3. Waves

3.2 Light

Paper 1 and 2

Question Paper

Paper 3

Questions are applicable for both core and extended candidates

1 **(a)** Fig. 8.1 shows a ray diagram for a thin converging lens.
The lens forms an image of the object. The object is positioned 30 cm from the centre of the lens.

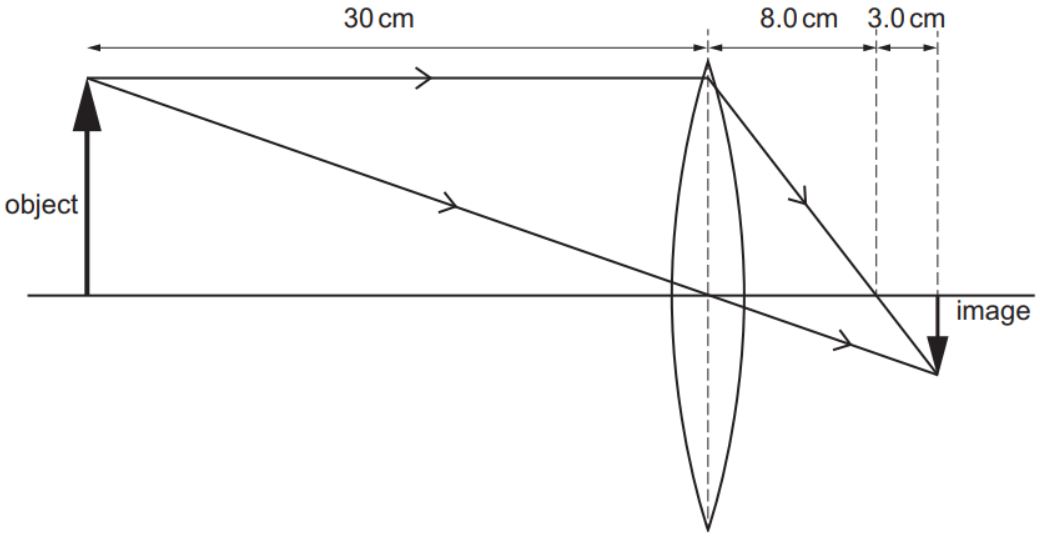


Fig. 8.1 (not to scale)

(i) Determine the distance of the image from the centre of the lens. Use information from Fig. 8.1.

image distance = ... m [1]

(ii) Determine the focal length of the lens. Use information from Fig. 8.1.

focal length = ... m [1]

(iii) State **two** characteristics of the image formed by the lens in Fig. 8.1.

1 .....

2 .....

[2]

(b) Fig. 8.2 shows labels for part of the electromagnetic spectrum in order of decreasing wavelength.

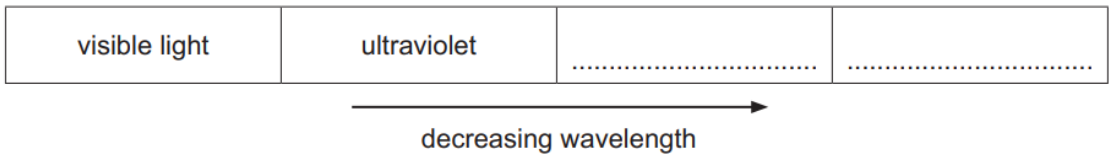


Fig. 8.2

(i) Complete Fig. 8.2 by writing the name of one type of radiation in each box. [2]

(ii) State **one** use of ultraviolet radiation.

..... [1]

(iii) State **one** danger to people from excessive exposure to ultraviolet radiation.

..... [1]

[Total: 8]

2 **(a)** Fig. 7.1 shows a ray of light striking a plane mirror. The ray is reflected as shown.

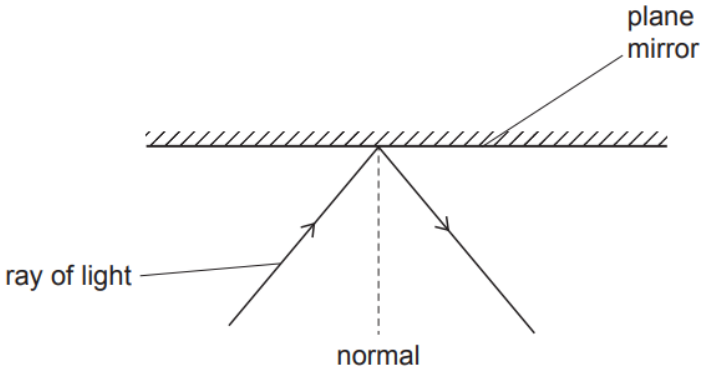


Fig. 7.1

The angle of incidence for the ray of light is 40°.

(i) Indicate the angle of reflection by drawing a letter R on Fig. 7.1. [1]

(ii) State the size of the angle of reflection in Fig. 7.1.

angle of reflection = ...° [1]

(b) An object O is placed to the left of a thin converging lens. F_1 is the principal focus on one side of the lens and F_2 is the principal focus on the other side of the lens.

Two rays from the top of the object are incident on the lens, as shown in Fig. 7.2.

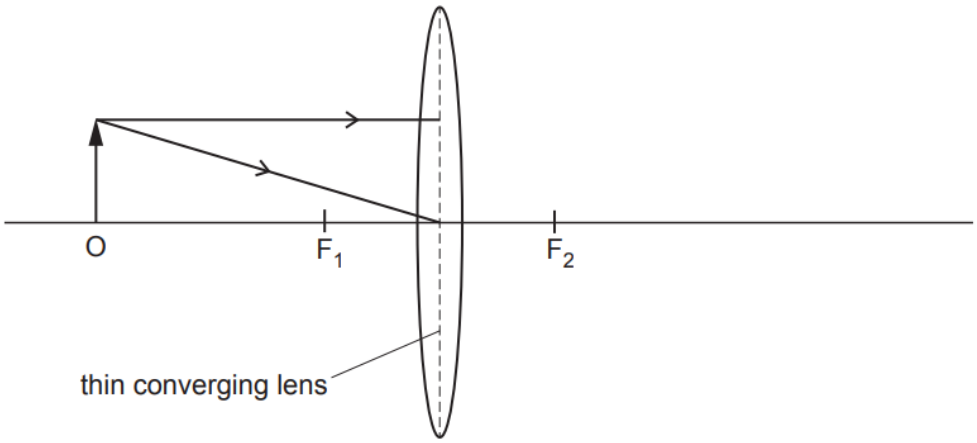


Fig. 7.2

(i) On Fig. 7.2, locate the image of O by continuing the path of each ray. [2]

(ii) Draw an arrow to represent the image of O. [1]

(c) Fig. 7.3 shows a prism producing a spectrum of colours from a narrow beam of white light.

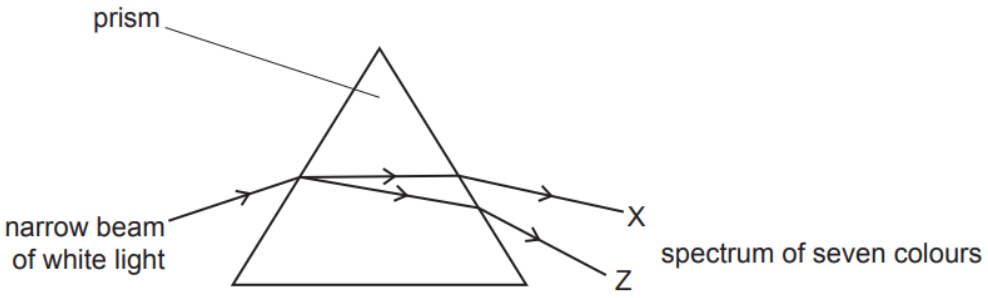


Fig. 7.3

(i) The prism refracts the white light.

State the name of the effect that produces a spectrum.

..... [1]

(ii) In the spectrum shown in Fig. 7.3, there are seven colours.

List the seven colours in the order they appear between X and Z.

X .....

.....

.....

.....

.....

.....

Z .....

[2]

[Total: 8]

3 Fig. 7.1 shows a ray diagram for an object positioned on the principal axis of a thin converging lens.

F_1 and F_2 are the focal points of the lens and C is the centre of the converging lens.

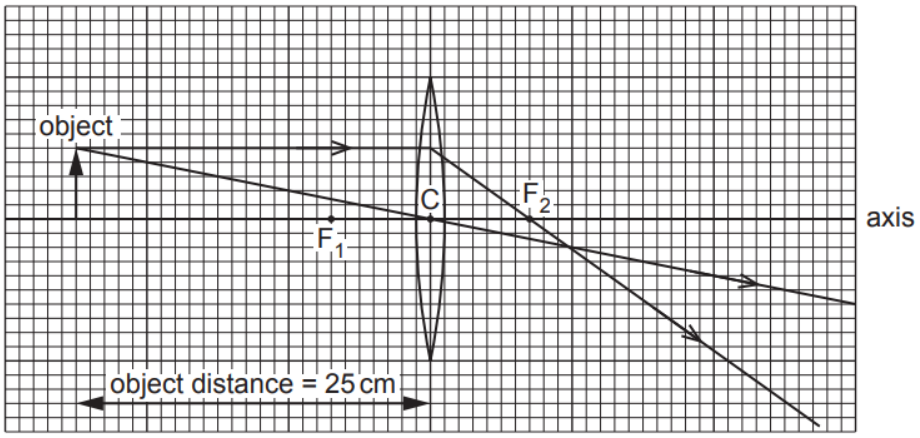


Fig. 7.1

(a) On Fig. 7.1, each small square of the grid represents 1.0 cm.

Determine the focal length of the converging lens.

focal length = ... cm [1]

(b) On Fig. 7.1, draw an arrow to show the position of the image formed by the converging lens. [1]

(c) State **three** characteristics of the image formed by the converging lens.

1 .....

2 .....

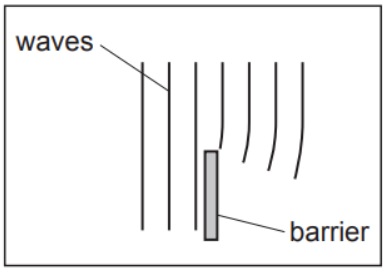
3 .....

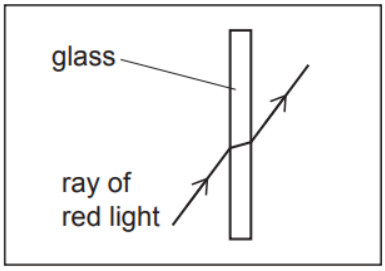
[3]

[Total: 5]

4 **(a)** In Fig. 8.1, each diagram illustrates a wave property.

Draw a line from each diagram to the correct wave property.





reflection

diffraction

dispersion

refraction

Fig. 8.1

[2]

(b) An object O is placed in front of a converging lens.

Fig. 8.2 shows two rays of light from the object passing through the lens.

Fig. 8.2 shows two rays of light from the object passing through the lens.

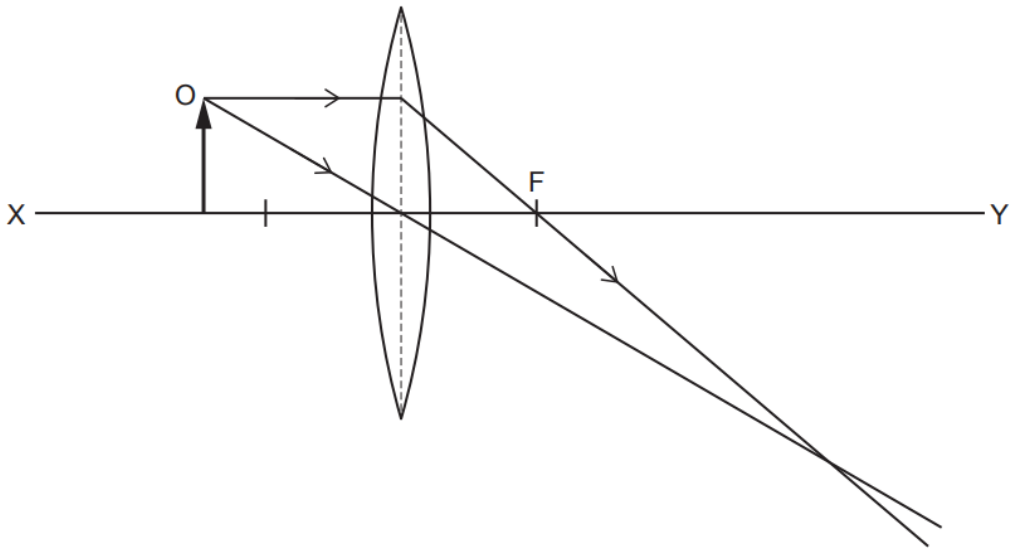


Fig. 8.2

(i) State the name of the line XY in Fig. 8.2.

..... [1]

(ii) State the name of the point labelled F in Fig. 8.2.

..... [1]

(iii) On Fig. 8.2, draw an arrow to represent the image of O. [1]

(iv) Using a ruler, measure the focal length of the converging lens.

focal length = ... cm [1]

(v) Describe characteristics of the image in Fig. 8.2.

Choose words from the list. Tick (✓) **three** boxes.

enlarged	
diminished	
same size	
inverted	
upright	
virtual	
real	

[3]

[Total: 9]

5 Fig. 7.1 represents two rays of light striking a thin converging lens. The rays are both parallel to the principal axis.
F_2 and F_1 are the focal points of the lens.

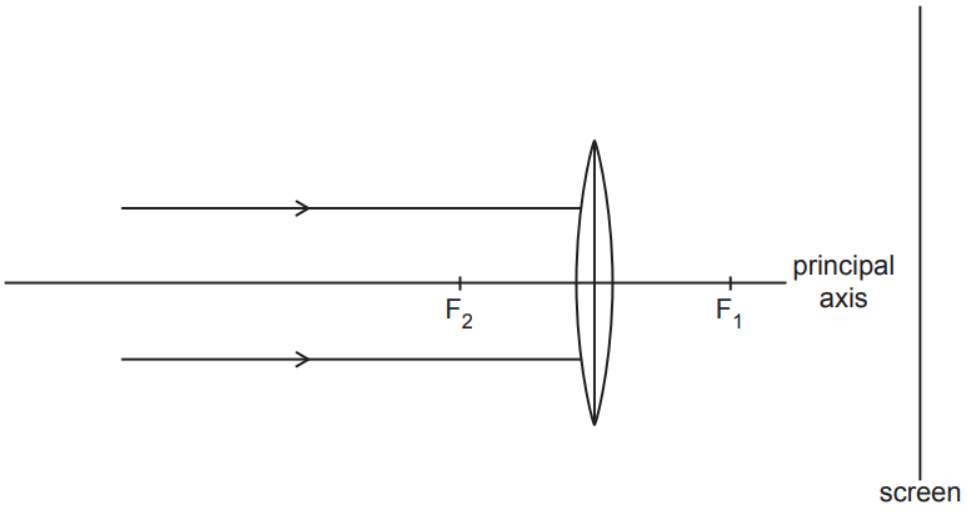


Fig. 7.1

(a) On Fig. 7.1, continue the path of each ray beyond the lens as far as the screen. [2]

6 Fig. 6.1 shows light waves passing from air into a glass block.

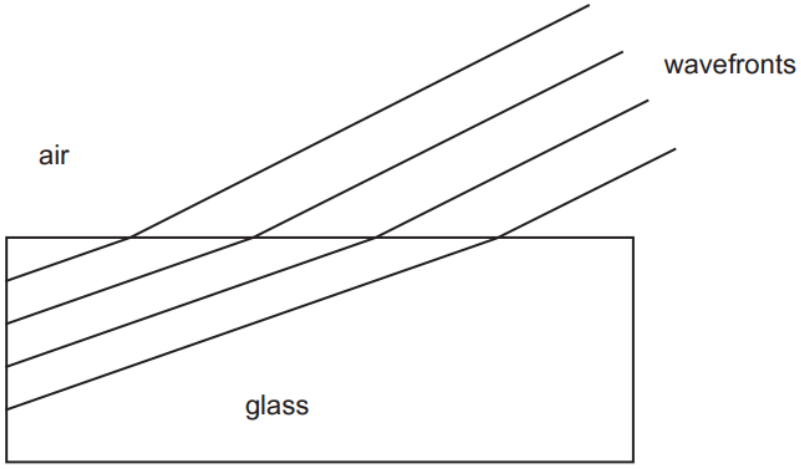


Fig. 6.1 (not to scale)

(a) (i) State the name of the process shown in Fig. 6.1 as the wavefronts enter the glass block.

..... [1]

(ii) State **two** changes in the light waves as they pass from air into glass.

1 .....

2 .....

[2]

(b) Fig. 6.2 shows a ray of red light travelling through a glass fibre. The glass fibre is made of solid glass.

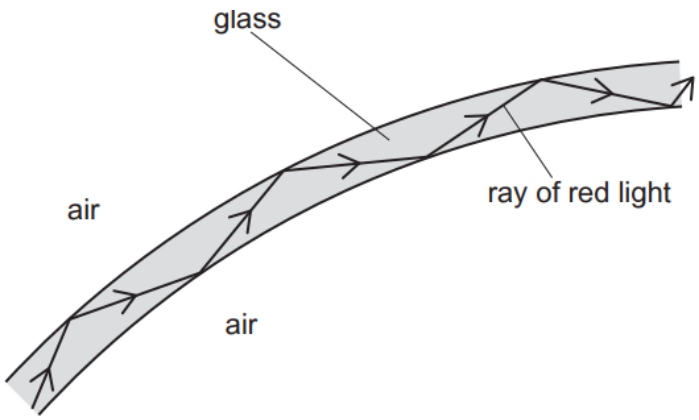


Fig. 6.2

State and explain how the ray of red light travels through the glass fibre as shown in Fig. 6.2.

.....

.....

..... [3]

[Total: 6]

7 **(a)** Fig. 6.1 shows a ray of light striking a plane mirror.

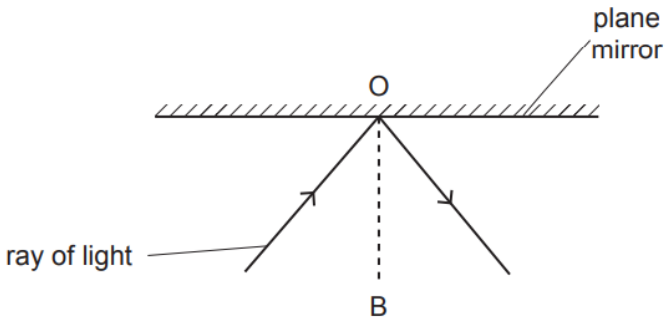


Fig. 6.1

(i) State the name of the dashed line OB in Fig. 6.1.

..... [1]

(ii) On Fig. 6.1, indicate the angle of reflection by drawing an X. [1]

(iii) State the law of reflection.

..... [1]

(b) A candle is placed in front of a plane mirror. An image of the candle is formed in the mirror.

Circle the words from the list that describe the image of the candle.

enlarged **diminished** **same size** **upside-down** **upright** [2]

(c) Fig. 6.2 shows a ray of red light striking one side of a glass prism.

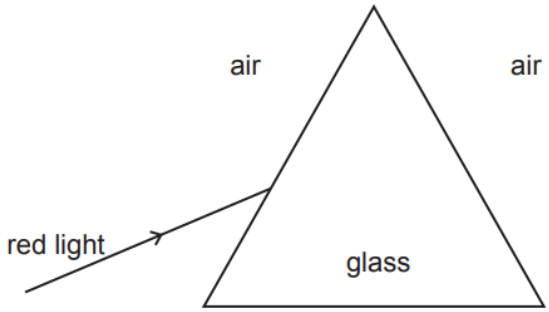


Fig. 6.2

(i) On Fig. 6.2, draw a line to indicate the path of the red light travelling through the glass prism and emerging into the air. [2]

(ii) Explain why the red light follows the path you have drawn in **(c)(i)**.

..... [1]

[Total: 8]

8 **(a)** A student investigates refraction through a parallel-sided glass block. Fig. 7.1 shows a ray of red light travelling from the air through the glass block.

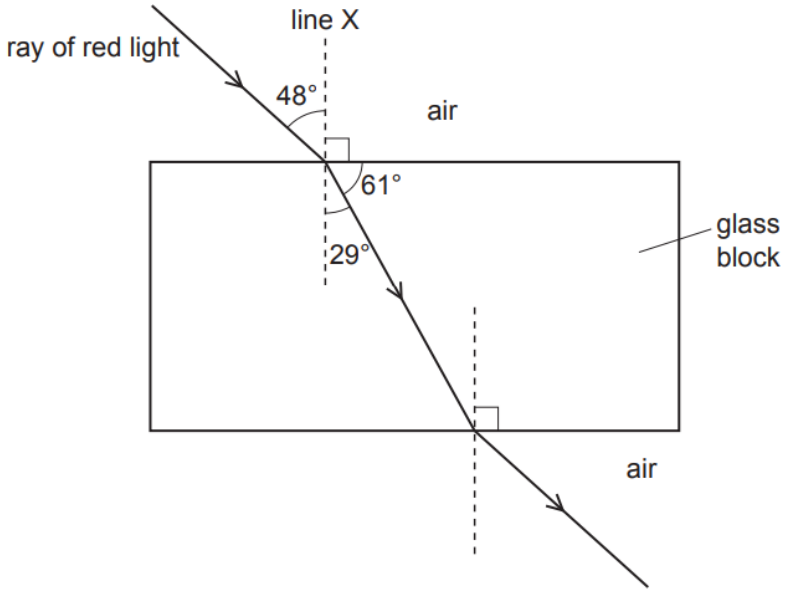


Fig. 7.1

(i) Using the information in Fig. 7.1, state the angle of refraction for the ray of red light travelling from air into the glass block.

angle of refraction = ... ° [1]

(ii) Using the information in Fig. 7.1, state the term used for line X.

..... [1]

(b) Fig. 7.2 shows an object OX to the left of a thin converging lens. The principal focus on each side of the lens is labelled F.

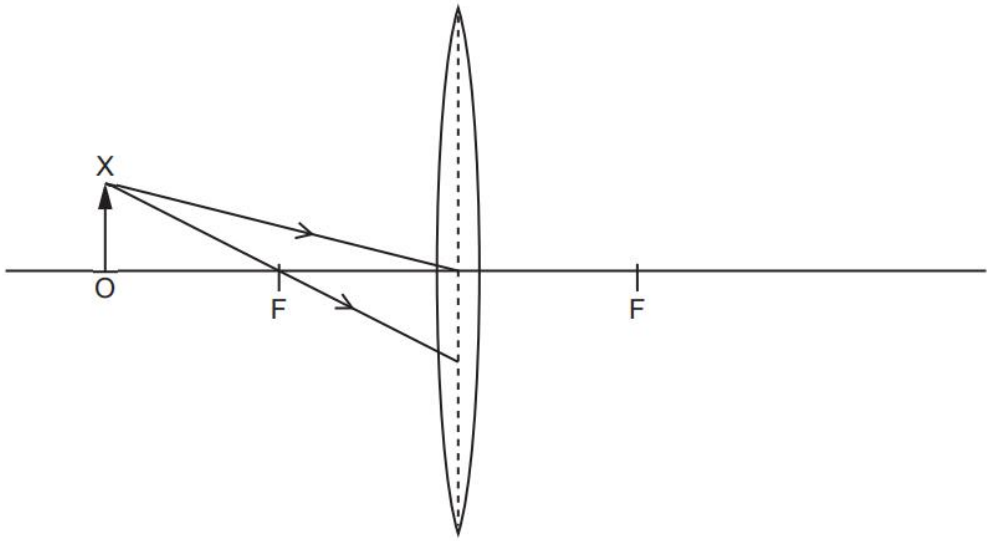


Fig. 7.2

(i) Two rays from the top of the object are incident on the lens, as shown in Fig. 7.2.

On Fig. 7.2, continue the paths of these two rays to show the position of the image of OX formed by the lens. [2]

(ii) Draw the image of OX formed by the lens. [1]

[Total: 5]

9 Fig. 7.1 shows a ray of red light entering a semicircular glass block. The ray strikes the flat surface of the block at X and emerges into the air. Fig. 7.1 does not show the path of the refracted ray in the air.

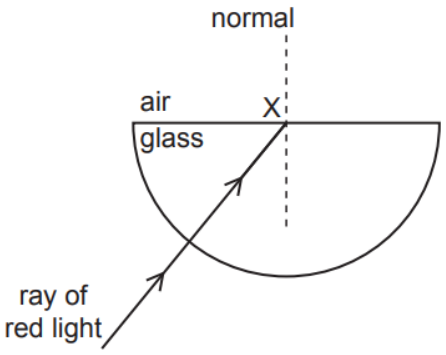


Fig. 7.1

(a) On Fig. 7.1:

(i) draw the path of the refracted ray in the air [1]

(ii) mark, and label with the letter *i*, the angle of incidence [1]

(iii) mark, and label with the letter *r*, the angle of refraction. [1]

(b) When the angle of incidence at X is 70°, the ray does **not** emerge from the glass into the air.

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

.....

.....

..... [2]

10 **(a)** Fig. 9.1 shows a ray of light reflected by a plane mirror.

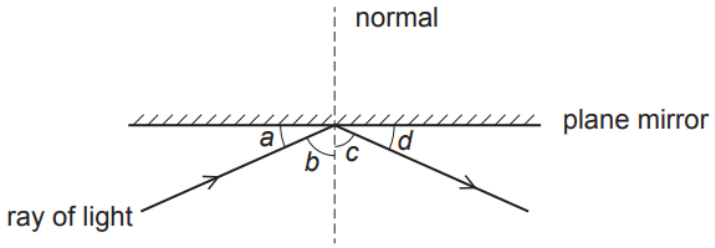


Fig. 9.1

(i) State which angle, *a*, *b*, *c* or *d*, is the angle of incidence. ..... [1]

(ii) State which angle, *a*, *b*, *c* or *d*, is the angle of reflection. ..... [1]

(b) Fig. 9.2 shows a road junction viewed from above. A plane mirror allows the drivers of the two cars A and B to see each other.

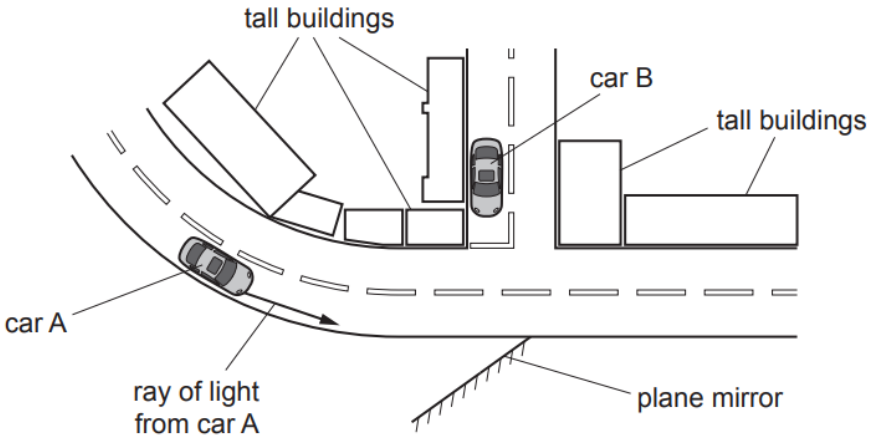


Fig. 9.2

Fig. 9.2 shows a ray of light from car A travelling towards the plane mirror.

On Fig. 9.2, carefully continue this ray to show how the driver of car B can see car A.

[2]

[Total: 4]

11 A student uses a semicircular glass block to investigate refraction.

(a) He shines a ray of red light into the block, as shown in Fig. 8.1.
X is the middle of the flat surface.

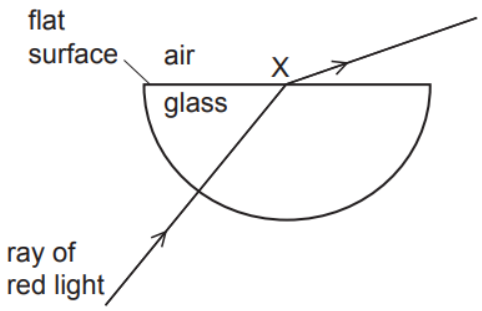


Fig. 8.1

(i) On Fig. 8.1, draw the normal where the ray meets the flat surface at X. [1]

(ii) On Fig. 8.1, label the angle of refraction. Use the letter R for the label. [1]

(iii) The student uses a semicircular glass block. State the name of **one** other piece of equipment that he needs for the investigation.

..... [1]

(b) Fig. 8.2 shows a ray of red light incident on the flat surface of the semicircular glass block.
The angle of incidence is greater than the critical angle for glass.

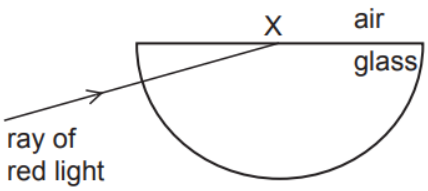


Fig. 8.2

On Fig. 8.2, draw the path of the ray after it strikes the flat surface. [2]

[Total: 5]

12 **(a)** Fig. 7.1 shows a ray of light incident on a plane mirror at point X.

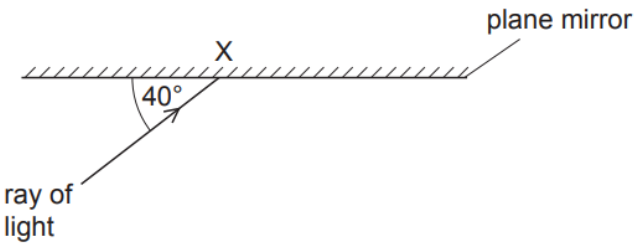


Fig. 7.1 (not to scale)

(i) Determine the value of the angle of reflection for the ray of light at point X.

..... [1]

(ii) On Fig. 7.1:

- draw the normal at point X and label the normal with the letter N
- draw the ray reflected from point X.

[2]

(b) Fig. 7.2 shows how a converging lens forms an image of an object.

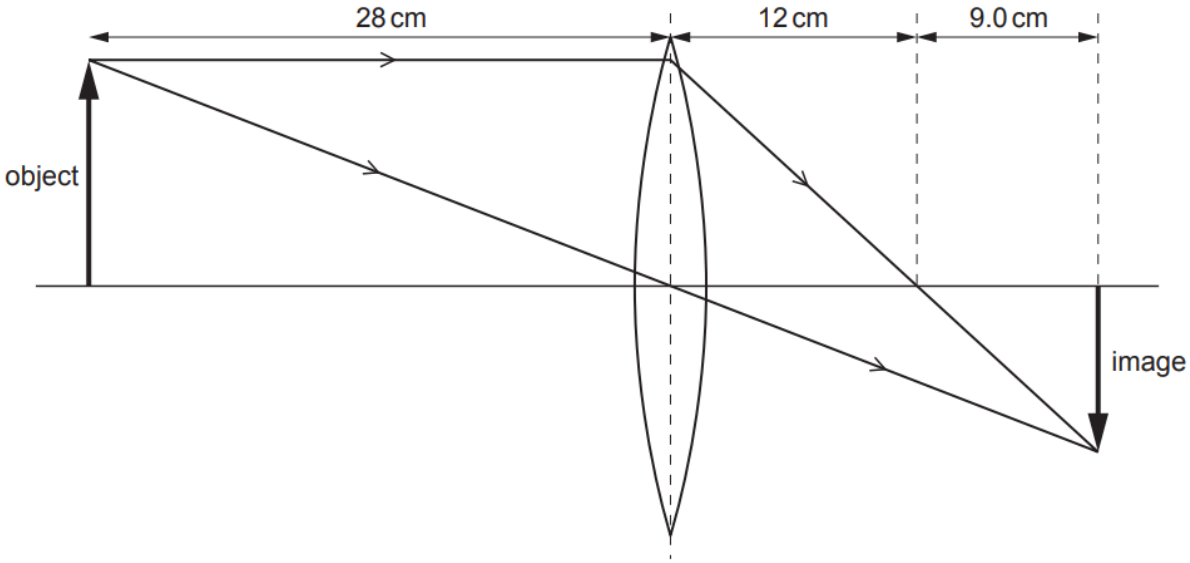


Fig. 7.2 (not to scale)

(i) Determine the focal length of the lens.

focal length = ... cm [1]

(ii) Determine the distance of the image from the lens.

distance = ... cm [1]

(iii) Describe the nature of the image formed by the lens in Fig. 7.2.

.....

.....

..... [2]

[Total: 7]

13 Fig. 8.1 shows a converging lens and an object. The side of each square represents 0.5 cm.

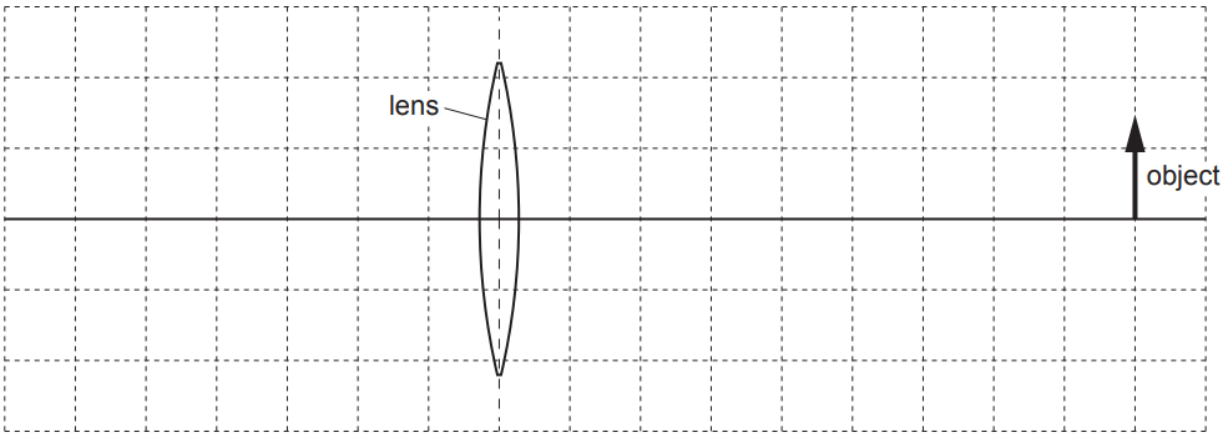


Fig. 8.1

(a) Using Fig. 8.1, determine the distance of the object from the centre of the lens.

distance = ... cm [2]

(b) Fig. 8.2 shows another lens forming the image IY of object OP.

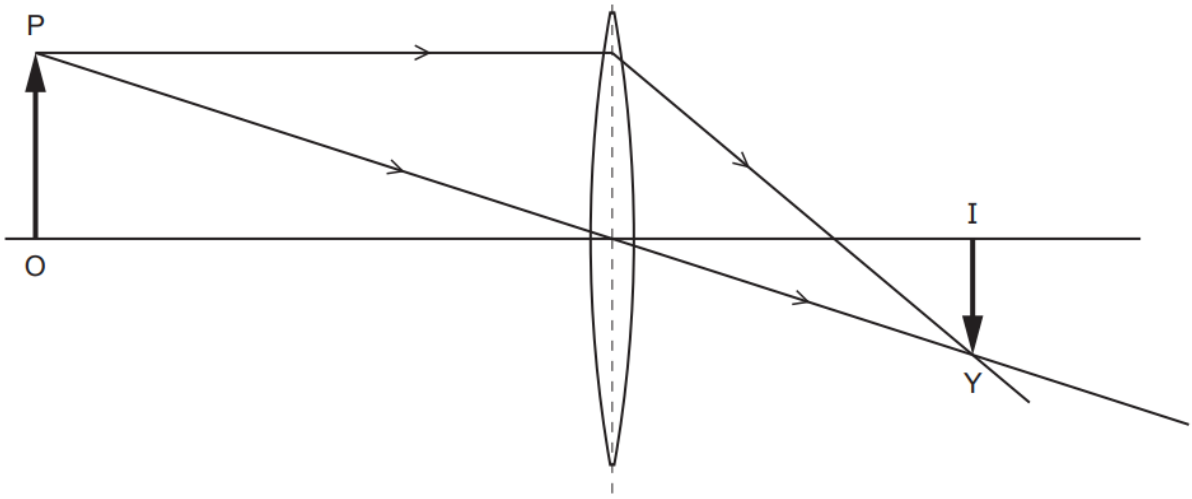


Fig. 8.2

(i) On Fig. 8.2, draw an arrow to represent the focal length of the lens. Label this arrow f. [2]

(ii) Circle **two** words or phrases from those shown to describe the image formed in Fig. 8.2.

enlarged **upright** **inverted** **same size** **diminished** [2]

[Total: 6]

14 **(a)** Fig. 7.1 shows a ray of light striking a plane mirror at point P.

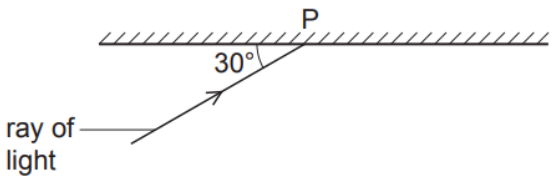


Fig. 7.1 (not to scale)

(i) Determine the value of the angle of incidence for the ray of light at point P.

angle of incidence = ... ° [1]

(ii) On Fig. 7.1,

- draw a normal at point P
- draw the ray reflected at point P
- determine the angle of reflection at point P.

angle of reflection = ... ° [3]

(b) Fig. 7.2 shows an object OB positioned 20 cm from a thin converging lens. Both principal focuses of the lens are labelled F.

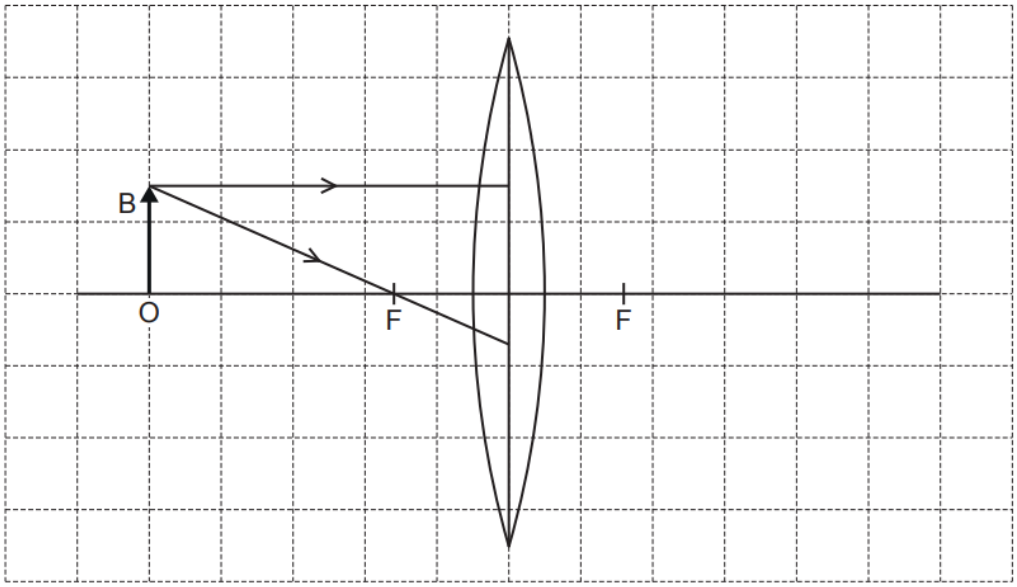


Fig. 7.2

Two rays from the tip B of the object are incident on the lens, as shown in Fig. 7.2.

On Fig. 7.2, continue the paths of these two rays to show the position of the image of OB formed by the lens. Draw an arrow to show the size, position and orientation of the image of OB. [4]

[Total: 8]

15 Fig. 5.1 shows a ray of red light passing through a semicircular glass block.

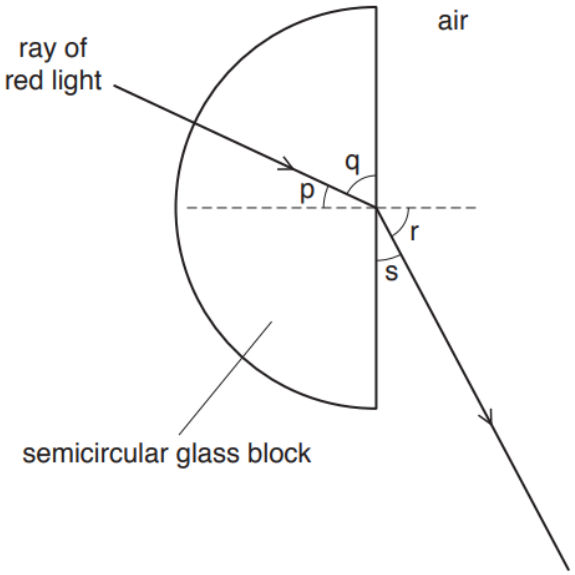


Fig. 5.1

(a) (i) State the term for the dotted line shown in Fig. 5.1.

..... [1]

(ii) State which angle p, q, r or s is the angle of incidence for the ray of red light.

..... [1]

(iii) State which angle p, q, r or s is the angle of refraction.

..... [1]

(iv) State what happens to the speed of the red light as it enters the semicircular glass block from the air.

..... [1]

(b) Fig. 5.2 shows the path of a ray of light entering a semicircular glass block. The critical angle for the glass block is 42°.

On Fig. 5.2, continue the path of the ray. Show clearly its direction on leaving the glass block.

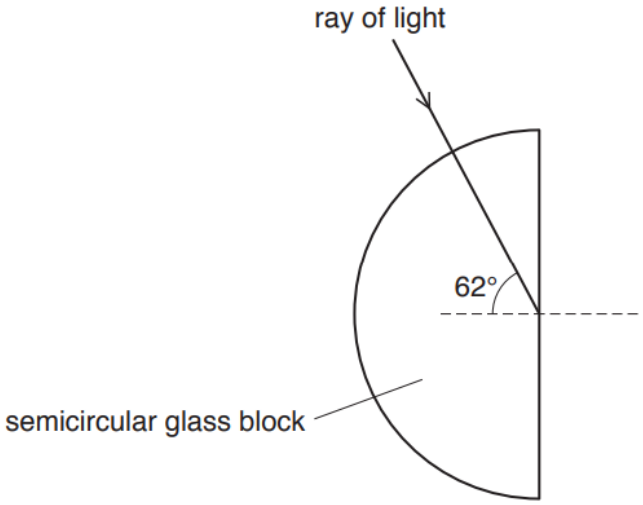
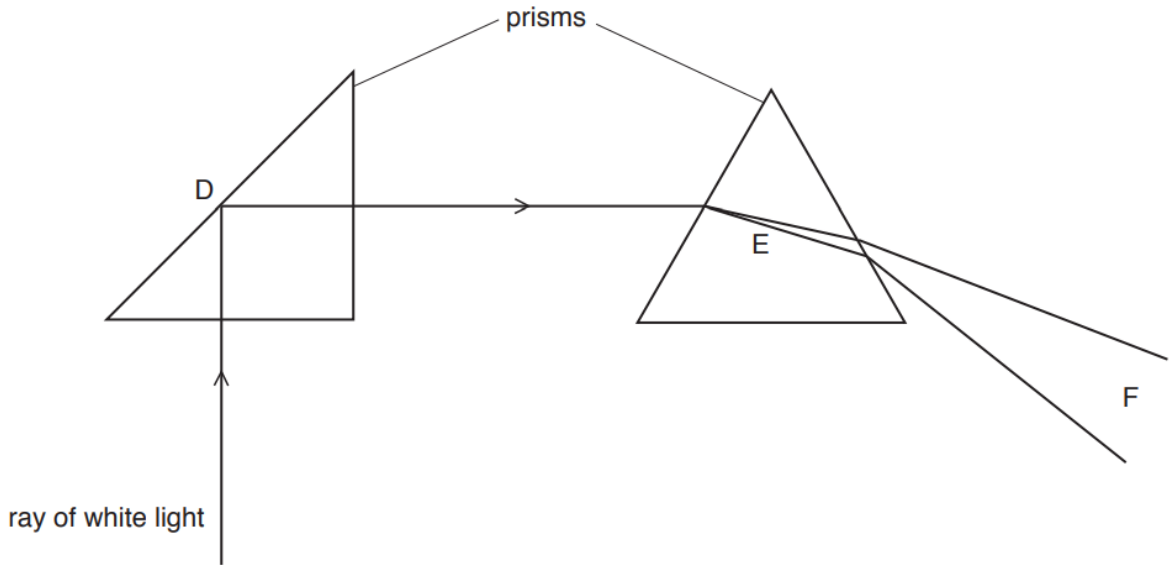


Fig. 5.2

[2]

(c) A ray of white light passes through two prisms as shown in Fig. 5.3.



Draw **one** line to link the letter for each position to the correct effect at that position.

position		effect
(i)		
		refraction
D		diffraction
		total internal reflection

[1]

(ii)		
		reflection
E		dispersion
		diffraction

[1]

(iii)		
		red, green and blue light only produced
F		white light produced
		spectrum of visible light produced

[1]

[Total: 9]

16 Fig. 6.1 shows a mirror periscope. The periscope is used to view a golfer over the heads of other people. The periscope has two plane mirrors each at an angle of 45° to the vertical.

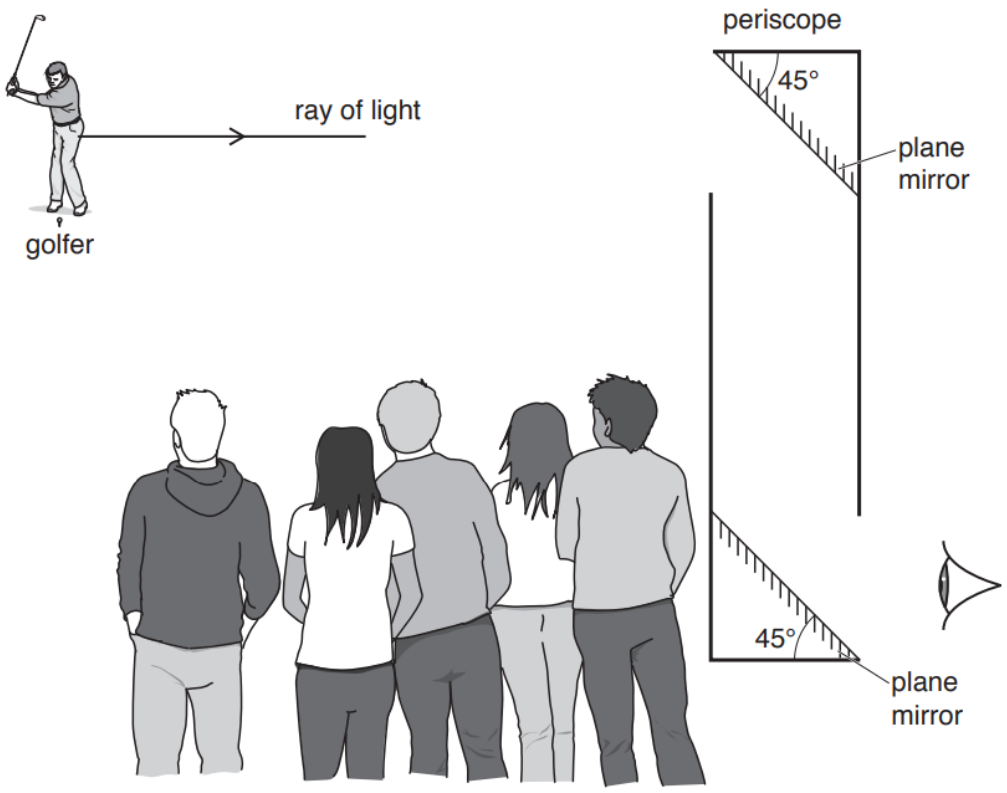


Fig. 6.1 (not to scale)

(a) (i) On Fig. 6.1:

1. Continue the ray of light from the golfer towards the upper mirror of the periscope

2. Draw and label the normal at the point where the ray strikes the mirror.

[1]

(ii) On Fig. 6.1, continue the ray of light after reflection at the upper mirror until it leaves the periscope. [1]

(iii) State the law of reflection used to deduce the position of the ray of light after striking the mirrors.

..... [1]

(b) Fig. 6.2 shows three rays of red light each entering a semi-circular glass block.

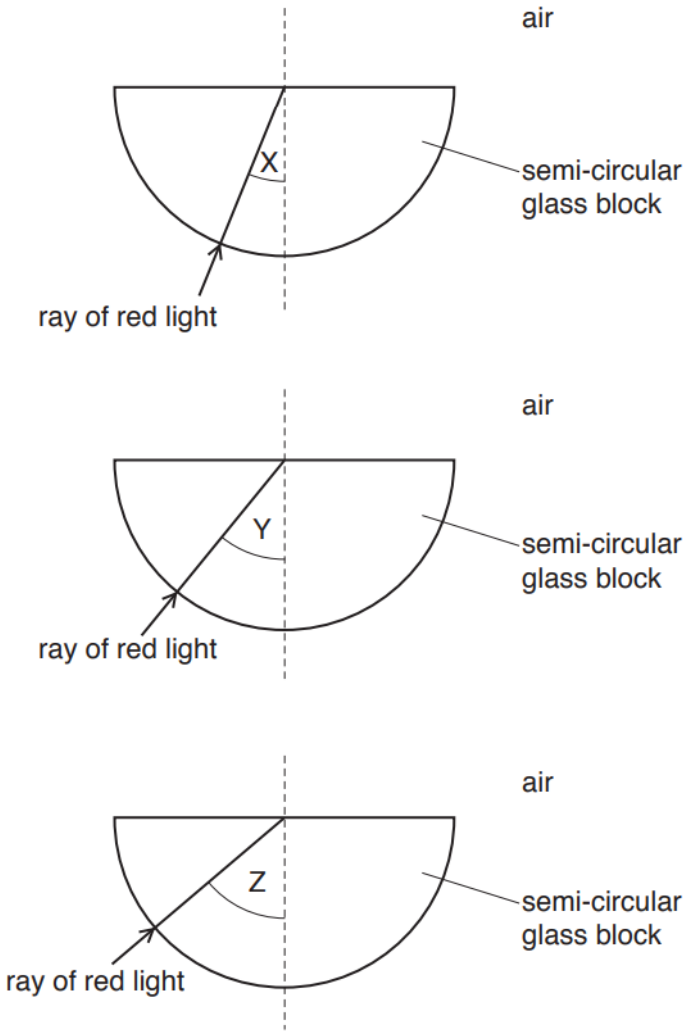


Fig. 6.2

Table 6.1

angle of incidence	description
X	less than the critical angle
Y	equal to the critical angle
Z	greater than the critical angle

Using the information in Table 6.1, draw on Fig. 6.2 to complete the path of each ray of red light. [3]

[Total: 6]

17 An object, OX, is placed in front of a converging lens.

Fig. 7.1 shows a ray of light from the object passing through the lens.

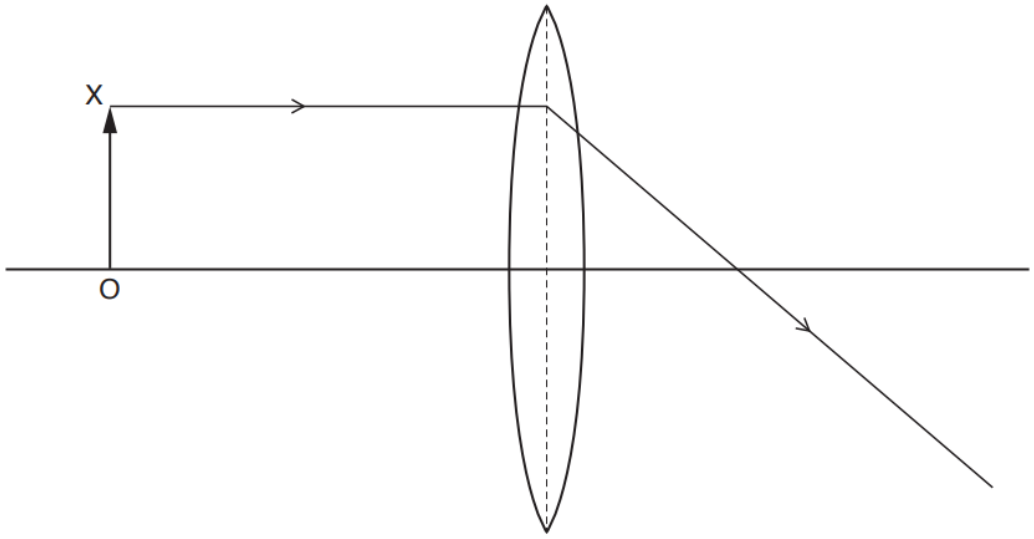


Fig. 7.1

(a) (i) The lens forms an image of object OX.

On Fig. 7.1, draw another ray from X to locate the position of the image. [1]

(ii) On Fig. 7.1, draw an arrow to represent the image of OX and label it I. [1]

(iii) On Fig. 7.1, mark a principal focus for the lens and label it F. [1]

(iv) On Fig. 7.1, measure and record the focal length of the lens.

focal length = ... cm [1]

(b) Describe the image I.

Choose words from the list. Tick (✓) **two** boxes.

- ☐ enlarged
- ☐ diminished
- ☐ same size
- ☐ inverted
- ☐ upright

[2]

[Total: 6]

18 Fig. 8.1 is a partially completed ray diagram.

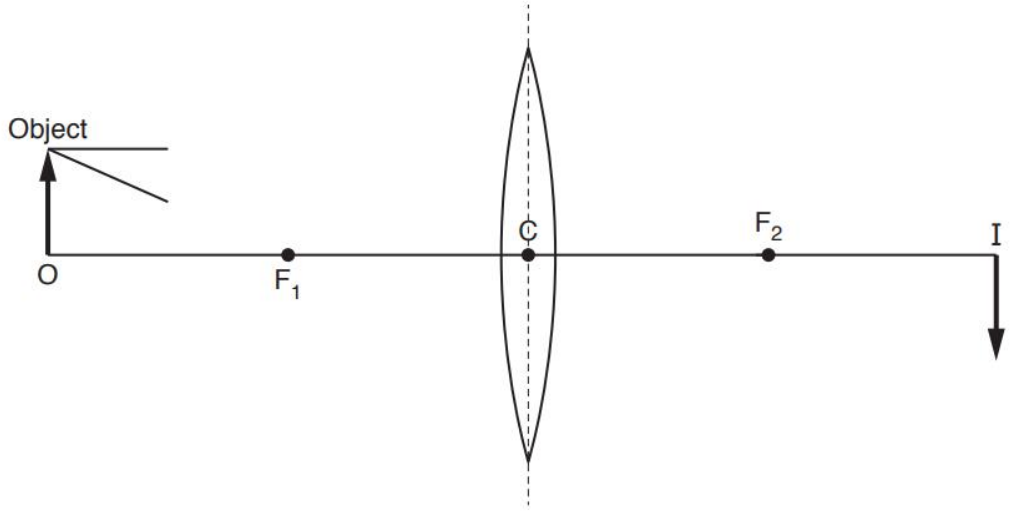


Fig. 8.1

The object is at O and its image is at I.

(a) Which distance is the focal length of the lens? Tick **one** box.

- ☐ C to F_1
- ☐ O to C
- ☐ F_2 to I
- ☐ O to I

[1]

(b) On Fig. 8.1, extend the **two** rays from the arrowhead on the object until both reach the position of the image. [3]

(c) The object is moved a small distance **away** from the lens. State the effect, if any, this has on the position and size of the image.

position .....

size .....

[2]

[Total: 6]

19 Fig. 6.1 shows a ray of light that is reflected by a mirror.

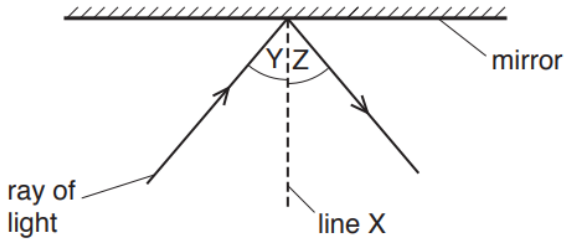


Fig. 6.1

(a) **(i)** State the name of line X shown on Fig. 6.1.

..... [1]

(ii) State the name of angle Y shown on Fig. 6.1.

..... [1]

(iii) A student moves the ray of light and doubles the size of angle Y. State the effect on angle Z.

..... [1]

(b) Fig. 6.2 shows a converging lens used to form an image I of an object O.

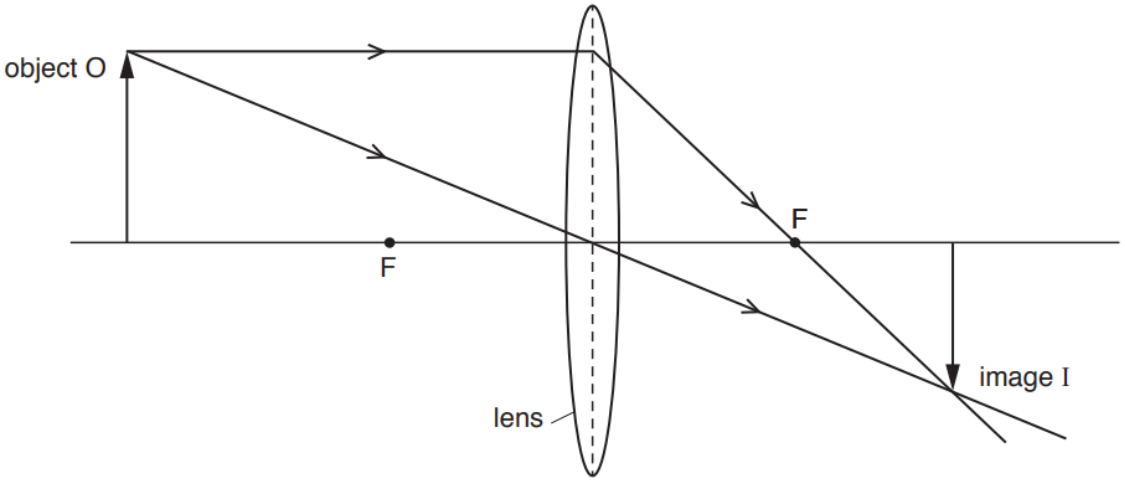


Fig. 6.2

(i) State the name of the points labelled F on Fig. 6.2.

..... [1]

(ii) Describe the nature of the image I.

.....

.....

..... [2]

[Total: 6]

20 **(a)** Fig. 6.1 shows a ray of red light incident on part of a lens.

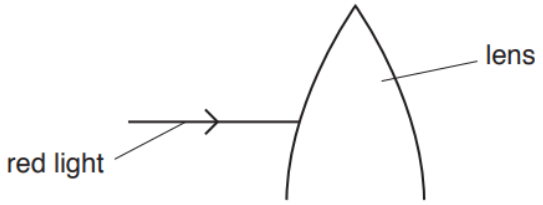


Fig. 6.1

(i) On Fig. 6.1, continue the path of the ray as it passes through the lens and emerges from it. [2]

(ii) State the term used to describe the process as the ray enters and leaves the lens.

..... [1]

(b) Fig. 6.2 shows two parallel rays of light travelling towards another lens.

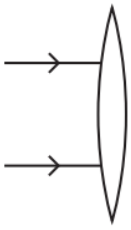


Fig. 6.2

The two rays of light pass through the lens to form an image.

On Fig. 6.2, continue the path of the rays. Extend the rays for at least 5 cm beyond the lens. [2]

[Total: 5]

21 The spectrum of white light is made up of seven colours.

(a) Fig. 7.1 shows a partially-completed spectrum. Two labels are missing.

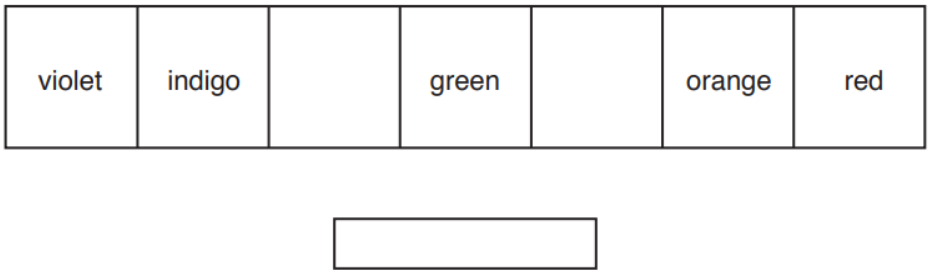


Fig. 7.1

(i) On Fig. 7.1, write the name of the missing colour in each blank space. [2]

(ii) On Fig. 7.1, indicate the direction of **increasing** wavelength for the spectrum. Draw an arrow in the box below the spectrum of colours. [1]

(b) A ray of red light strikes one face of a triangular glass prism as shown in Fig. 7.2.

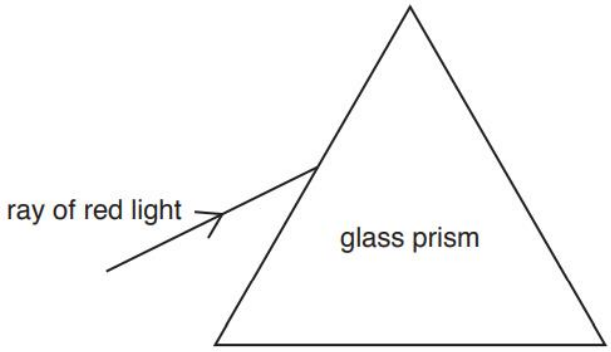


Fig. 7.2

(i) On Fig. 7.2, draw the path of the ray as it travels through the glass prism and enters the air. [2]

(ii) State the term used to describe what happens to the ray of red light as it enters and leaves the prism.

.....[1]

[Total: 6]

22 Fig. 5.1 represents an object positioned on the principal axis of a thin lens.

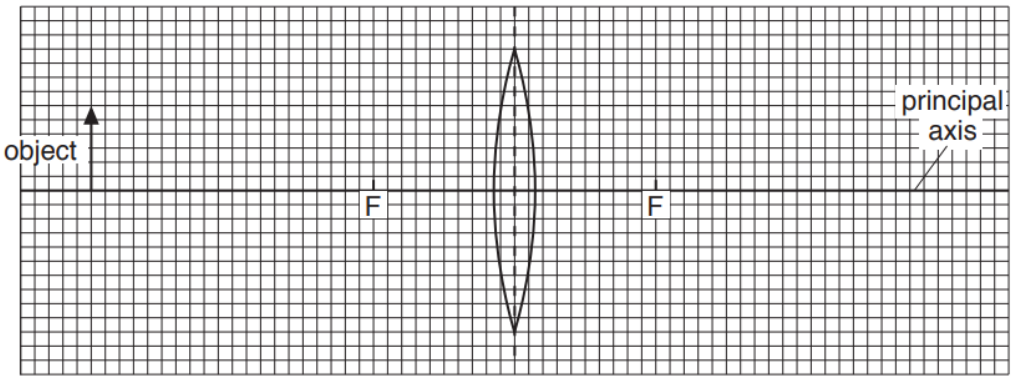


Fig. 5.1

Each small square of the grid represents 0.5 cm. Each principal focus of the lens is labelled F.

(a) Use the grid to determine the focal length of the lens.

focal length = ... cm [1]

(b) **(i)** On Fig. 5.1, draw a ray from the top of the object that passes through a principal focus, then through the lens and beyond it.

[1]

(ii) On Fig. 5.1, draw a second ray from the top of the object that passes through the centre of the lens. Continue the path of this ray to the edge of the grid. [1]

(iii) On Fig. 5.1, draw an arrow to show the position and nature of the image produced by the lens. [2]

[Total: 5]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

23 The lens in a magnifying glass is a converging lens.

(a) Fig. 4.1 shows the lens of the magnifying glass, its two focal points, F_1 and F_2, and its principal axis.

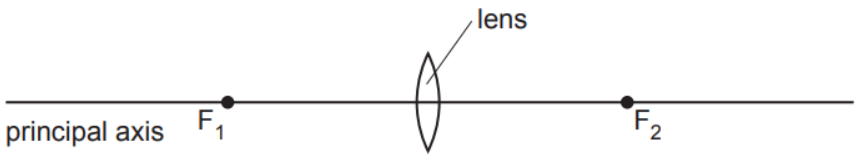


Fig. 4.1

(i) State what is meant by 'focal point'.

.....

.....

..... [2]

(ii) A student using the magnifying glass sees a magnified image of an object.

On Fig. 4.1, mark: **(extended only)**

- a point X on the principal axis for a possible position of the object
- a point E for a possible position of the student's eye.

[1]

(iii) Underline **two** words in the list that describe the image produced in **(a)(ii)**. **(extended only)**

inverted **real** **upright** **virtual**

[1]

(b) The refractive index of the glass used to make the lens is 1.5. **(extended only)**

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

Calculate the speed of light in the glass.

speed in glass = ... [2]

(ii) State what happens to the wavelength of light as it passes into the lens.

.....

..... [1]

(c) Converging lenses are used in spectacles (glasses) to correct one problem with vision.

(extended only)

State the name of the problem and explain how a converging lens is used to correct it. You may draw a diagram.

name of problem: .....

.....

.....

.....

.....

[3]

[Total: 10]

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

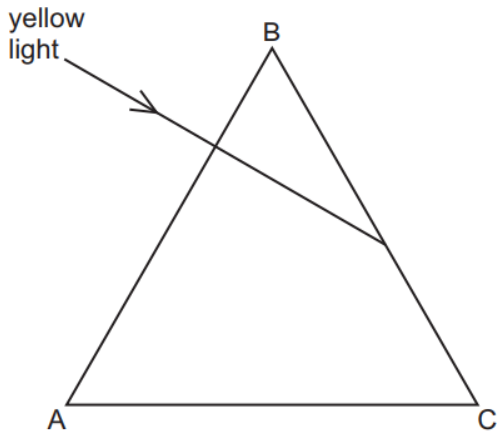


Fig. 5.1

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

.....

..... [1]

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

(i) Calculate the refractive index of the glass. **(extended only)**

Show your working.

refractive index = ... [2]

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

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

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

1 .....

2 ..... [2]

[Total: 8]

25 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.

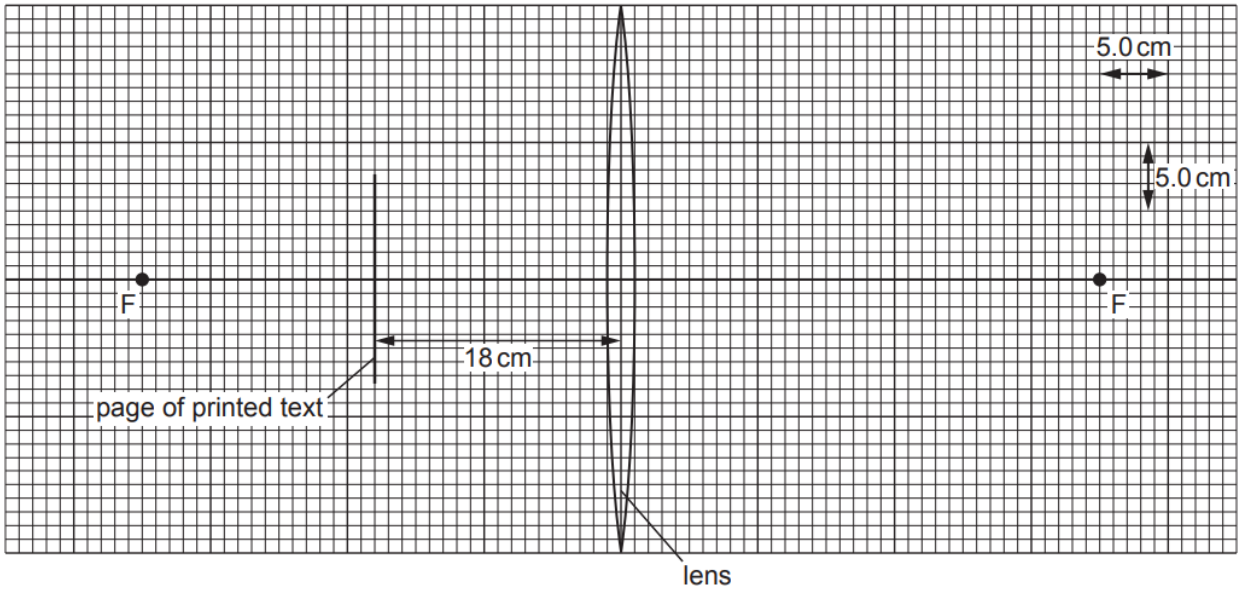


Fig. 6.1

(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] **(extended only)**

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

actual distance from lens = ... [2]

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

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. **(extended only)**

.....

.....

..... [2]

[Total: 8]

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

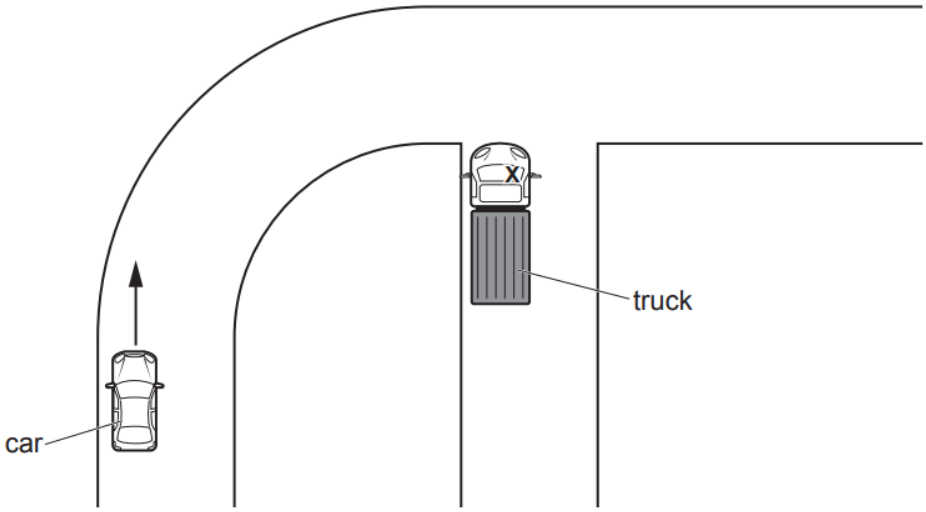


Fig. 5.1

(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. **(extended only)**

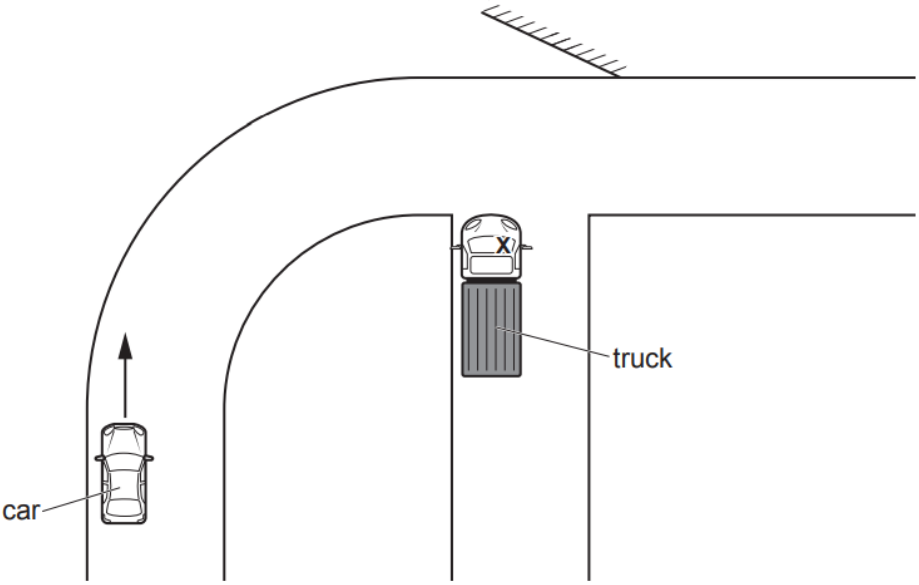


Fig. 5.2

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. **(extended only)**

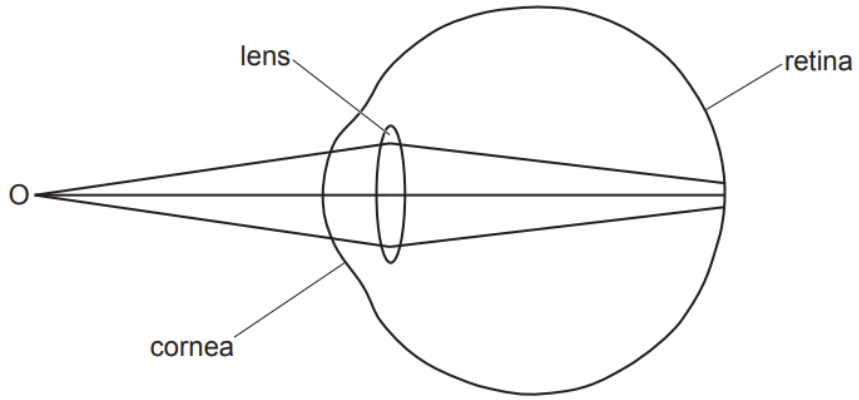


Fig. 5.3

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.

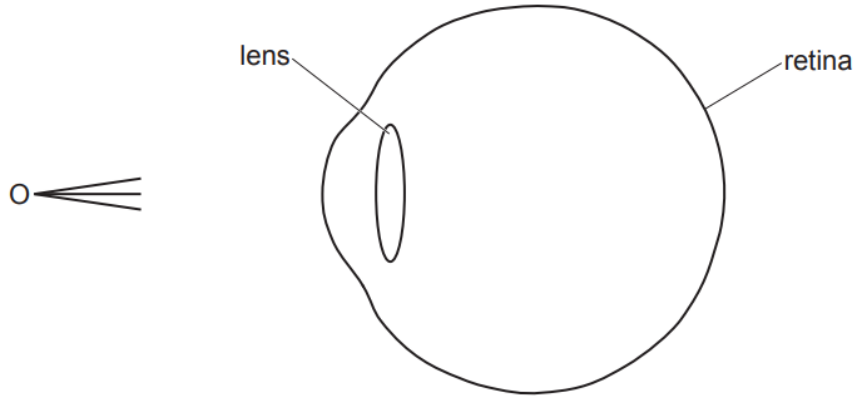


Fig. 5.4

[4]

[Total: 7]

27 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.

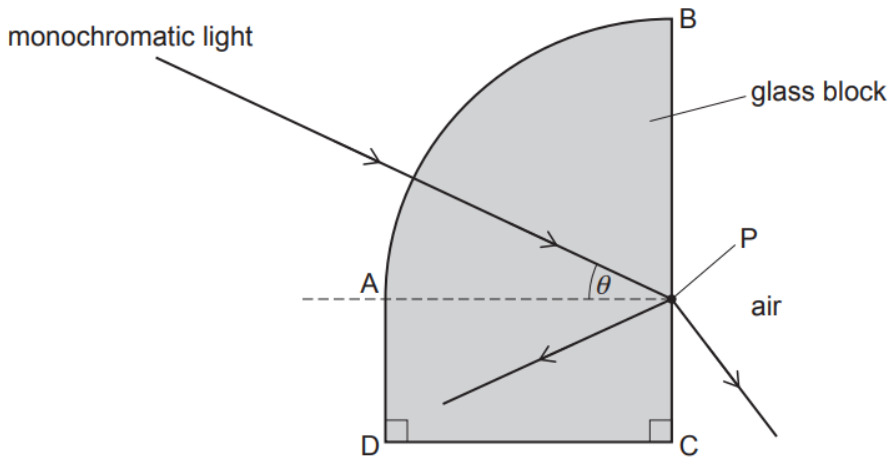


Fig. 5.1

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. **(extended only)**

.....

..... [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°. **(extended only)**

[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]

[Total: 8]

28 Fig. 7.1 shows a container of oil.

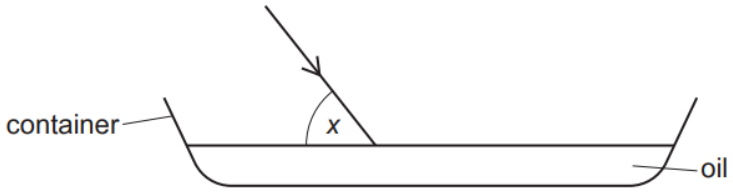


Fig. 7.1

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°. **(extended only)**

Calculate the value of the angle of refraction.

angle of refraction = ... [3]

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

..... [1]

(d) Calculate the speed of light in the oil. **(extended only)**

Give your answer to three significant figures.

speed = ... [2]

[Total: 7]

29 The red light produced by a laser is monochromatic.

(a) State what is meant by monochromatic. **(extended only)**

.....

..... [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.

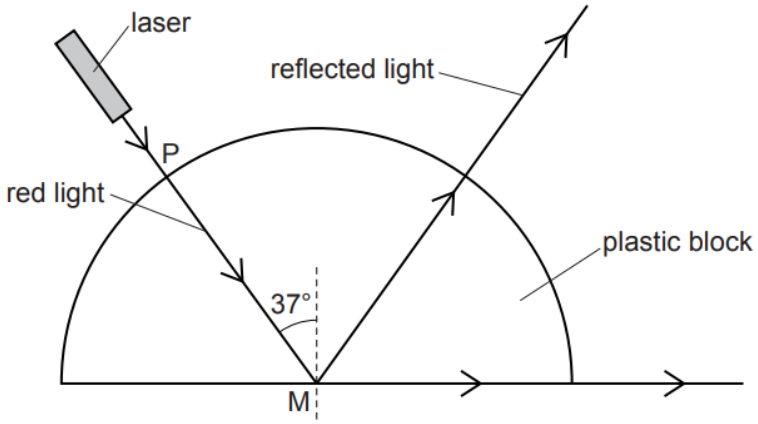


Fig. 6.1

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. **(extended only)**

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]

[Total: 10]

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

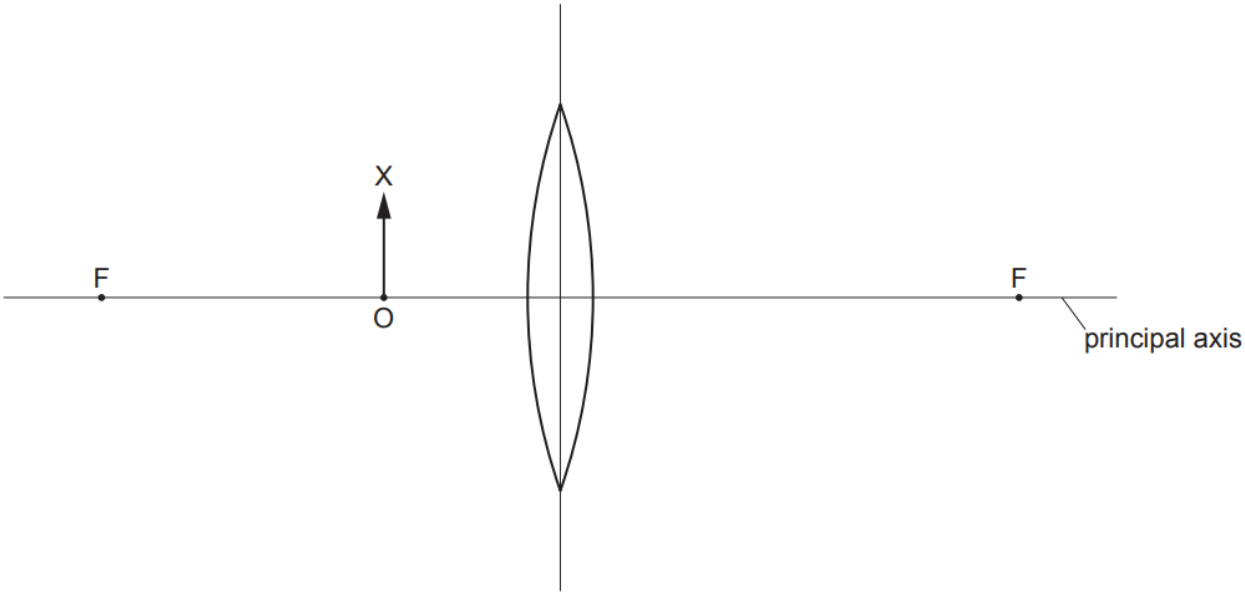


Fig. 6.1

(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. **(extended only)**

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. **(extended only)**

1. .....

2. .....
[2]

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

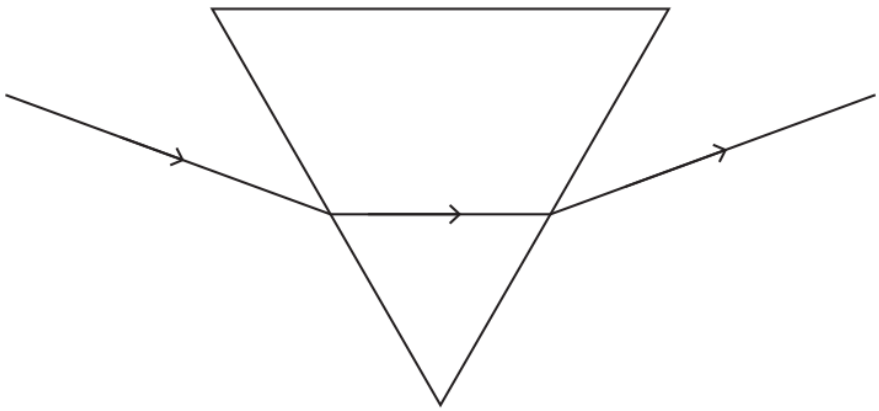


Fig. 6.2

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]

[Total: 9]

31 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.

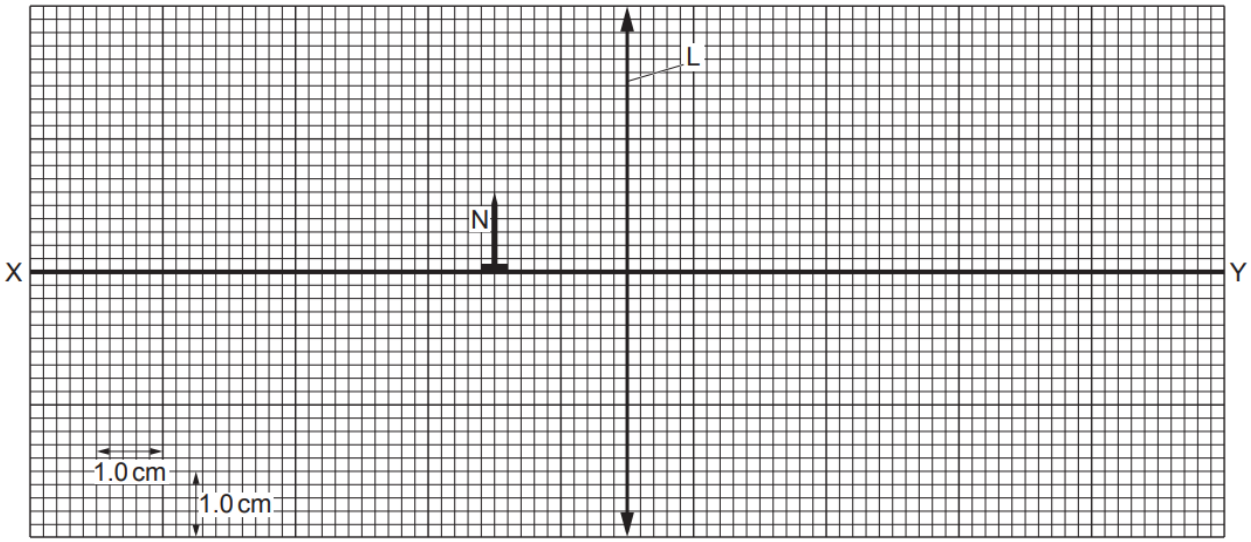


Fig. 7.1 (full scale)

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. **(extended only)** [3]

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

.....

..... [1]

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

..... [1]

[Total: 9]

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

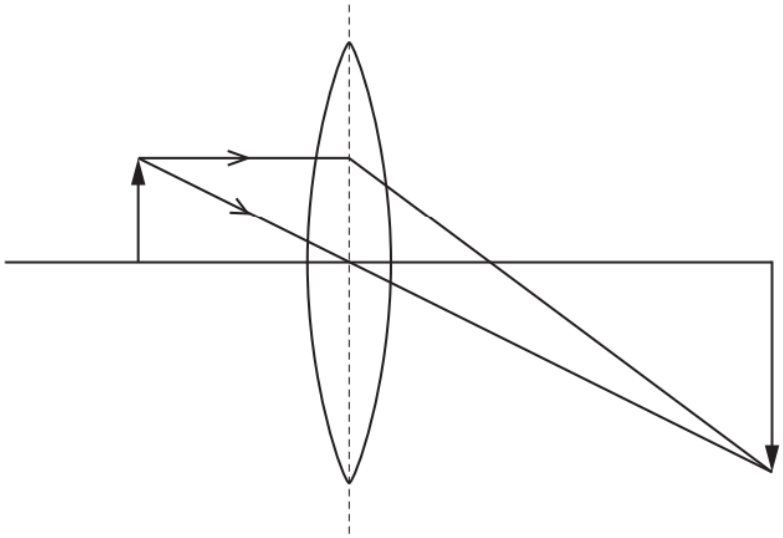


Fig. 6.1 (full size)

(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]

[Total: 5]

33 **(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.

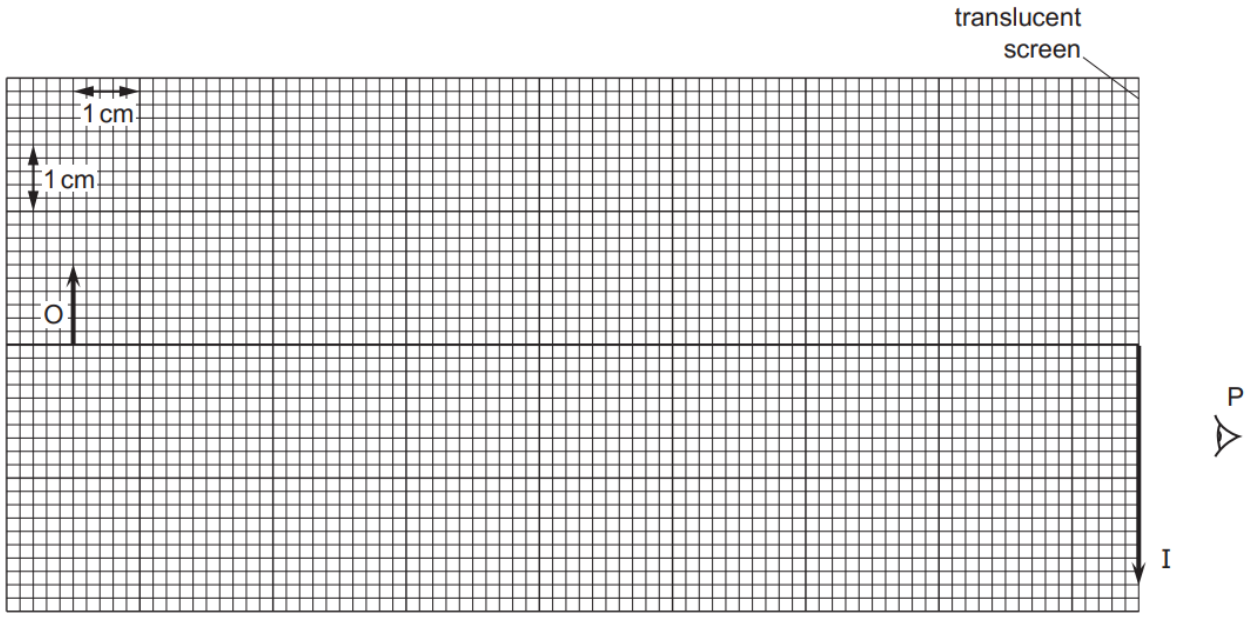


Fig. 5.1

(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.

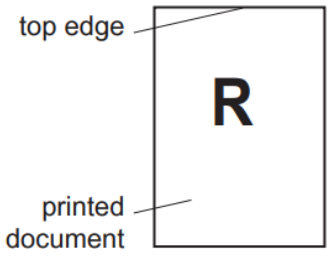


Fig. 5.2

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]

[Total: 8]

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

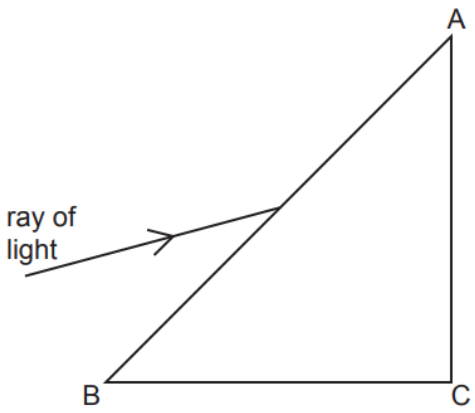


Fig. 7.1

(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. **(extended only)**

[4]

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

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. **(extended only)** [1]

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

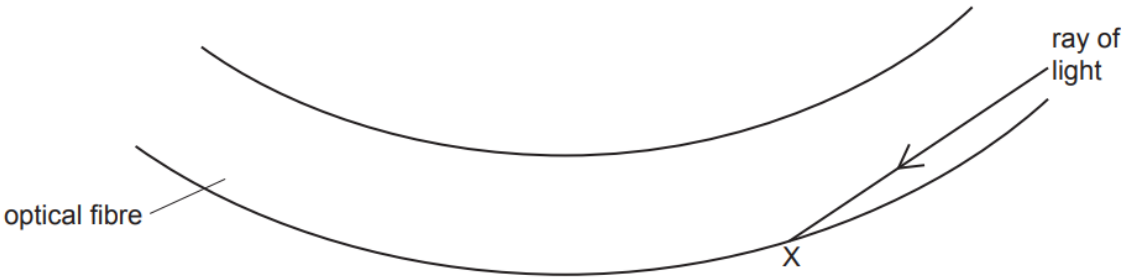


Fig. 7.2

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

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

[Total: 9]

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

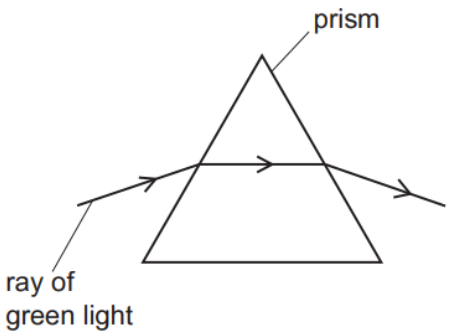


Fig. 6.1

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. **(extended only)**

Calculate the frequency of the blue light.

frequency = ... [3]

[Total: 6]

36 **(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. **(extended only)**

.....

.....

.....

..... [3]

[Total: 6]

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

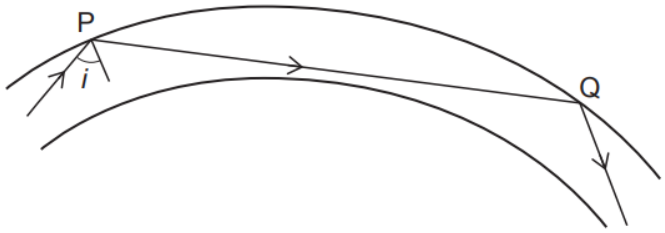


Fig. 7.1

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. **(extended only)**

angle = ... [2]

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

.....

.....

.....

.....

.....

..... [3]

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

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

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

.....

..... [2]

[Total: 8]

38 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. **(extended only)** [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. **(extended only)**

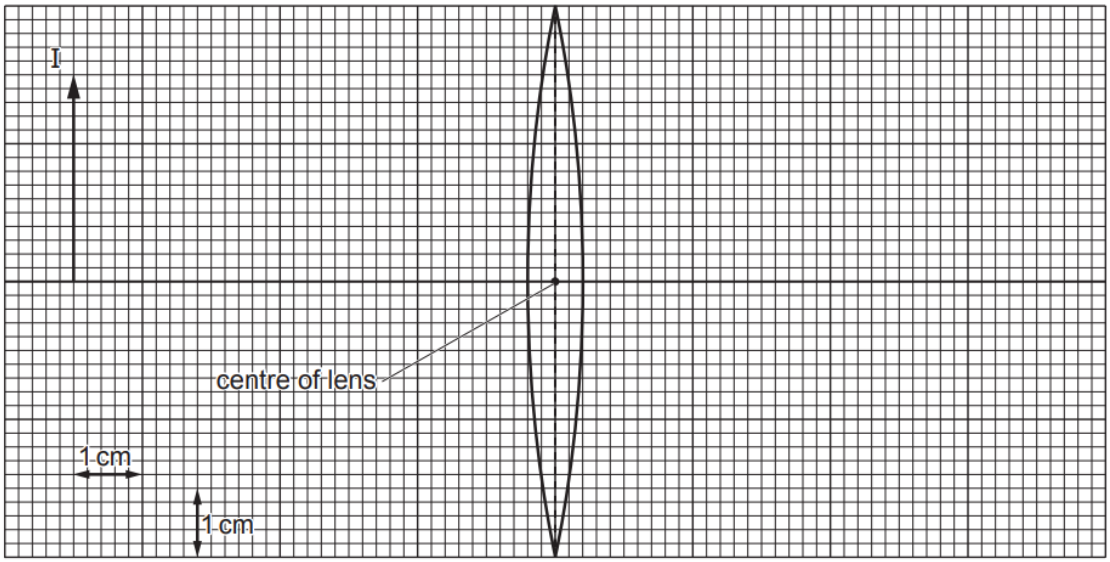


Fig. 5.1 (full-scale)

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. **(extended only)**

distance = ... [1]

[Total: 9]

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

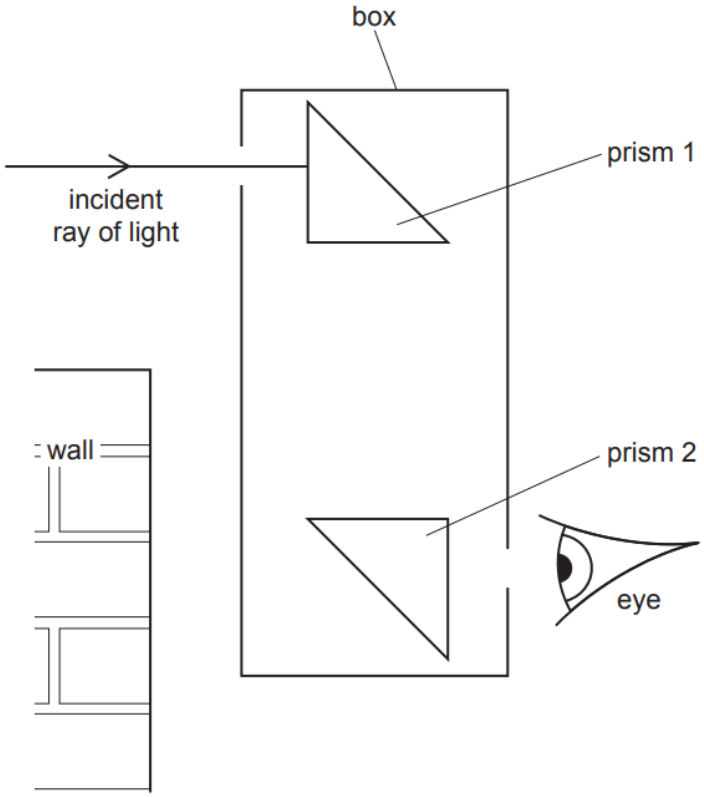


Fig. 6.1 (not to scale)

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. **(extended only)**

[2]

[Total: 5]

40 **(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.

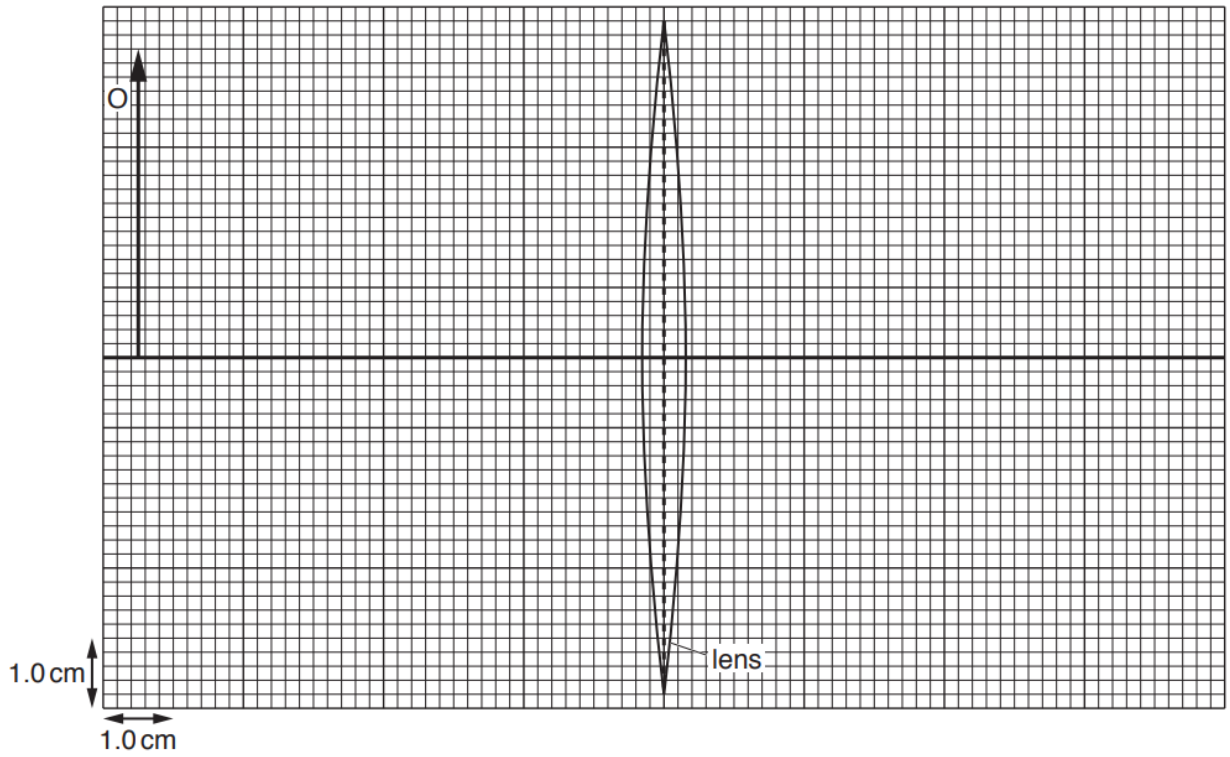


Fig. 5.1

(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]