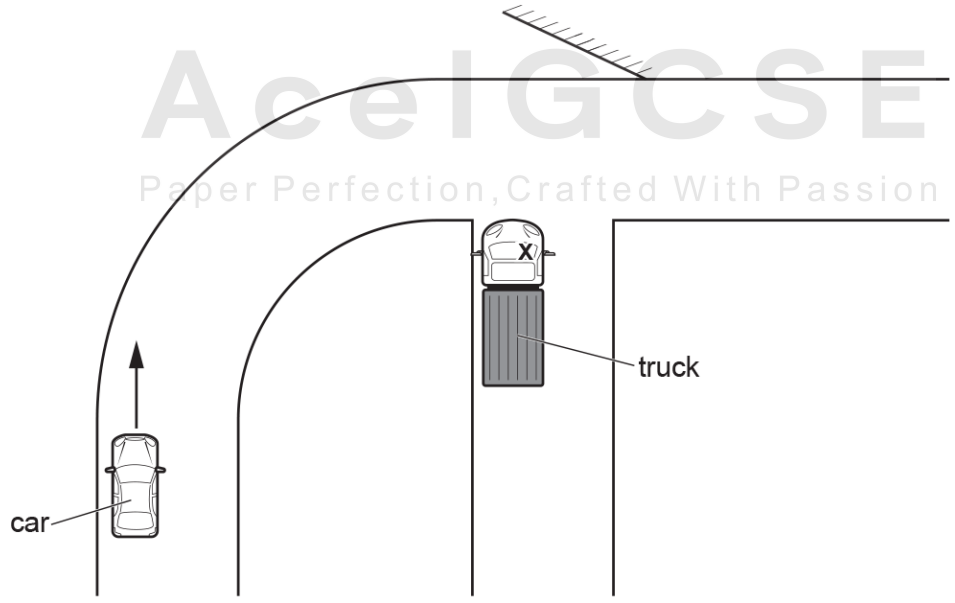

Fig. 5.2

Show how this mirror allows the driver of the truck to see the car when it is at the position shown in Fig. 5.2. [2]

(c) The truck driver wears spectacles to correct long-sightedness. Fig. 5.3 shows how a blurred image of an object O forms on the retina. Any effect of the cornea on the rays of light can be ignored.

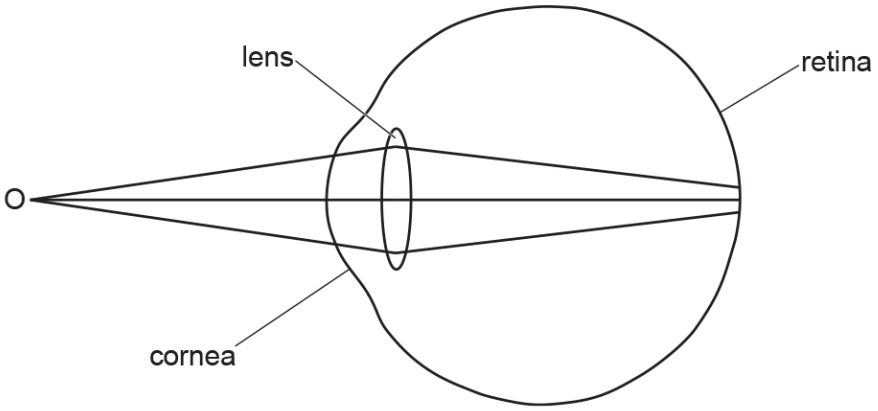

Fig. 5.3

On Fig. 5.4, show how long-sightedness is corrected by:

- adding a suitable lens in front of the eye
- continuing the path of the **three** rays of light until they meet to form an image.

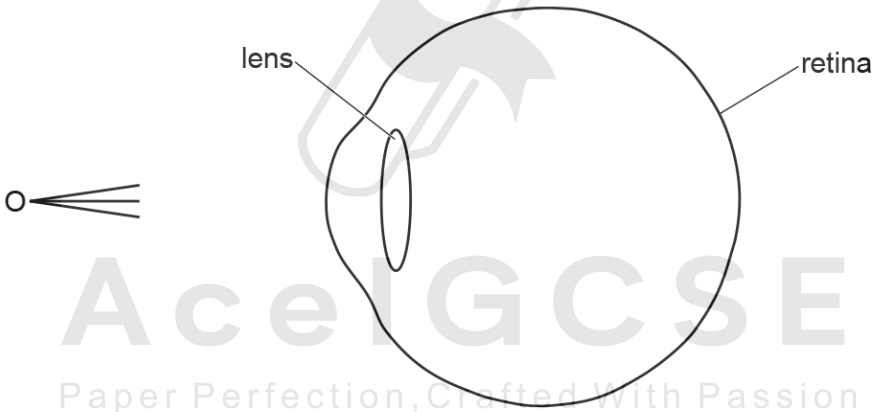

Fig. 5.4

[4]

07. 0625_m22_qp_42 Q: 5

A boy looks at the image of a clock in a plane mirror. Fig. 5.1 shows the mirror, the clock and the position of one of the boy's eyes.

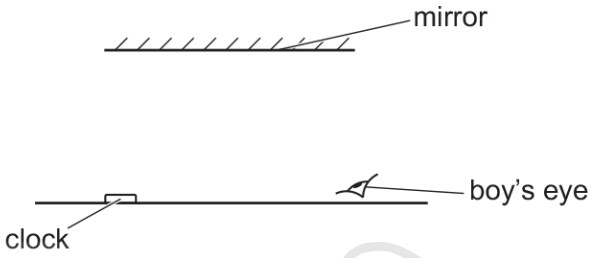

Fig. 5.1

(a) (i) On Fig. 5.1, draw a ray of light from the clock, reflected to the boy's eye. [2]

(ii) On Fig. 5.1, mark with an X the position of the image of the clock. [1]

(iii) State whether the image formed by the mirror is virtual or real.

Explain your answer.

.....

..... [1]

(iv) Fig. 5.2 shows the image of the clock seen by the boy.

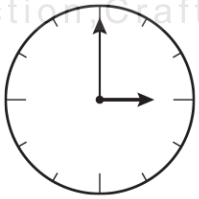

Fig. 5.2

The boy now looks directly at the clock.

On Fig. 5.3, draw what the boy sees.

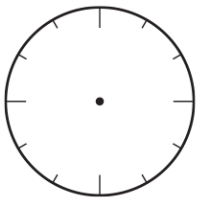

Fig. 5.3

[1]

(b) (i) The clock is illuminated by a source of monochromatic green light.

State the meaning of monochromatic.

..... [1]

(ii) The green light has a wavelength of 5.6×10^{-7} m.

Calculate the frequency of this green light.

frequency = ... [3]

08. 0625_s22_qp_41 Q: 7

Fig. 7.1 is a full-scale diagram of a small nail N in front of a thin converging lens. The line L represents the lens.

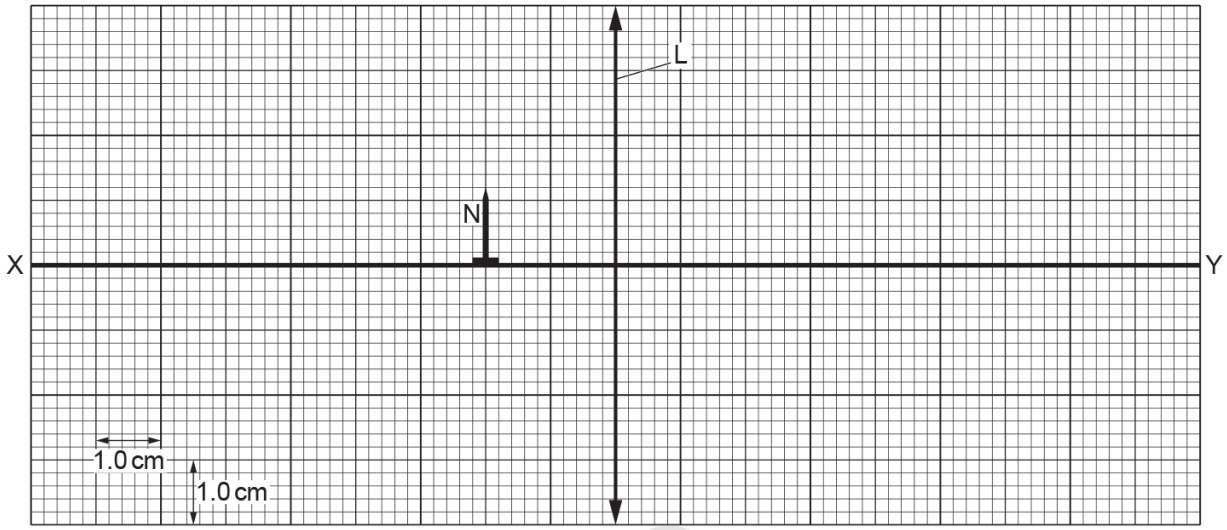

Fig. 7.1 (full scale)

The focal length of the lens is 3.0 cm.

(a) Rays of light, parallel to XY, are travelling towards the lens.

Describe what happens to the light after it passes through the lens.

.....

.....

.....

..... [3]

(b) On Fig. 7.1, mark and label with an F each of the **two** principal focuses of the lens. [1]

(c) The small nail N, of height 1.2 cm, is positioned 2.0 cm to the left of the lens.

(i) By drawing on Fig. 7.1, find the position of the image I of N and add image I to the diagram. [3]

(ii) State and explain whether I is a real or a virtual image.

.....

..... [1]

(iii) State the name given to a lens when it is used in this way.

..... [1]

09. 0625_s22_qp_42 Q: 6

Fig. 6.1 is a full-size ray diagram showing the formation of an image by a thin glass lens.

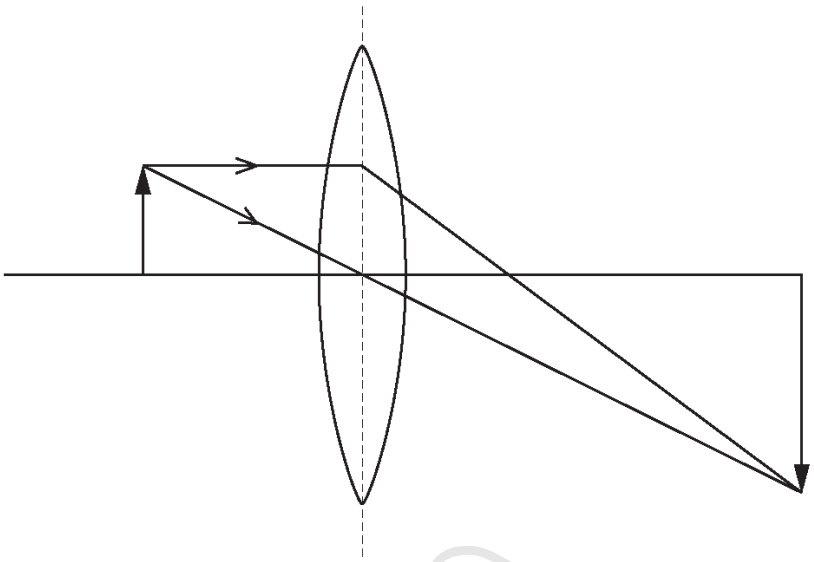

Fig. 6.1 (full size)

(a) Determine the focal length of the lens.

focal length = ... [1]

(b) Circle **three** items in the list which describe the nature of the image formed.

enlarged	**same size**	**diminished**	**inverted**
upright	**real**	**virtual**	

[3]

(c) State **one** feature of a virtual image.

..... [1]

10. 0625_w22_qp_41 Q: 6

The red light produced by a laser is monochromatic.

(a) State what is meant by monochromatic.

.....

..... [1]

(b) The red light from the laser hits the curved surface of a semicircular transparent plastic block at point P and passes into the plastic.

The red light travels through the plastic and hits the straight edge of the block at its midpoint M. Fig. 6.1 shows that some of the light is reflected and that some light travels in the air along the straight edge of the plastic block.

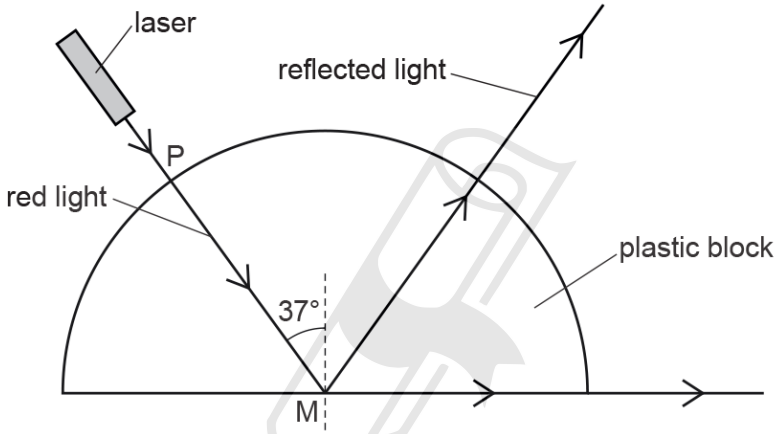

Fig. 6.1

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

(i) Explain why the red light does **not** change direction as it enters the plastic block.

.....

.....

..... [2]

(ii) At M, the angle between the red light in the plastic and the normal is 37°.

Calculate the speed of the red light in the plastic.

speed = ... [4]

(iii) In the plastic, blue light travels slightly slower than red light and so the critical angle for blue light is smaller than the critical angle for red light.

The laser that emits red light is replaced by one that emits blue light. Now blue light enters the block at P and hits the straight edge at M.

Explain what happens to the blue light after it hits the straight edge at M.

.....

.....

.....

..... [3]

11. 0625_w22_qp_42 Q: 6

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

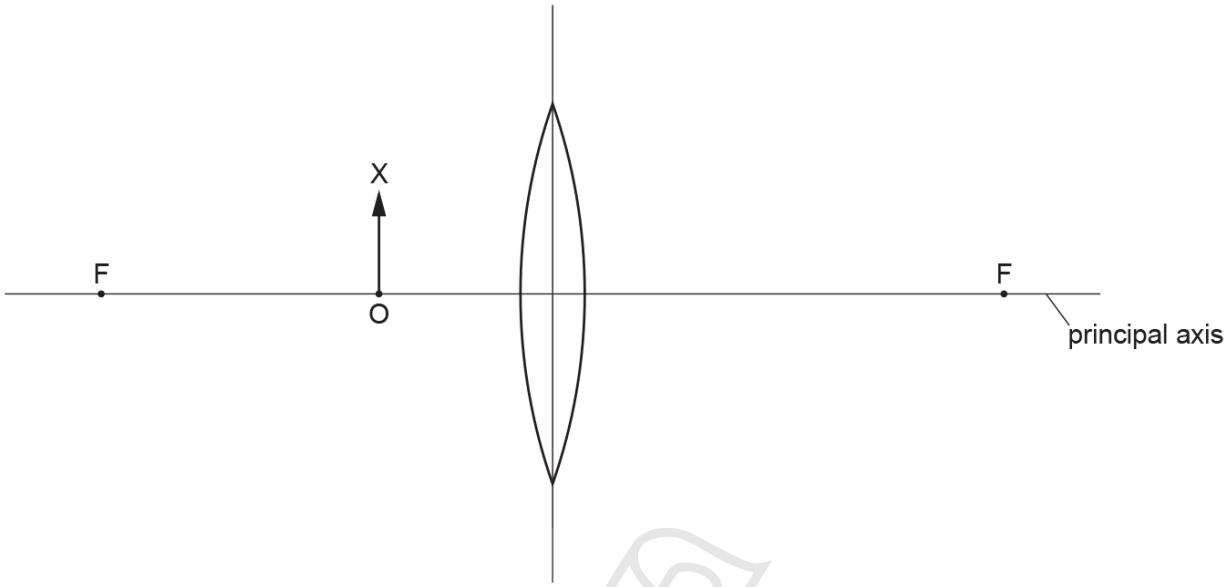

Fig. 6.1

(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]

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

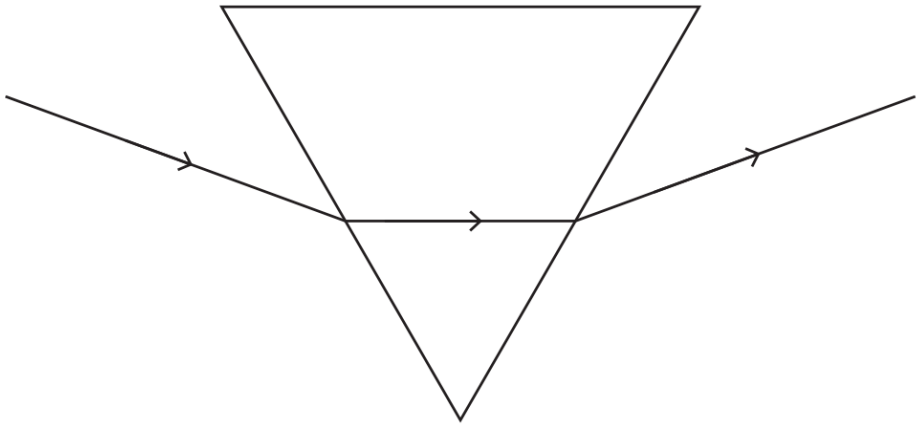

Fig. 6.2

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]

12. 0625_w22_qp_43 Q: 7

(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.

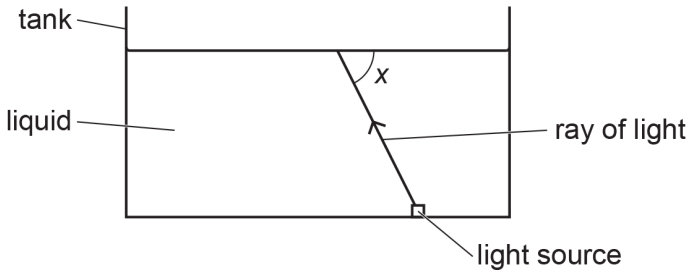

Fig. 7.1

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]

13. 0625_m21_qp_42 Q: 6

(a) Fig. 6.1 is a full scale diagram showing a converging lens, the two principal focuses F_1 and F_2 and an object PO.

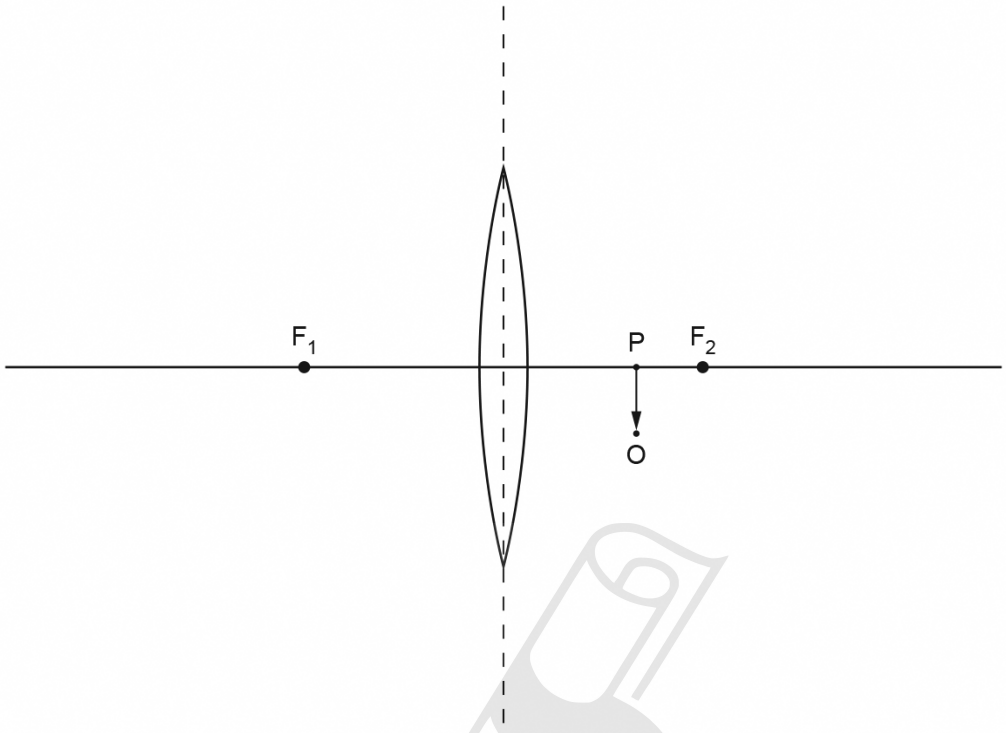

Fig. 6.1

On Fig. 6.1, draw two rays from point O of the object to determine the position of the image. Label the image IJ. Measure the length of the image.

image length = ...

[3]

(b) Ring **three** descriptions of the image.

diminished	**magnified**	**real**	**same size**
same way up as object	**upside down compared to object**	**virtual**	

[3]

(c) Fig. 6.2 shows three rays of green light passing through glass blocks.

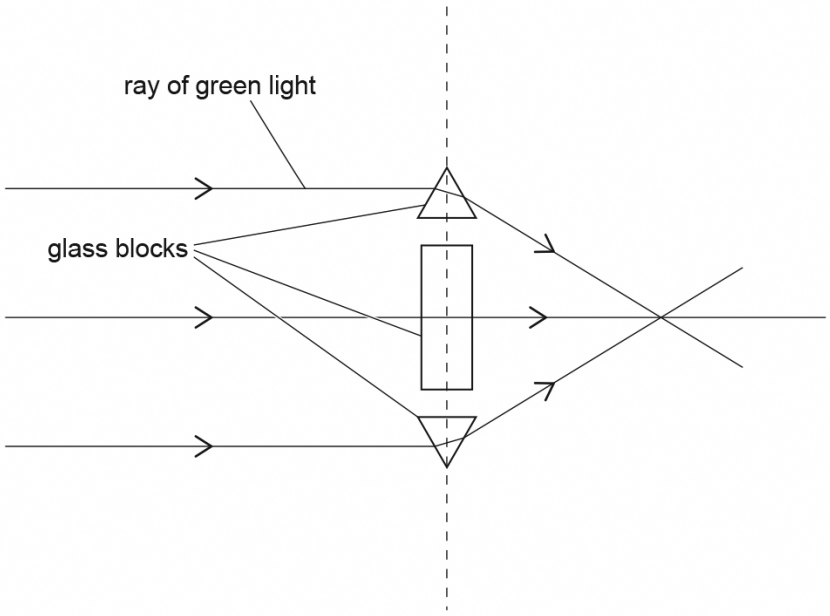

Fig. 6.2

Three rays of red light approach the glass blocks on the same paths as the rays of green light.

On Fig. 6.2, draw the paths of these rays of red light to the right of the glass blocks. [2]

[Total: 8]

14. 0625_s21_qp_42 Q: 6

(a) Fig. 6.1 shows a ray of green light passing through a prism.

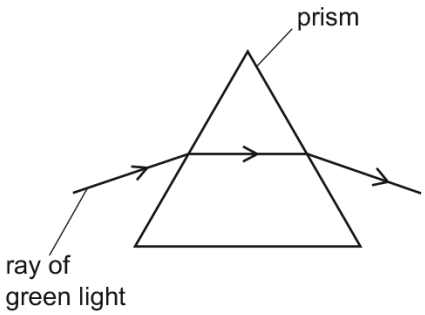

Fig. 6.1

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

On Fig. 6.1, draw the path of the blue light through and out of the prism. [3]

(b) The wavelength of the blue light in air is 4.8×10^{-7} m.

Calculate the frequency of the blue light.

frequency = ... [3]

[Total: 6]

15. 0625_s21_qp_43 Q: 6

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

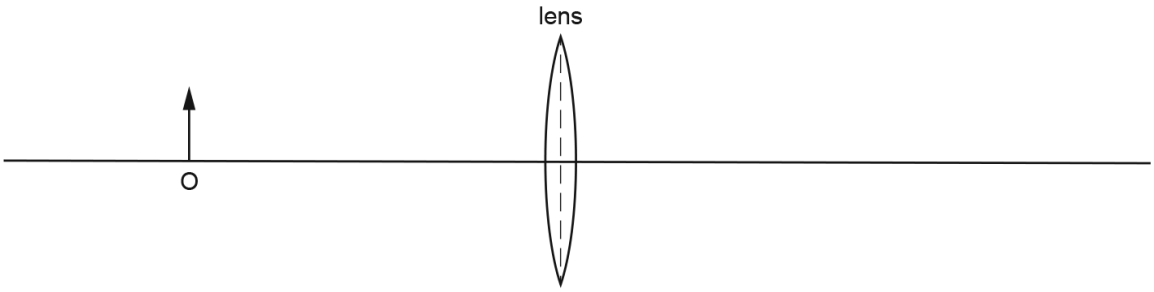

Fig. 6.1

(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]

16. 0625_w21_qp_41 Q: 5

(a) Explain, in terms of the behaviour of light rays, what is meant by *principal focus* for a thin converging lens.

.....

.....

..... [2]

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

.....

..... [1]

(c) A lens is used to produce a focused image of an object on a translucent screen. Fig. 5.1 shows the object O and its image I.

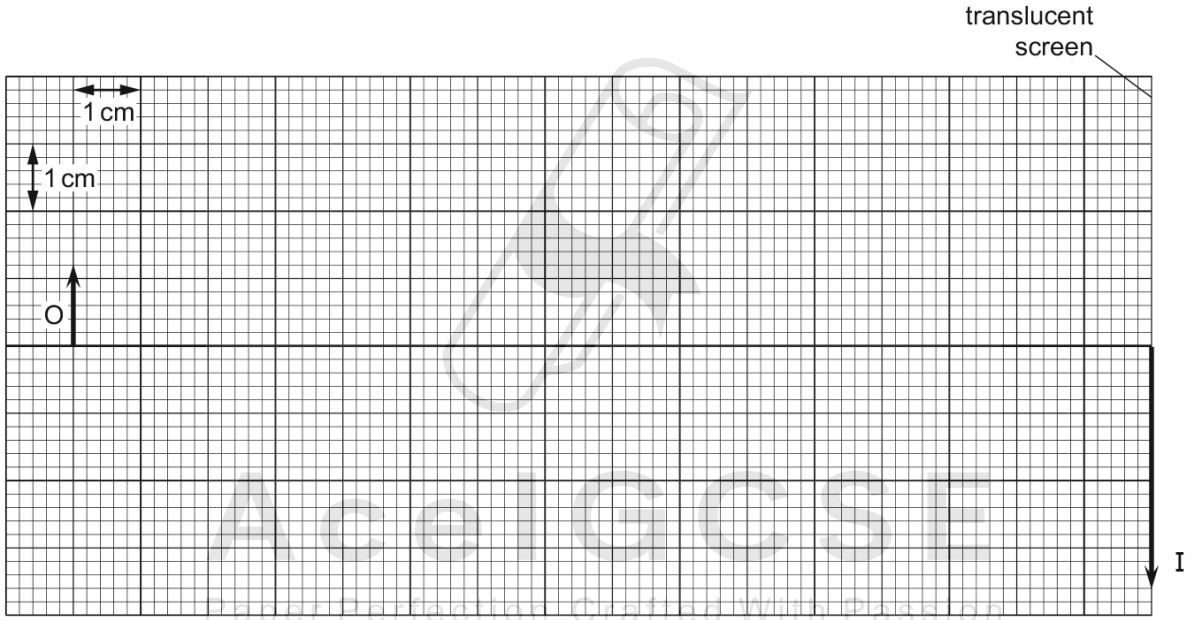

Fig. 5.1

(i) Consider the straight ray that passes from the tip of O to the tip of I and find the position of the lens. Mark the position of the lens by drawing a vertical line labelled L from the top of the grid to the bottom. [1]

(ii) On Fig. 5.1, draw a ray that passes through one of the principal focuses and determine the focal length of the lens.

focal length = ... [2]

(iii) Object O is a printed document that includes a large letter R on the side facing the lens. The top edge of the document corresponds to the tip of O. Fig. 5.2 shows the printed document.

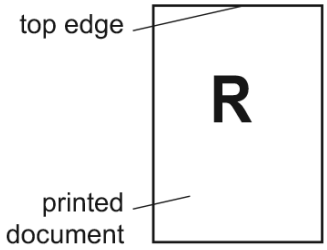

Fig. 5.2

Fig. 5.3

On Fig. 5.3, mark a tick in **one** of the boxes (☑) to indicate how the image on the translucent screen appears to someone who is looking at the screen from point P. Explain why the image has this appearance.

.....

.....

..... [2]

17. 0625_w21_qp_42 Q: 7

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

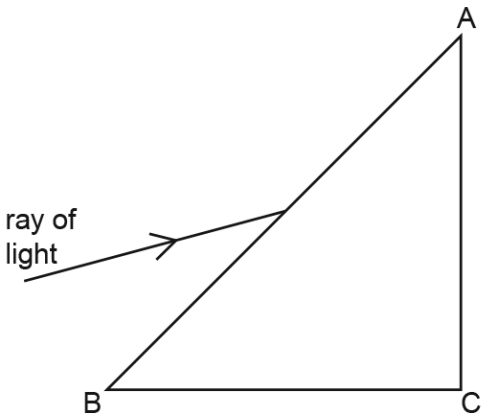

Fig. 7.1

(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.

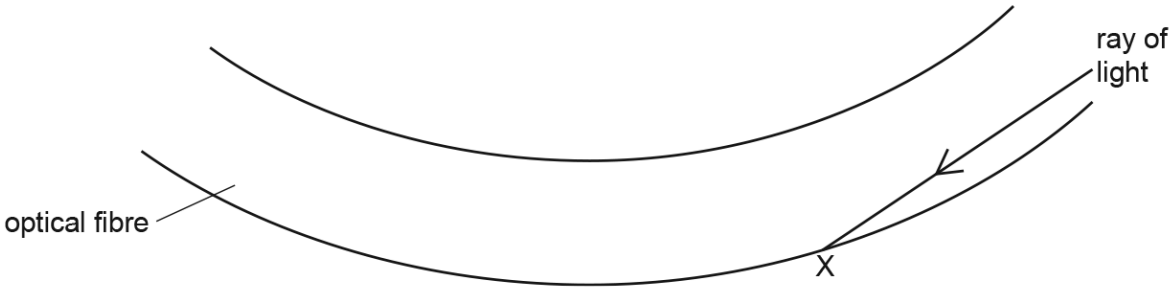

Fig. 7.2

(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]

18. 0625_w21_qp_43 Q: 7

(a) Fig. 7.1 shows a ray of green light emerging from one face of a glass prism.

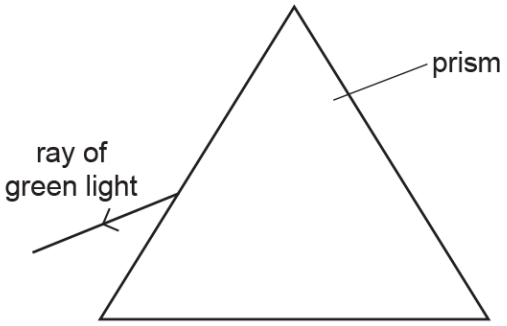

Fig. 7.1

(i) On Fig. 7.1, draw the path of the green light entering and passing through the prism. [2]

(ii) The green light is monochromatic. State, in terms of a **wave property**, what is meant by monochromatic light.

..... [1]

(b) (i) State the speed of light in air.

..... [1]

(ii) The wavelength of green light in air is 5.2×10^{-7} m.

Calculate the frequency of green light.

frequency = ... [2]

(iii) The refractive index of glass for green light is 1.52.

Calculate the speed of green light in glass.

speed = ... [2]

19. 0625_m20_qp_42 Q: 7

(a) Fig. 7.1 shows a converging lens and the image I formed when an object is placed to the left of the lens. The principal focuses are labelled A and B and the centre of the lens is labelled C.

(i) On Fig. 7.1, draw two rays to locate the position of the object.
Draw the object and label it O.

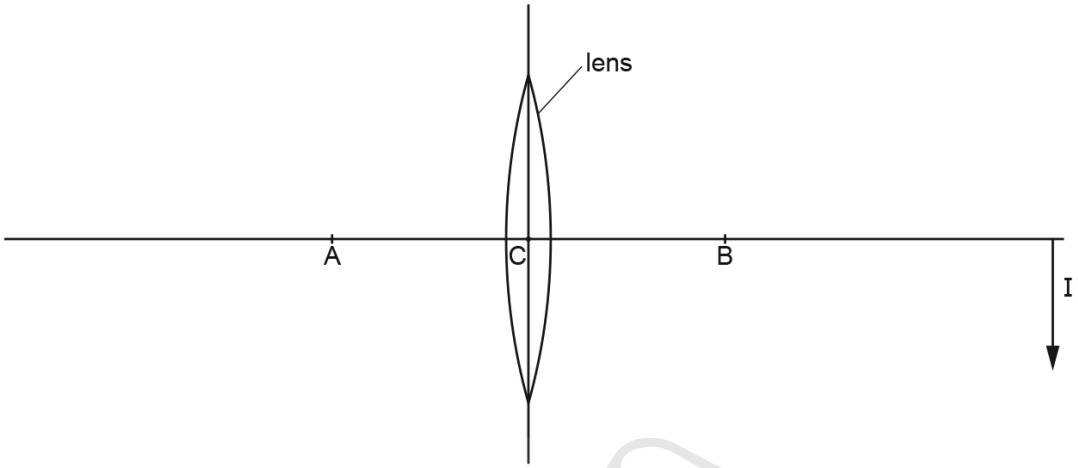

Fig. 7.1

[3]

(ii) Ring all of the following distances that are equal to the focal length of the lens.

AB AC CB 2AB

[2]

(b) Fig. 7.2 shows green light passing through a triangular glass block.

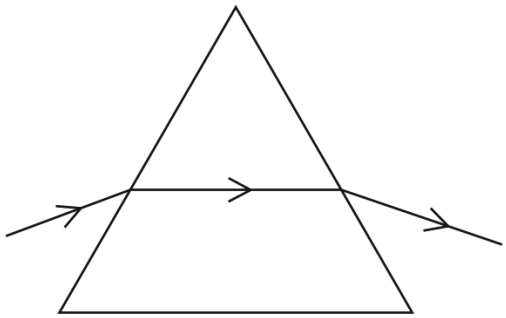

Fig. 7.2

Red light enters the triangular glass block shown in Fig. 7.2 along the same path as the green light.

(i) On Fig. 7.2, draw the path of the red light within the triangular glass block. [1]

Fig. 7.3 shows green light passing through a rectangular glass block.

Red light enters the rectangular glass block shown in Fig. 7.3 along the same path as the green light.

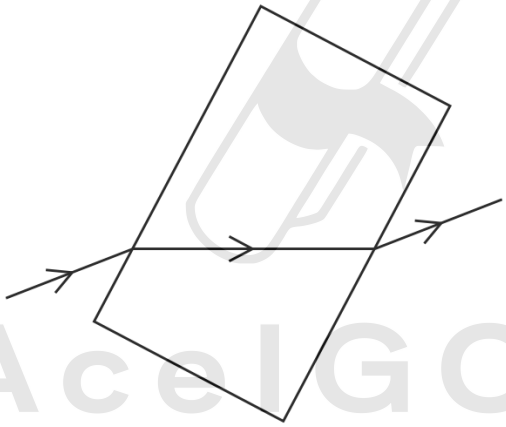

Fig. 7.3

On Fig. 7.3:

(ii) draw the path of the red light within the rectangular glass block [1]

(iii) draw the path of the red light after leaving the rectangular glass block. [1]

[Total: 8]

20. 0625_s20_qp_41 Q: 5

The distance between the centre of a thin converging lens and each principal focus is 5.0 cm.

(a) Describe what is meant by the term *principal focus* for a thin converging lens.

.....

.....

..... [2]

(b) The lens is used as a magnifying glass to produce an image I of an object O.

(i) Underline the terms that describe the nature of the image produced by a magnifying glass. [2]

diminished **enlarged** **inverted** **real** **same size** **upright** **virtual**

(ii) Fig. 5.1 is a full-scale diagram of the lens and the image I.

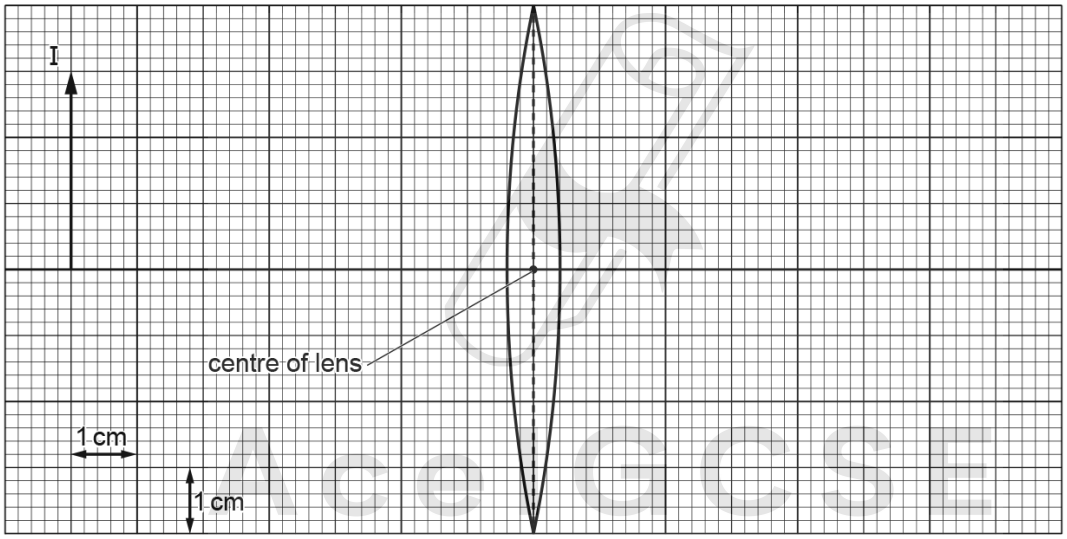

Fig. 5.1 (full-scale)

1. On Fig. 5.1, mark both principal focuses and label each of them F. [1]

2. By drawing on Fig. 5.1, find the position of object O and add object O to the diagram. [3]

(iii) Using Fig. 5.1, determine the distance of object O from the centre of the lens.

distance = ... [1]

[Total: 9]

21. 0625_s20_qp_42 Q: 6

(a) Fig. 6.1 shows an arrangement of glass prisms inside a box. The angles of the prisms are 45°, 45° and 90°.

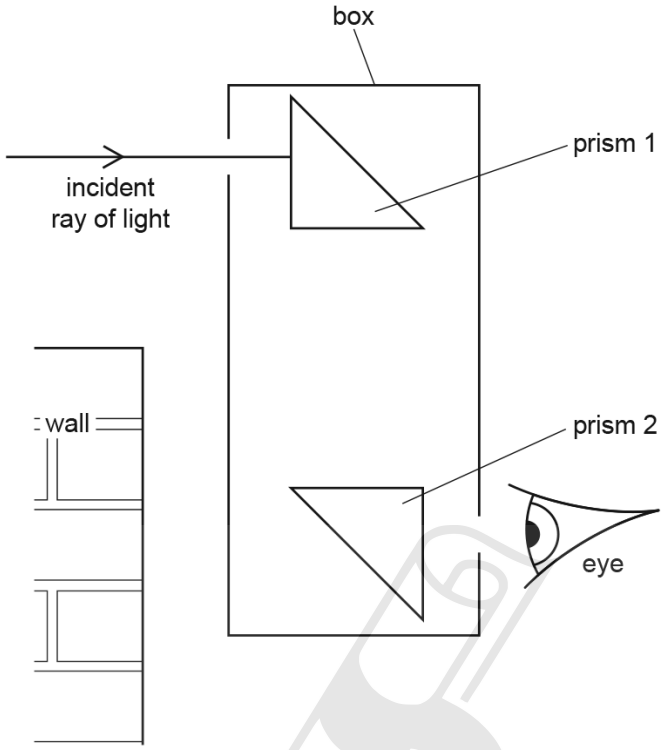

Fig. 6.1 (not to scale)

This is a device used to view objects that are behind a wall.
The incident ray of light undergoes total internal reflection in the prisms.

On Fig. 6.1, complete the path of the ray through the device and show the ray as it emerges from the box. [3]

(b) Show that the refractive index of glass with a critical angle of 45° is 1.41.

[2]

[Total: 5]

22. 0625_s20_qp_43 Q: 7

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

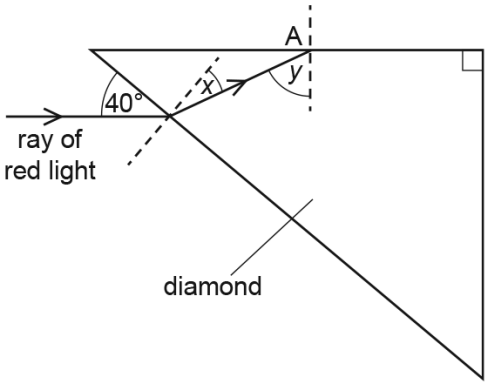

Fig. 7.1 (not to scale)

(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]

23. 0625_w20_qp_41 Q: 6

Fig. 6.1 shows a shallow tank viewed from above. The depth of the water is different in the two parts of the tank. Fig. 6.1 shows the crests and the troughs of a wave that pass from left to right.

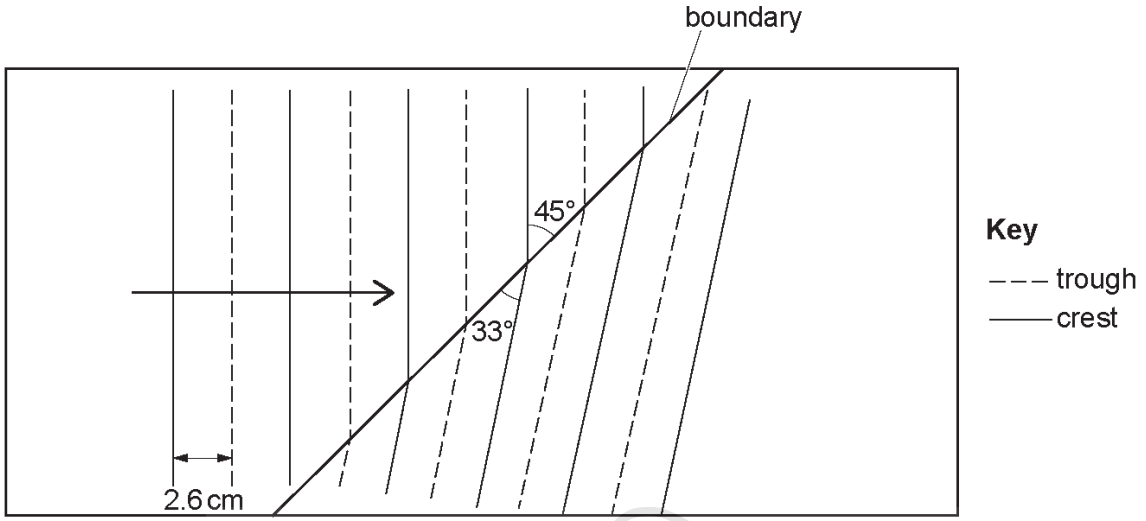

Fig. 6.1 (not to scale)

As the wave passes from one side to the other, the direction of the wavefronts changes.

(a) Explain why the direction of the wavefronts changes in the way shown in Fig. 6.1.

.....

.....

.....

.....

..... [3]

(b) The speed of the wave in the left-hand part of the tank is 0.39 m/s.

(i) Using information from Fig. 6.1, determine the frequency of the wave.

frequency = ... [3]

(ii) Determine the speed of the wave in the right-hand side of the tank.

speed = ... [3]

---

24. 0625_w20_qp_41 Q: 9

(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]

---

25. 0625_w20_qp_42 Q: 7

Fig. 7.1 shows a ray of light passing through an optical fibre.

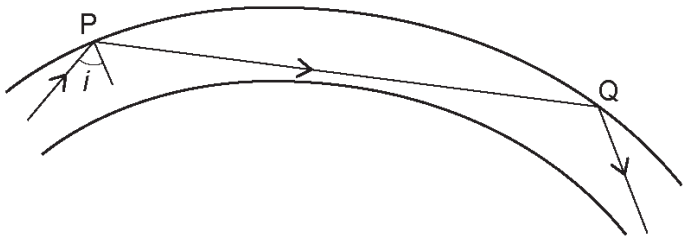

Fig. 7.1

The optical fibre is made of glass that has a refractive index of 1.4.

(a) (i) No light refracts from the fibre at points P and Q.

State the name of the process that occurs at P and Q.

..... [1]

(ii) Calculate the minimum value of angle *i* for there to be no refraction at point P.

angle = ... [2]

(b) State and explain the use of optical fibres in medicine.

.....

.....

.....

.....

.....

..... [3]

(c) The ray of light shown in Fig. 7.1 is monochromatic light from a laser.

State what is meant by monochromatic light. Use **one** of the following quantities in your answer.

amplitude **brightness** **frequency** **refractive index** **speed**

.....

..... [2]

26. 0625_m19_qp_42 Q: 8

Fig. 8.1 shows parallel wavefronts of a light wave in ice. The wavefronts are incident on a boundary with air.

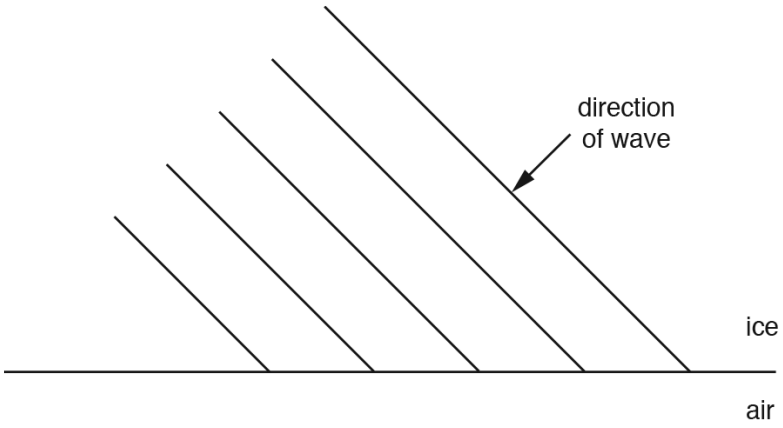

Fig. 8.1

The speed of the light wave in air is 3.0×10^8 m/s. The refractive index of the ice is 1.3.

(a) On Fig. 8.1:

(i) draw the wavefronts of the wave that passes into the air [3]

(ii) draw arrows to show the direction of travel of the refracted wave [1]

(iii) label the angle of incidence *i* and the angle of refraction *r*. [1]

(b) Calculate the speed of the light wave in the ice.

speed = ... [2]

[Total: 7]

27. 0625_s19_qp_41 Q: 6

Green light of frequency 5.7×10^{14} Hz is travelling in air at a speed of 3.0×10^{8} m/s. The light is incident on the surface of a transparent solid.

Fig. 6.1 shows the wavefronts and the direction of travel of the light in the air.

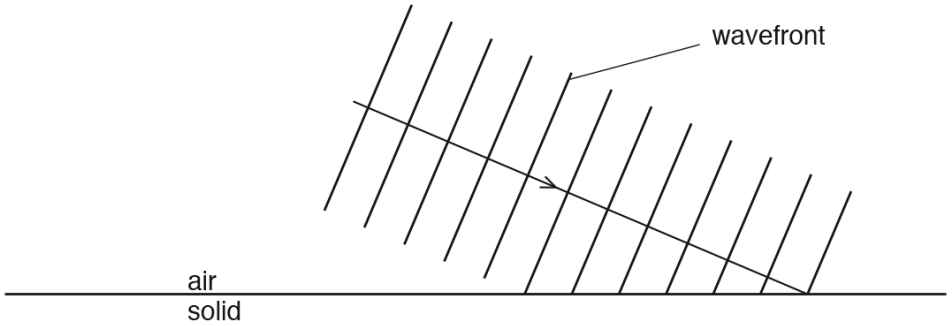

Fig. 6.1

The light travels more slowly in the transparent solid.

(a) Explain, in terms of the wavefronts, why the light changes direction as it enters the solid. You may draw on Fig. 6.1 as part of your answer.

.....

.....

.....

..... [3]

(b) The refractive index of the transparent solid is 1.3.

(i) The light is incident on the surface of the solid at an angle of incidence of 67°.

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

angle of refraction = ... [2]

(ii) Determine the wavelength of the green light in the transparent solid.

wavelength = ... [4]

[Total: 9]

---

28. 0625_s19_qp_42 Q: 7

(a) In Fig. 7.1, a converging lens projects a sharp image of an object O on to a screen.

Complete the paths of the two rays from the object to the screen.

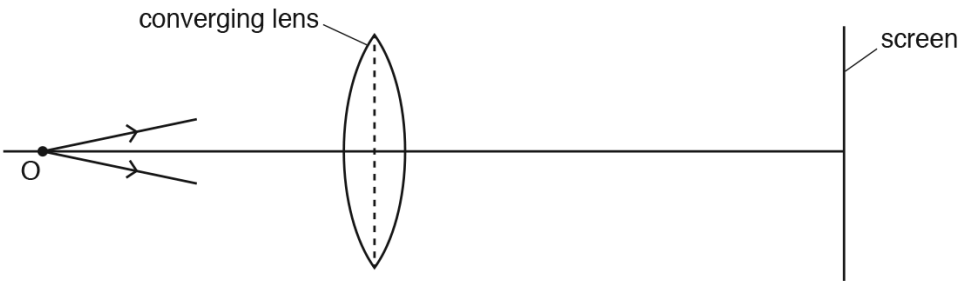

Fig. 7.1 [2]

(b) The converging lens in **(a)** is replaced with a thinner converging lens. The object O and the screen remain in the same positions as in **(a)**. The thinner converging lens has a longer focal length than the converging lens in **(a)**.

Complete the paths of the two rays from the object to the screen in Fig. 7.2.

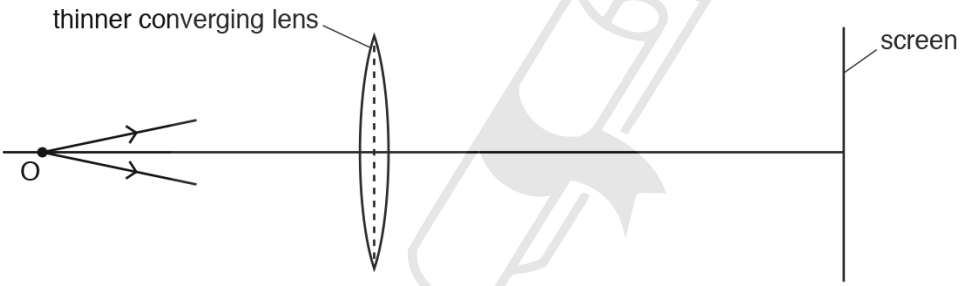

Fig. 7.2 [2]

(c) A converging lens is used as a magnifying glass.
The focal length of the lens is 10 cm.

(i) Describe the position of the object in relation to the lens.

.....

..... [1]

(ii) Describe the position of the image in relation to the lens and the object.

.....

..... [1]

(iii) Give three properties of the image formed by a magnifying glass.

.....

.....

..... [2]

[Total: 8]

29. 0625_s19_qp_43 Q: 7

Fig. 7.1 shows light approaching a boundary between two materials at speed v. The speed of the light after crossing the boundary is $1.3v$.

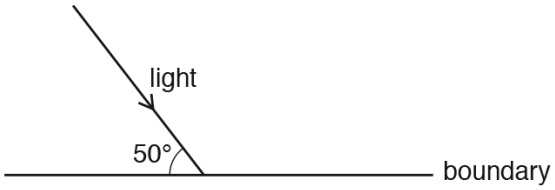

Fig. 7.1

(a) Determine the angle of incidence.

angle of incidence = ... [1]

(b) Calculate the angle of refraction.

angle of refraction = ... [3]

[Total: 4]

30. 0625_w19_qp_41 Q: 8

Fig. 8.1 shows a ray of red light incident on one side of a glass prism in air.

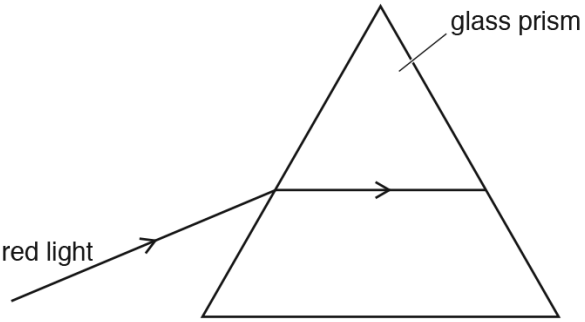

Fig. 8.1

For red light, the refractive index of glass is n_R.

(a) The angle of incidence is 53° and the angle of refraction in the glass is 30°.

(i) Calculate n_R.

n_R = ... [2]

(ii) On Fig. 8.1, sketch a line to indicate the path of the red light when it emerges from the glass prism. Label this path R. [1]

(iii) Explain why the quantity *refractive index* does not have a unit.

.....

..... [1]

(b) For violet light, the refractive index n_V of glass is slightly larger than n_R.

(i) A ray of violet light is incident on the prism along the same path as the ray of red light.

On Fig. 8.1, sketch a line to indicate the path of the violet light in the prism and when it emerges into the air. Label this path V. [1]

(ii) When a ray of white light is incident on the prism, dispersion produces a continuous spectrum of coloured light.

State how the speed of light in glass depends on its frequency. Explain how this is shown by the dispersion of white light in the prism.

statement .....

explanation .....

.....

[3]

[Total: 8]

31. 0625_w19_qp_42 Q: 6

(a) Fig. 6.1 shows an empty container and an observer's eye. There is a small coin at position O. The observer is unable to see the coin.

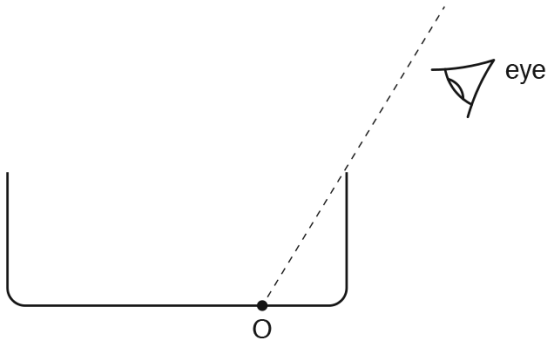

Fig. 6.1

The observer and the coin stay in the same position and the container is filled with water. The observer can now see the coin.

(i) Explain why the coin can be seen by the observer.

.....

..... [2]

(ii) State the name of the wave process which occurs as the light passes from the water into the air.

..... [1]

(iii) Explain why the image of the coin is a virtual image.

..... [1]

(b) State the speed of light in air.

..... [1]

(c) The refractive index of water is 1.3.

Calculate the speed of light in water.

speed of light in water = ... [3]

[Total: 8]

32. 0625_w19_qp_43 Q: 7

(a) Fig. 7.1 shows the position of a converging lens, its principal axis and an object O.

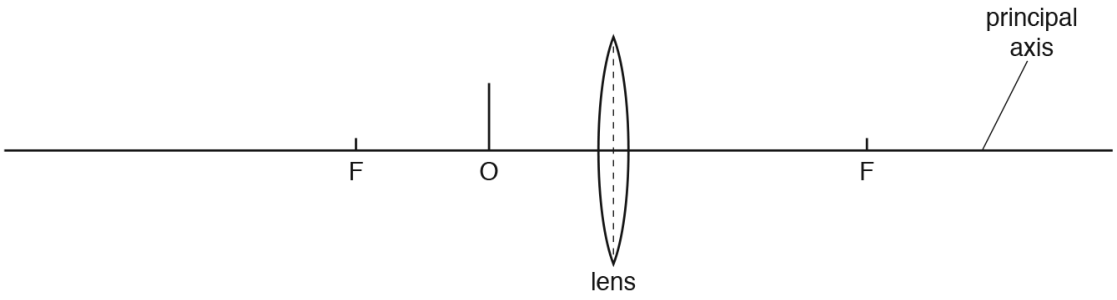

Fig. 7.1

Each principal focus of the lens is labelled F.

On Fig. 7.1, draw a ray diagram to locate the position of the image formed by the lens.

Label the image I. [3]

(b) Describe the nature of the image I.

..... [2]

(c) Images formed by lenses sometimes have coloured edges.

Suggest a reason for this.

.....

..... [1]

[Total: 6]

33. 0625_m18_qp_42 Q: 7

(a) The speed of a light wave in air is 3.00×10^8 m/s. The refractive index of water is 1.33.

Calculate the speed of the light wave in water.

speed = ... [2]

(b) Fig. 7.1 shows parallel wavefronts of a light wave in air incident on a boundary with a transparent plastic.

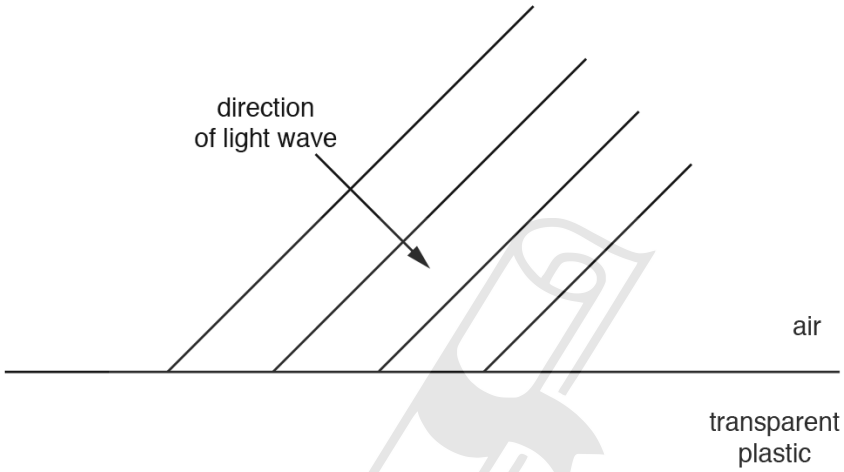

Fig. 7.1

On Fig. 7.1,

(i) draw the positions of the four refracted wavefronts in the plastic, [3]

(ii) draw an arrow to show the direction of travel of the refracted wave, [1]

(iii) label the angle of refraction *r* of the light wave. [1]

[Total: 7]

34. 0625_s18_qp_41 Q: 5

(a) A ray of light in air is incident on a glass block. The light changes direction.

State

(i) the name of this effect,

.....[1]

(ii) the cause of this effect.

.....[1]

(b) Fig. 5.1, drawn to full scale, shows a thin converging lens of focal length 3.5 cm.

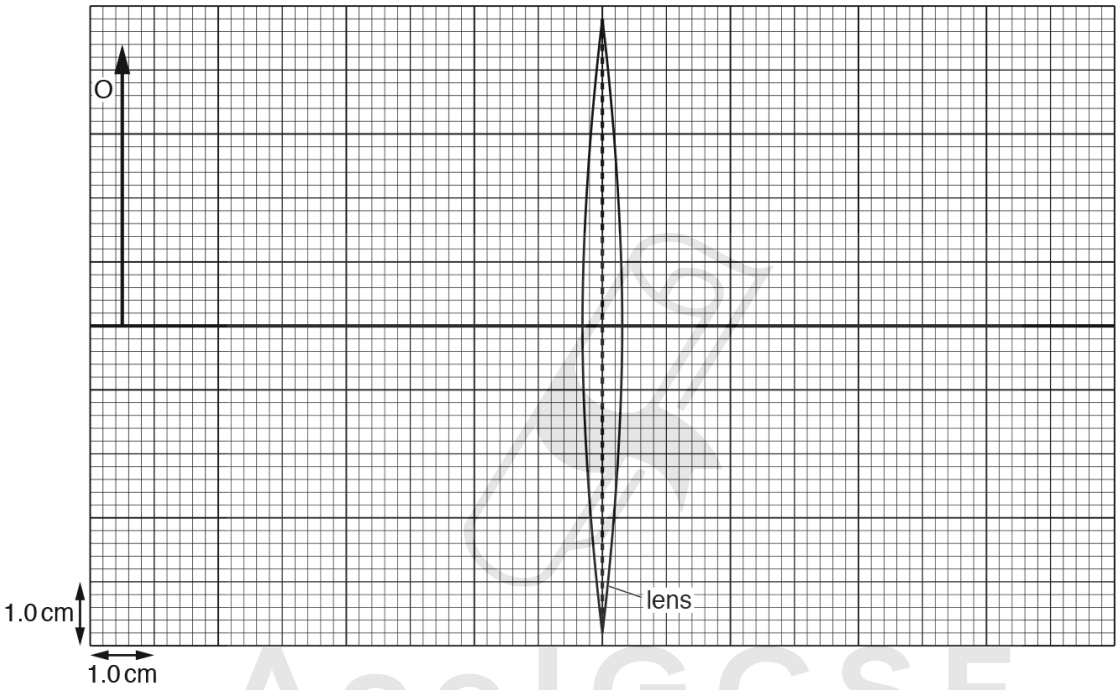

Fig. 5.1

(i) On Fig. 5.1, mark each of the two principal focuses and label each with the letter F. [1]

(ii) An object O of height 4.4 cm is placed a distance of 7.5 cm from the lens.

On Fig. 5.1, draw rays from the tip of the object O to locate the image. Draw and label the image. [3]

(iii) Determine the height of the image.

height of the image = ...[1]

(iv) State and explain whether the image is real or virtual.

.....

.....[1]

[Total: 8]

35. 0625_s18_qp_42 Q: 7

(a) Fig. 7.1 shows a ray of light in water that is incident on a submerged, transparent plastic block.

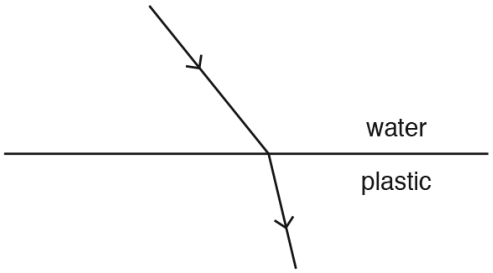

Fig. 7.1

State what happens to the speed of light as it enters the plastic block. Explain your answer.

.....

.....

.....[2]

(b) Fig. 7.2 shows the two principal focuses F_1 and F_2 of a thin converging lens.

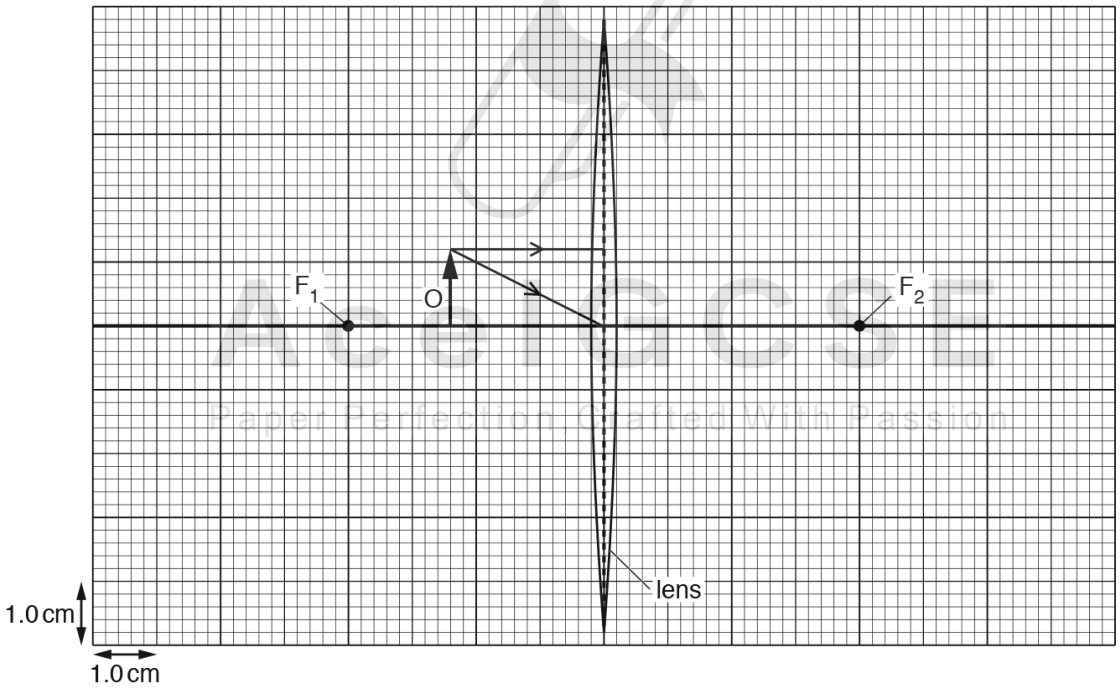

Fig. 7.2

Fig. 7.2 also shows an object O of height 1.2 cm placed close to the lens. Two rays from the tip of the object O are incident on the lens.

(i) On Fig. 7.2, continue the paths of these two rays for a further distance of at least 5 cm. [2]

(ii) Using your answer to **(b)(i)**, find and mark on Fig. 7.2 the image I of object O and label this image. [2]

(iii) Determine the height of image I.

height = ...[1]

(iv) State and explain whether I is a real image or a virtual image.

.....

.....[1]

[Total: 8]

---

36. 0625_s18_qp_43 Q: 7

(a) A ray of light travelling in air strikes a glass block at an angle of 30° to the normal. The light slows down as it enters the glass block.

State and explain, in terms of wavefronts, what happens to the light.

.....

.....

.....

.....[3]

(b) The speed of light in this block of glass is 1.9×10^8 m/s.

Calculate the refractive index of the glass.

refractive index = ...[2]

[Total: 5]

---

37. 0625_s18_qp_43 Q: 8

(a) A thin converging lens is used to produce an image I of object O.

Fig. 8.1 shows O, I and the screen on which the image is produced.

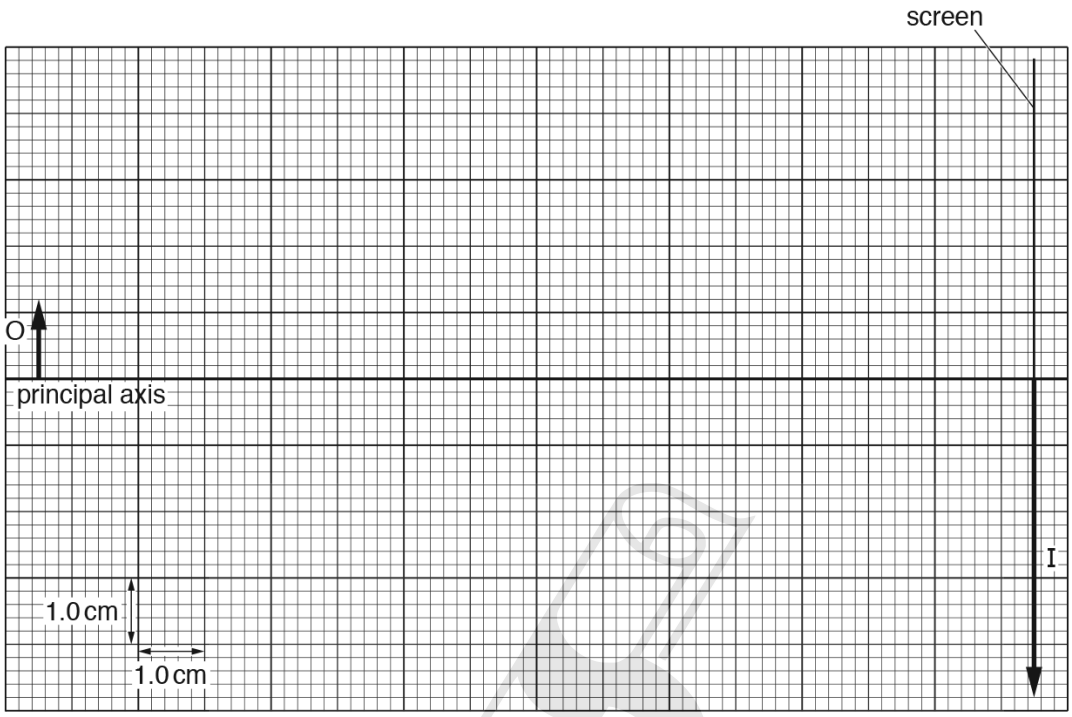

Fig. 8.1

(i) On Fig. 8.1, draw a straight line to represent a ray from the tip of the arrowhead of O to the tip of the arrowhead of I. Draw a vertical dotted line to indicate the position of the lens. This dotted line must extend above and below the principal axis. [2]

(ii) Draw a second ray from the tip of the object O to the tip of image I. This ray should pass through a principle focus. Label the principle focus, F. [1]

(iii) Determine the focal length of the lens.

focal length = ...[1]

(iv) Image I is further from the lens than object O is from the lens. Image I is described as enlarged and inverted.

State and explain one other characteristic of I.

.....

.....[1]

(b) Fig. 8.2 shows a spherical fishbowl, full of water, by a window. A black curtain hangs behind the fishbowl.

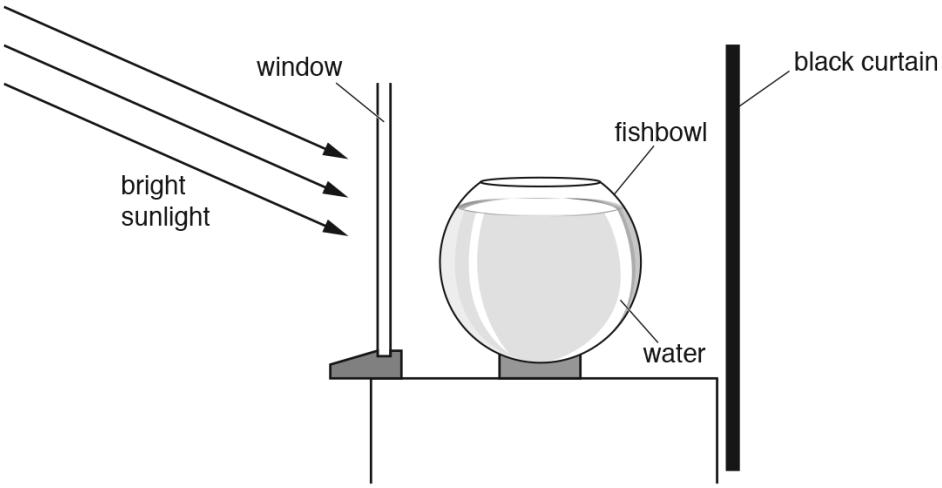

Fig. 8.2

When full of water, the fishbowl can act as a converging lens.

Suggest one possible hazard of leaving the fishbowl next to the window in bright sunlight.

.....

.....[1]

[Total: 6]

38. 0625_w18_qp_41 Q: 7

(a) A laser produces a beam of monochromatic light. State what is meant by the term *monochromatic*.

.....[1]

(b) A wave, in air, is incident on a glass block. Fig. 7.1 shows the wavefronts at the air-glass boundary. The arrow shows the direction of travel of the wavefronts.

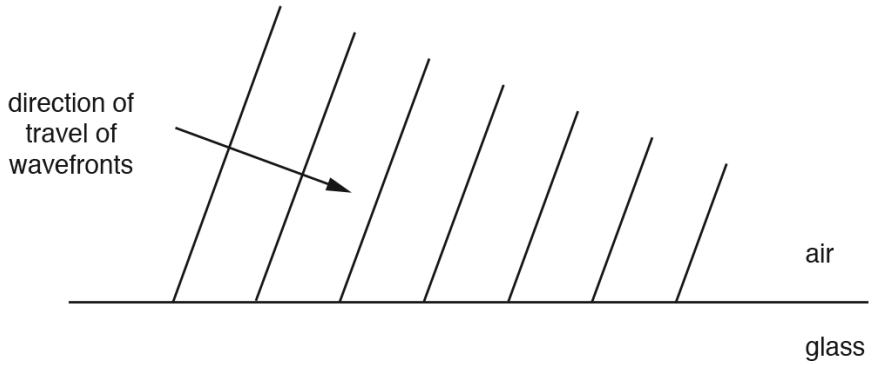

Fig. 7.1

The wave undergoes reflection and refraction at the air-glass boundary.

On Fig. 7.1 draw:

(i) the wavefronts of the reflected wave [3]

(ii) the wavefronts of the refracted wave. [3]

(c) A transverse wave is produced in a long, horizontal rope. The rope is much longer than the wavelength of the wave.

In the space below, sketch a diagram to show the appearance of the rope as the wave passes along it. Label **two** important features of the wave.

[2]

[Total: 9]

39. 0625_w18_qp_42 Q: 5

(a) Fig. 5.1 shows a visible spectrum focused on a screen by passing light from a source of white light through a lens and a prism.

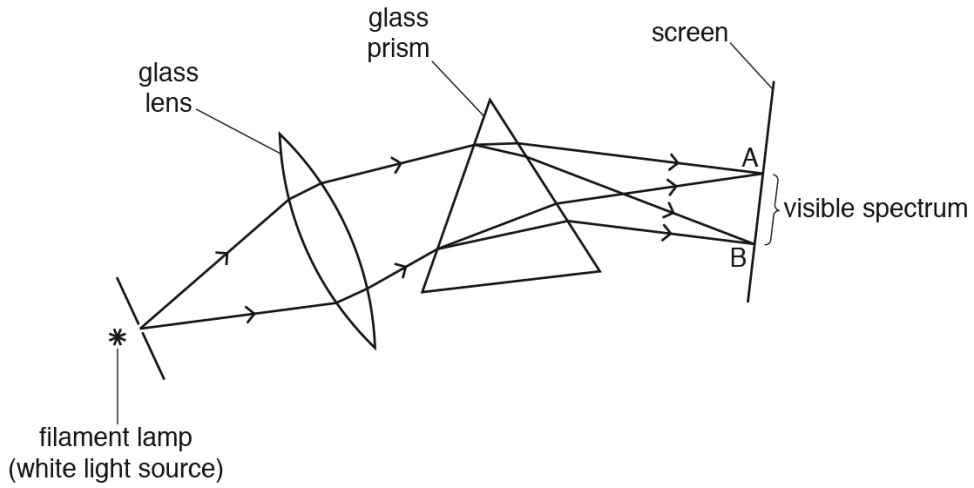

Fig. 5.1

(i) State the name of the process that separates the colours in white light.

.....[1]

(ii) State the colour of the light on the screen at:

point A .....

point B .....

[1]

(iii) State the property of the glass of the prism that causes white light to be split into the different colours of the spectrum.

.....[1]

(b) Fig. 5.2 shows a section of an optical fibre in air. A ray of light is incident on the fibre wall at X.

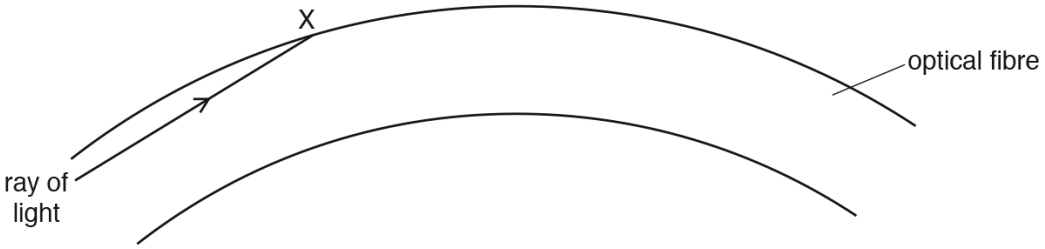

Fig. 5.2

(i) On Fig. 5.2, continue the path of the ray of light up to the end of the fibre. [1]

(ii) The refractive index of the material of the fibre is 1.46. Calculate the critical angle of the material of the fibre.

critical angle = ...[2]

(iii) State **two** uses of optical fibres.

1 .....

2 .....
[2]

[Total: 8]

40. 0625_w18_qp_43 Q: 6

(a) Fig. 6.1 shows white light incident at point X on a glass prism.

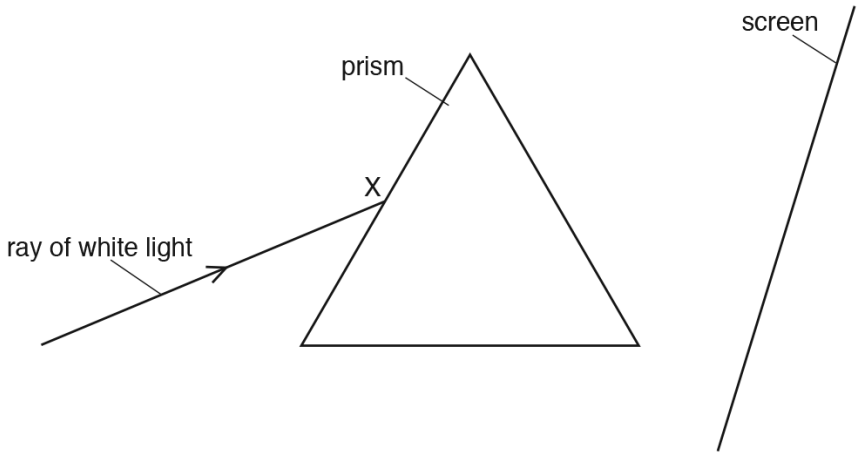

Fig. 6.1

(i) From point X on Fig. 6.1, draw a ray of red light, labelled R and a ray of violet light, labelled V, to show how a spectrum is formed on the screen. [2]

(ii) State the colour of light in the visible spectrum with the shortest wavelength.

.....[1]

(b) The critical angle for a type of glass is 42°.

Fig. 6.2 and Fig. 6.3 show two prisms ABC and PQR made of this type of glass. A ray of monochromatic red light passes into each of the prisms.

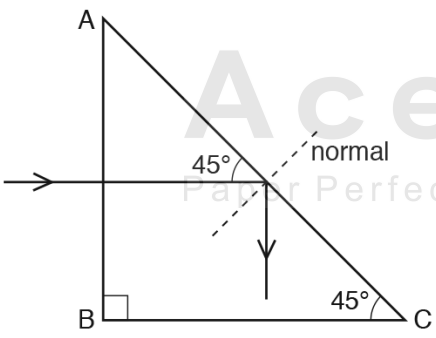

Fig. 6.2

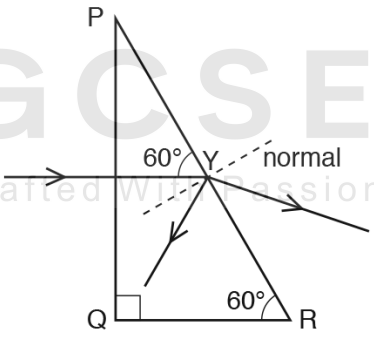

Fig. 6.3

(i) State what is meant by *monochromatic* light.

.....

.....[1]

(ii) Describe and explain what happens to the ray of light in Fig. 6.2 as it strikes side AC of the prism.

.....

.....

.....[2]

(iii) Describe and explain what happens to the ray of light in Fig. 6.3 as it strikes the glass at point Y.

.....

.....

.....

.....[3]

[Total: 9]

41. 0625_m17_qp_42 Q: 7

Fig. 7.1 shows an object and its image formed by a converging lens. One ray from the tip of the object to the tip of the image is shown.

Fig. 7.1 is drawn full size.

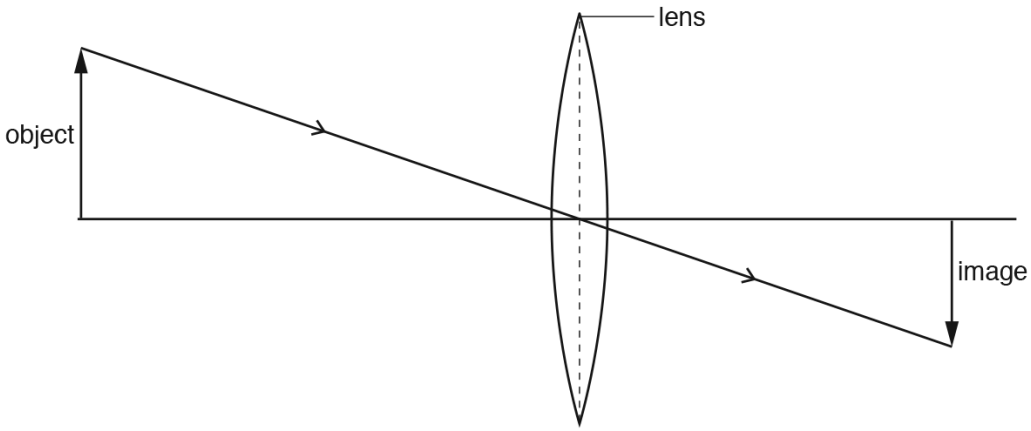

Fig. 7.1

(a) Place a tick (✓) in **all** boxes that correctly describe the image.

- ☐ diminished
- ☐ enlarged
- ☐ inverted
- ☐ upright
- ☐ real
- ☐ virtual

[2]

(b) On Fig. 7.1, draw a ray, passing through a principal focus of the lens, from the tip of the object to the tip of the image. Label the principal focus F. [1]

(c) Use the ray you have drawn in **(b)** to determine the focal length of the lens.

focal length = ...[1]

(d) Draw another ray, **not** passing through a principal focus of the lens, that passes from the tip of the object to the tip of the image. [1]

[Total: 5]

42. 0625_s17_qp_41 Q: 6

(a) A ray of light in glass is incident on a boundary with air.

State what happens to the ray when the angle of incidence of the ray is

(i) less than the critical angle of the glass,

.....[1]

(ii) greater than the critical angle of the glass.

.....[1]

(b) Fig. 6.1 shows a ray of light incident on a glass block at A. The critical angle of the glass is 41°.

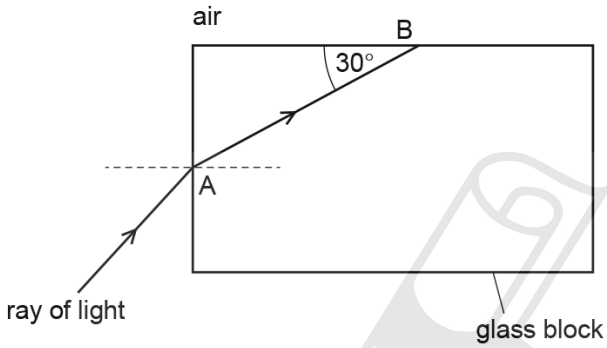

Fig. 6.1 (not to scale)

(i) On Fig. 6.1, without calculation, continue the ray from point B until it leaves the glass block. [2]

(ii) Calculate the refractive index of the glass.

refractive index = ...[2]

[Total: 6]

43. 0625_s17_qp_42 Q: 7

(a) The speed of light in air is 3.0×10^8 m/s.
The speed of light in a transparent liquid is 2.0×10^8 m/s.

A ray of light is incident on the surface of the liquid at an angle of incidence of 40°.

Calculate

(i) the refractive index of the liquid,

refractive index = ...[2]

(ii) the angle of refraction in the liquid.

angle of refraction = ...[2]

(b) Fig. 7.1 shows a side view of an object at the bottom of a tank of liquid. Light travels slower in this liquid than in air.

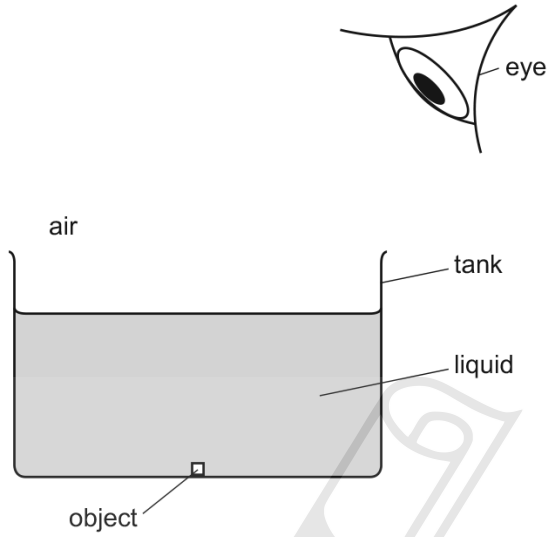

Fig. 7.1

On Fig. 7.1, draw **two** rays from the object into the air. Use these rays to locate the image. Label this image I. [3]

[Total: 7]

44. 0625_s17_qp_43 Q: 8

Red light travelling in air strikes the curved surface of a semi-circular glass block at P.
Fig. 8.1 shows the ray of light.

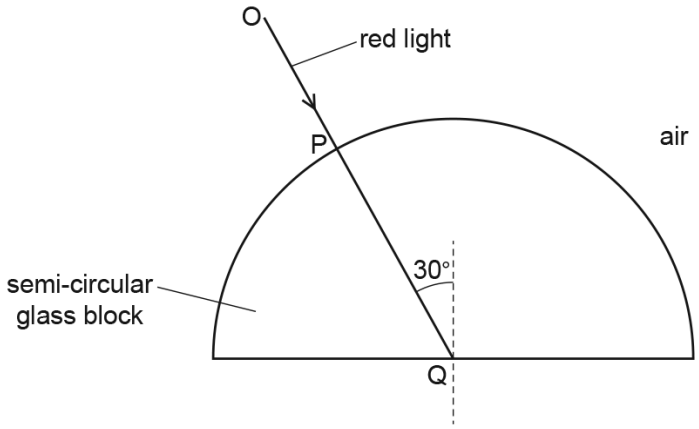

Fig. 8.1

The light travels in a straight line from O to Q.

(a) Explain why the light does **not** change direction as it enters the glass block at P.

.....

.....[1]

(b) The light travels in the glass to Q where it strikes the edge of the block at 30° to the normal. The light then emerges into the air.

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

Calculate the angle between the normal and the ray in the air after the light emerges from the block at Q.

angle = ...[3]

(ii) On Fig. 8.1, sketch the path of the light in the air after it emerges at Q. [1]

(c) The direction of the light striking the curved surface of the glass block is changed. The angle between the ray and the normal at Q gradually increases from 30° to 90°.

Describe what happens to the light that strikes the block at Q as this angle increases.

.....

.....

.....

.....

.....

.....[3]

[Total: 8]

---

45. 0625_w17_qp_41 Q: 7

(a) Fig. 7.1 shows a converging lens and its principal axis. The points labelled F are each a principal focus of the lens.

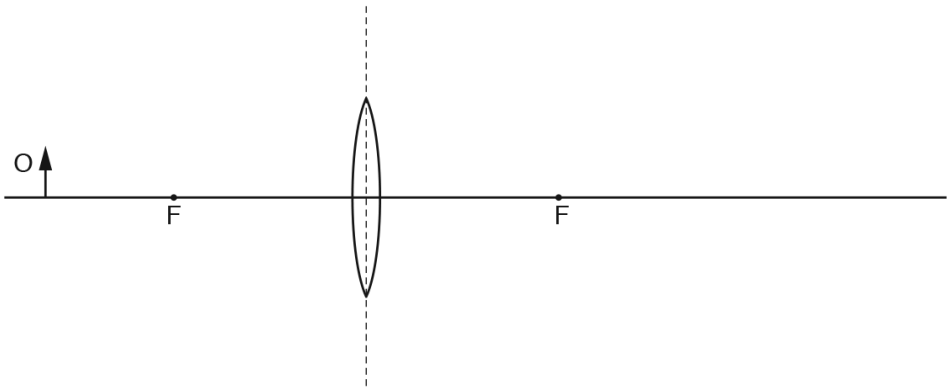

Fig. 7.1

On Fig. 7.1, draw **two** rays from the top of the object O, to locate the image of O.
Label the image I. [3]

(b) Underline **three** of the terms below to describe the nature of the image produced by a converging lens used as a magnifying glass.

diminished enlarged inverted real same size upright virtual

[2]

(c) Fig. 7.2 shows the path of a ray of red light passing through a glass prism.

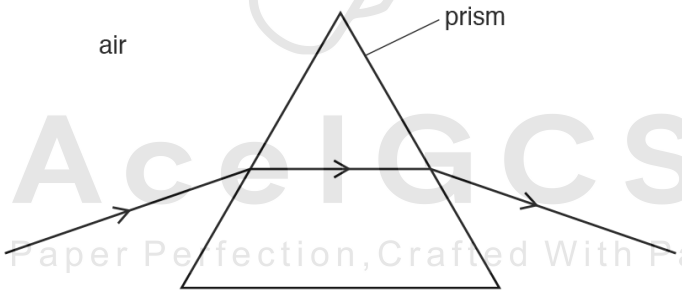

Fig. 7.2

A ray of green light enters the prism along the same path as the ray of red light.

On Fig. 7.2, draw the path of the ray of green light as it passes through the prism and emerges into the air. [2]

[Total: 7]

46. 0625_w17_qp_42 Q: 7

(a) Fig. 7.1 is a diagram of a converging lens used to produce an image of an object. Each point marked F is a principal focus.

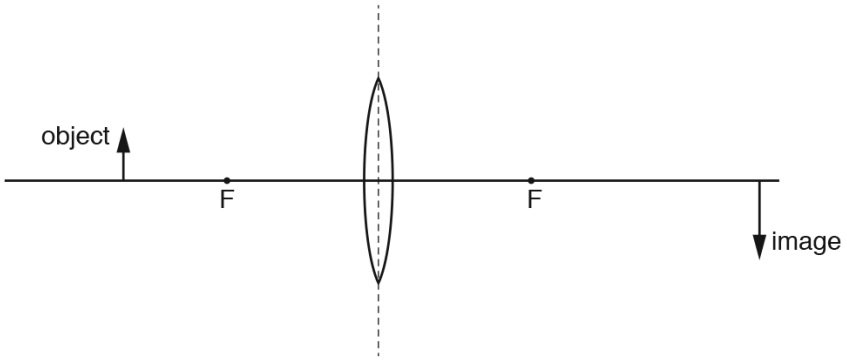

Fig. 7.1

Write down **three** terms that describe the image produced.

.....

.....

.....[3]

(b) Fig. 7.2 shows a plane mirror, a point object O and an observer's eye.

Fig. 7.2

(i) On Fig. 7.2, draw **two** rays from the object reflected to the observer's eye. [2]

(ii) On Fig. 7.2, complete your drawing to determine the position of the image of the object O. Label this image I.

[2]

[Total: 7]

47. 0625_w17_qp_43 Q: 7

(a) Fig. 7.1 shows a converging lens and its principal axis. The points F_1 and F_2 are each a principal focus of the lens.

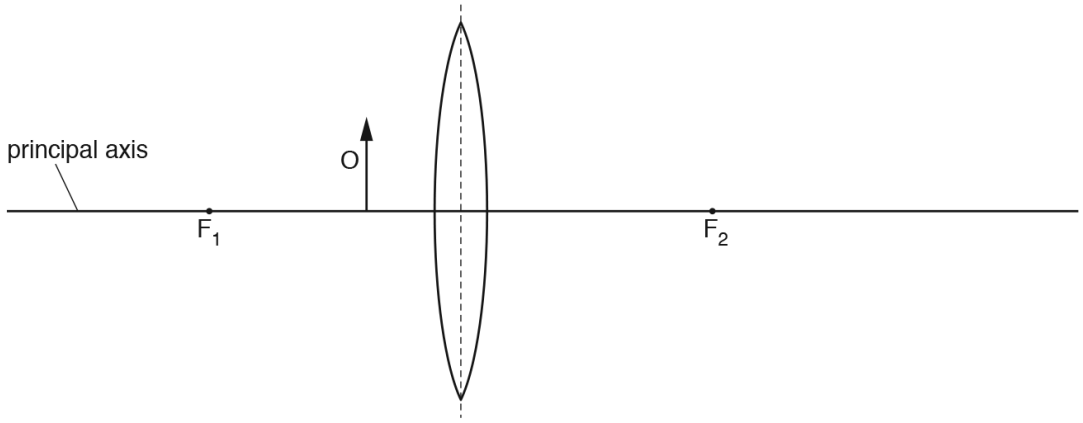

Fig. 7.1

An object O is placed between F_1 and the lens.

(i) On Fig. 7.1, draw **two** rays from the top of the object O to locate the image. Label the image I. [3]

(ii) The object O is moved to the left along the principal axis so that it is further from the lens than F_1.

Fig. 7.2 is a diagram of the new arrangement with the new image shown.

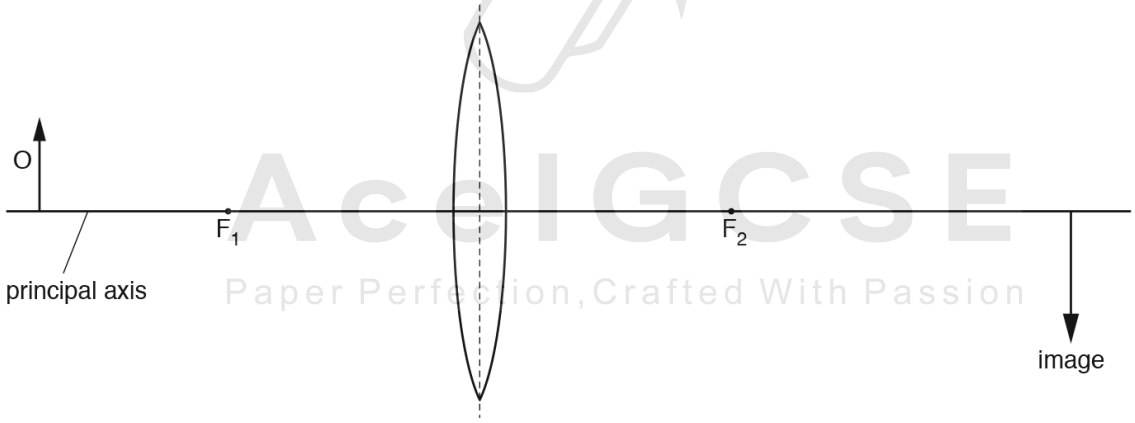

Fig. 7.2

Underline **three** of the terms below that describe the image shown in Fig. 7.2. [2]

diminished **enlarged** **inverted** **real** **same size** **upright** **virtual**

(b) Fig. 7.3 shows yellow light passing through a glass prism.

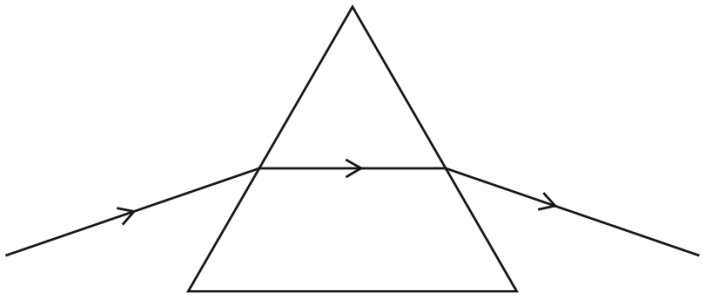

Fig. 7.3

Blue light enters the prism along the same path as the yellow light.

On Fig. 7.3, draw the path of the blue light as it enters, passes through and leaves the prism. [2]

[Total: 7]
