1. Question part 1/2 | 5054 May-June 2023 P2 V1 Q6

6 The virtual reality headset in Fig. 6.1 contains a display and a lens, as shown in Fig. 6.2.

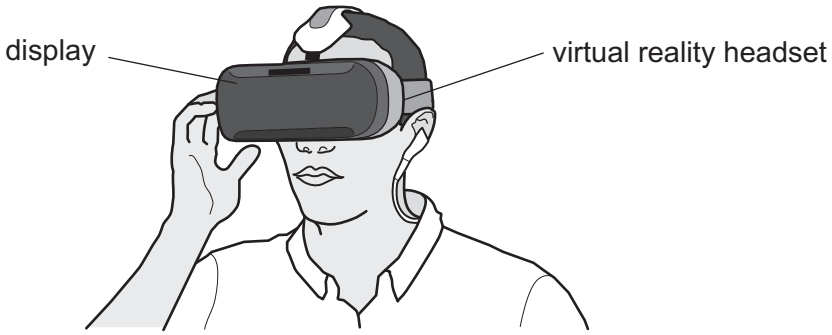

Fig. 6.1

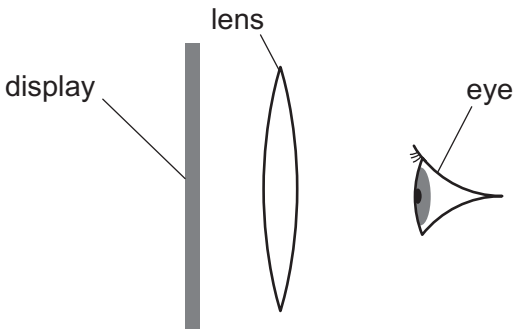

Fig. 6.2 (not to scale)

The display is the object for the lens.

The lens acts as a magnifying glass and forms a virtual image of the display.

(a) (i) Describe where the display must be positioned relative to the focal length of the lens for the lens to act as a magnifying glass for the image on the display.

.....

..... [1]

(ii) Explain how a virtual image is formed.

.....

.....

..... [1]

1. Question part 2/2 | 5054 May-June 2023 P2 V1 Q6

(b) An arrow on the display is 3.4 cm from the lens. The virtual image of the arrow is 22 cm from the lens.

Fig. 6.3 shows the arrow O, the lens L and the virtual image of the arrow I, drawn on a grid with a scale of 1:2.

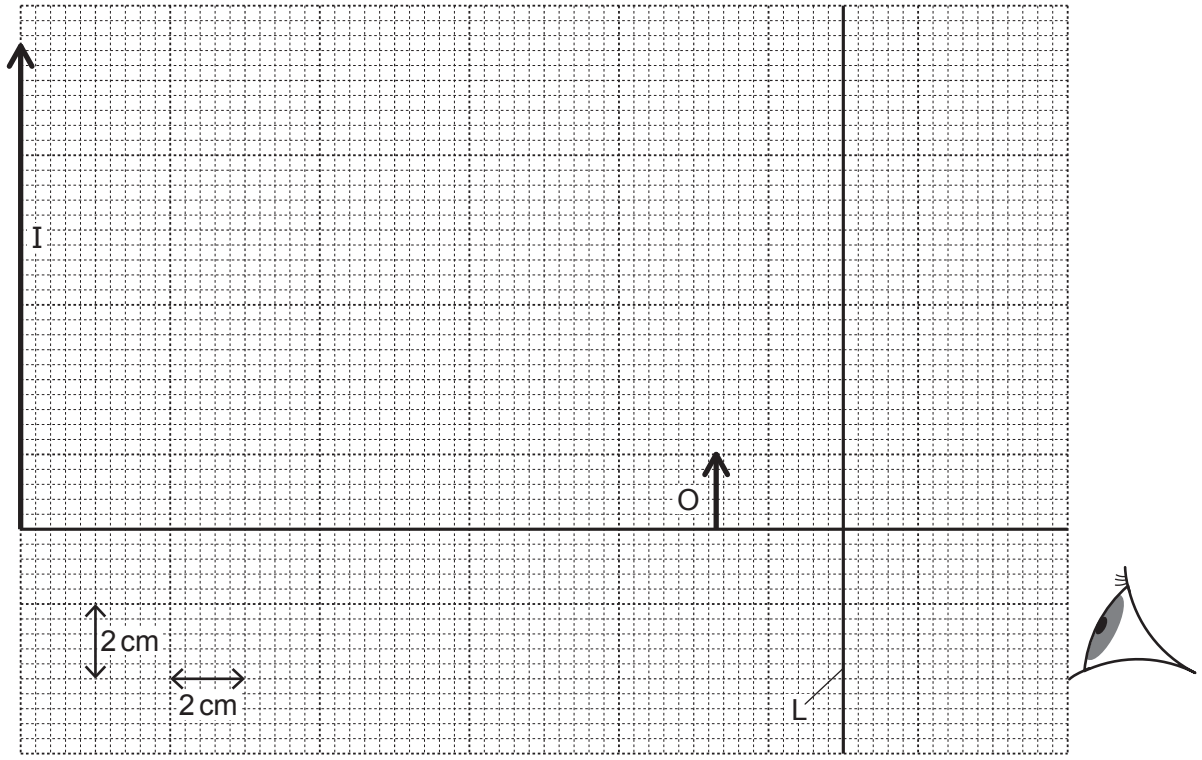

Fig. 6.3 (scale: 1 cm represents 2 cm)

(i) On Fig. 6.3, draw a ray diagram to show the formation of the virtual image I. [3]

(ii) Determine the focal length of the lens.

focal length = ... cm [1]

[Total: 6]

2. Question part 1/2 | 5054 May-June 2023 P2 V1 Q7

7 A water wave in a ripple tank diffracts as it passes through the gap in a barrier.

Fig. 7.1 shows a drawing made by a student of the crests in the pattern.

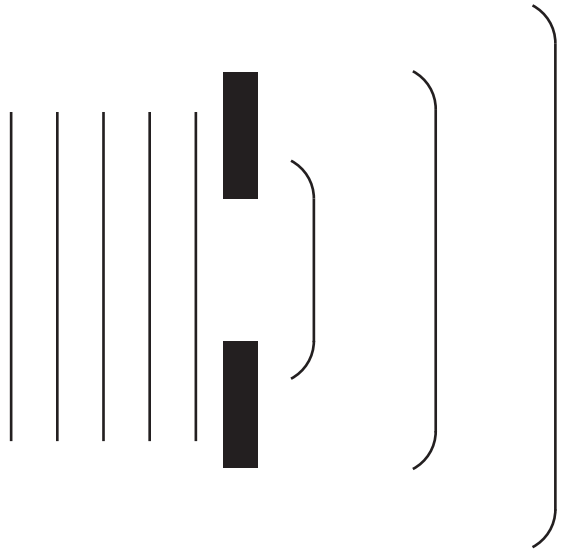

Fig. 7.1

(a) State **one** way in which the student's drawing of the crests is wrong.

.....

..... [1]

(b) The gap in the barrier is now made smaller than the wavelength, as shown in Fig. 7.2.

Complete Fig. 7.2 with at least three crests to show the new diffraction pattern.

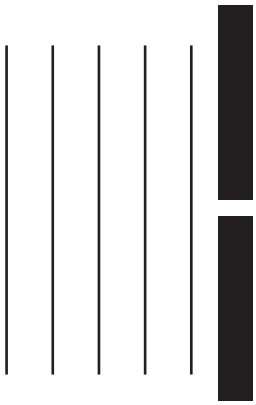

Fig. 7.2

[2]

2. Question part 2/2 | 5054 May-June 2023 P2 V1 Q7

(c) In one part of the ripple tank, the water wave has a speed of 6.0 cm / s and a wavelength of 2.0 cm.

The wave then passes into a shallower region of the tank.

The speed of the wave in the shallow region is 4.0 cm / s.

(i) Define the term ‘wavelength’.

.....

..... [1]

(ii) Calculate the frequency of the wave.

frequency = ... Hz [2]

(iii) Calculate the wavelength of the wave in the shallow part of the tank.

wavelength = ... cm [1]

[Total: 7]

3. Question | 5054 May-June 2023 P2 V2 Q5

5 Water waves are transverse waves.

(a) Underline **two** other examples of transverse waves.

seismic P-waves **seismic S-waves** **sound** **X-rays** [1]

(b) Fig. 5.1 shows a wooden bar and a glass block in a ripple tank. The depth of water in the tank is less than the height of the glass block.

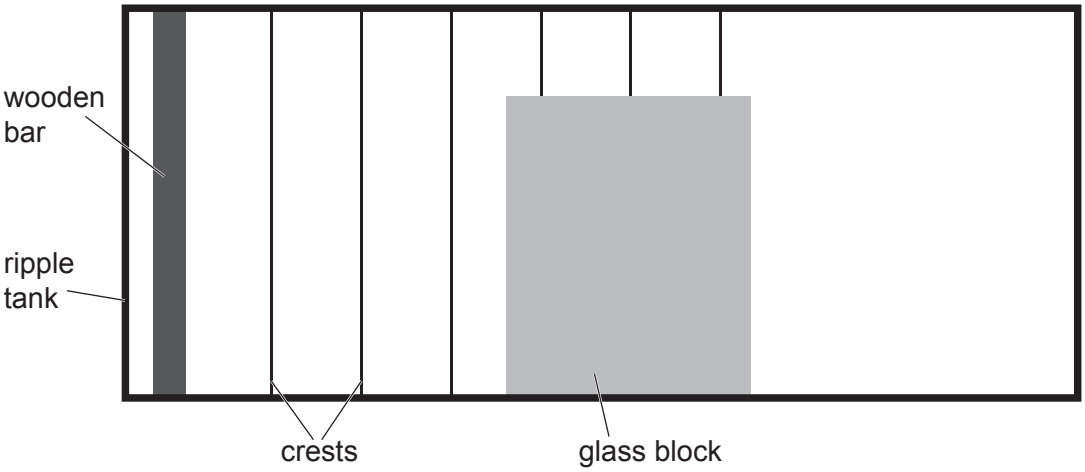

Fig. 5.1 (not to scale)

The wooden bar moves up and down once every 0.15 s to create the crests.

(i) The speed of the water wave is 27 cm / s.

Calculate the frequency and the wavelength of the wave.

frequency = ... Hz

wavelength = ... cm
[3]

(ii) The wave diffracts at the right-hand edge of the glass block.

On Fig. 5.1 draw **two** crests after they pass the glass block to show the diffraction. [2]

(iii) Describe how a wave with a smaller wavelength is made with the wooden bar.

.....

..... [1]

(iv) Describe how a decrease in wavelength affects the diffraction.

.....

..... [1]

[Total: 8]

4. Question | 5054 May-June 2023 P2 V2 Q7

7 **(a)** Ultraviolet radiation is one component of the electromagnetic spectrum.

(i) State the name of **two** components of the electromagnetic spectrum that have a smaller wavelength than ultraviolet radiation.

1 .....

2 .....
[1]

(ii) State **one** useful application of ultraviolet radiation.

..... [1]

(iii) Exposure to ultraviolet radiation from the Sun damages the eyes.

State **one** type of damage to the eye caused by ultraviolet radiation.

..... [1]

(b) Fig. 7.1 shows a ray of light. The ray passes into a semi-circular block of glass at A and leaves the glass at B, travelling along the surface to C.

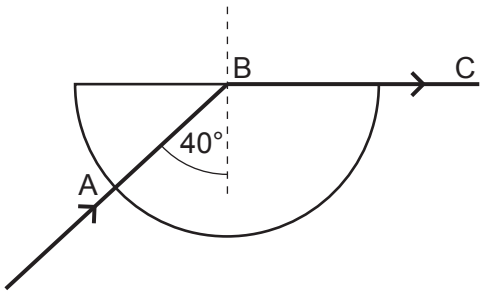

Fig. 7.1

(i) State the name given to the angle of incidence marked as 40°.

..... [1]

(ii) Calculate the refractive index of the glass.

refractive index = ... [2]

[Total: 6]

4 Red light of frequency 4.7×10^{14} Hz travels in air at a speed of 3.0×10^{8} m/s.

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

wavelength = ... m [3]

(b) Fig. 4.1 shows a narrow beam of this red light striking the surface of a parallel-sided glass block.

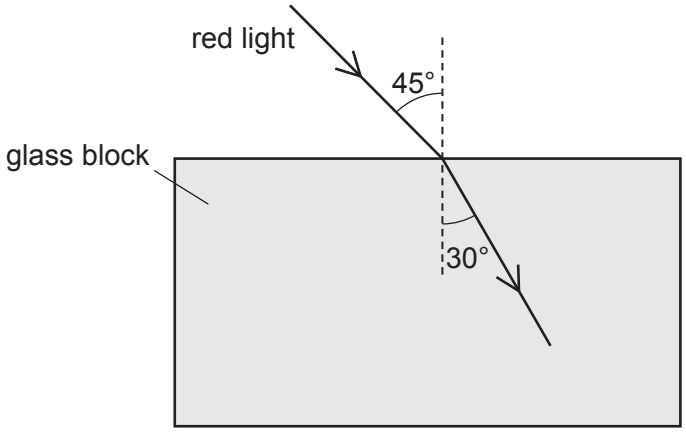

Fig. 4.1

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

speed .....

frequency .....

wavelength .....

[2]

(ii) Using the angles shown on Fig. 4.1, calculate the refractive index of the glass.

refractive index = ... [3]

(iii) The light continues along the path shown in Fig. 4.1 until it strikes the bottom surface of the block. Light then emerges into the air.

Draw on Fig. 4.1 to show the path taken by the light until it strikes the bottom surface and the path of the light that emerges into the air. [2]

[Total: 10]

6. Question | 5054 Oct-Nov 2023 P2 V1 Q5

5 Most of the energy emitted by the Sun is in three regions of the electromagnetic spectrum.

(a) The name of one of these three regions is the ultraviolet region.

(i) State the names of all three regions in order of increasing frequency.

smallest frequency .....

intermediate frequency .....

largest frequency .....
[2]

(ii) Some of the ultraviolet radiation emitted by the Sun reaches the surface of the Earth.

Give one possible damaging effect of ultraviolet radiation on the human body and the property of ultraviolet radiation that causes this damage.

damaging effect .....

.....

property .....

.....
[2]

(b) Electromagnetic radiation is a transverse wave.

Describe the difference between a transverse wave and a longitudinal wave.

.....

.....

..... [2]

[Total: 6]

7. Question | 5054 Oct-Nov 2023 P2 V2 Q6

6 The loudspeaker shown in Fig. 6.1 produces a sound of frequency 800 Hz.

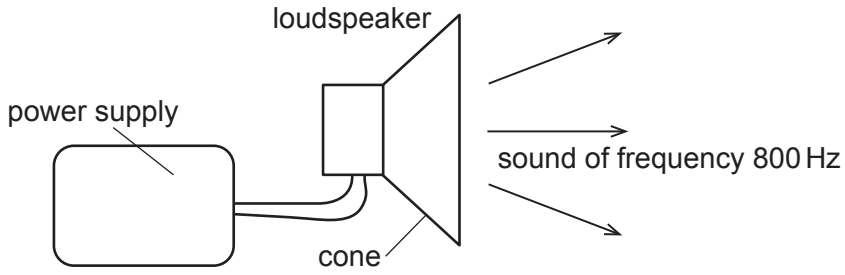

Fig. 6.1

(a) State what is meant by 'frequency'.

.....

..... [2]

(b) Explain whether the sound produced by the speaker is audible to a human with healthy hearing.

.....

..... [1]

(c) Describe the motion of the cone in Fig. 6.1 and explain how this causes the production of sound.

.....

.....

.....

.....

..... [3]

(d) The Sun is a very large and extremely violent ball of gas. Electromagnetic radiation from explosions on the surface of the Sun reaches the Earth.

Explain why sound from explosions on the surface of the Sun does **not** reach the Earth.

.....

.....

..... [2]

[Total: 8]

8. Question | 5054 Specimen 2023 P2 Q5

5 Fig. 5.1 shows light in air, incident on the side of a rectangular glass block at an angle of 60°.

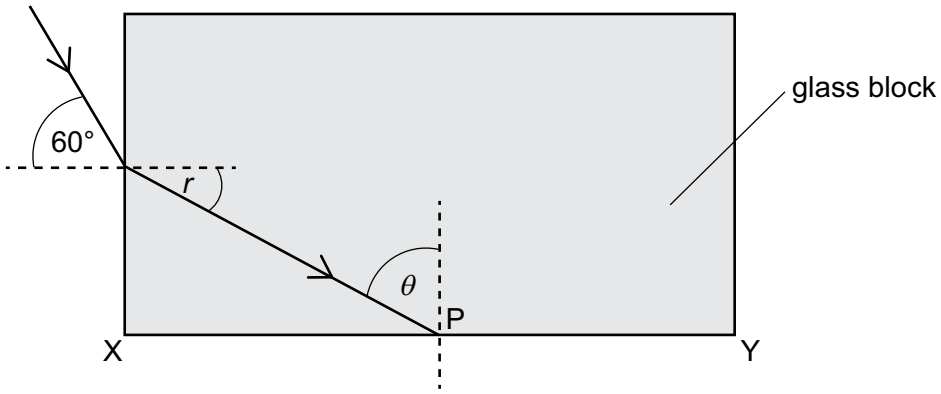

Fig. 5.1

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

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

electromagnetic **longitudinal** **radioactive** **transverse** [1]

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

Calculate angle *r*.

r = ... ° [2]

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

c = ... ° [2]

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

State and explain what happens to the light when it is incident on side XY.

.....

.....

..... [2]

[Total: 7]

9. Question part 1/2 | 5054 May-June 2024 P2 V1 Q4

4 **(a)** Ultrasound of frequency 30 kHz has a wavelength of 0.011 m in air.

(i) State what is meant by ‘frequency’.

.....

..... [1]

(ii) Calculate the speed of ultrasound in air.

Show your working.

speed = ... m/s [2]

(iii) State **one** use of ultrasound.

..... [1]

(b) Sound waves are longitudinal waves. Water waves are transverse waves.

(i) Describe, by referring to the movement of the particles in the wave, the difference between a longitudinal wave and a transverse wave.

You may include a labelled diagram to help your description.

.....

.....

.....

.....

..... [3]

9. Question part 2/2 | 5054 May-June 2024 P2 V1 Q4

(ii) State **one** source of waves that generates both longitudinal and transverse waves.

..... [1]

(c) Fig. 4.1 shows radio waves of long and short wavelength passing over the same hill.

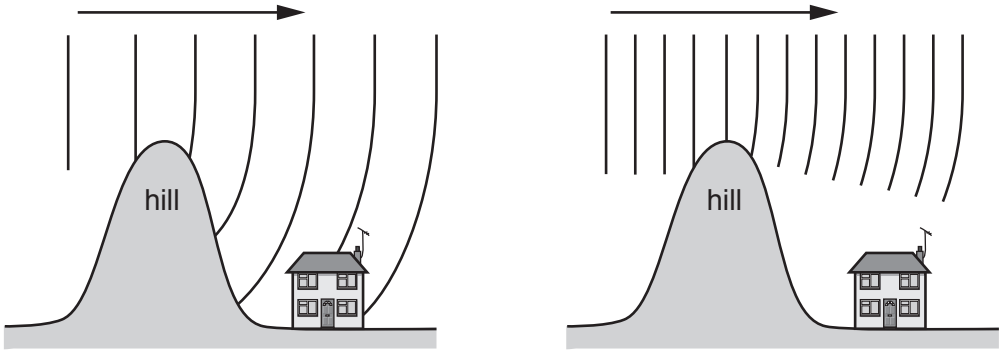

diagram A diagram B

Fig. 4.1 (not to scale)

Explain why the radio waves in diagram A reach the house but the radio waves in diagram B do not reach the house.

.....

.....

.....

..... [2]

[Total: 10]

10. Question | 5054 May-June 2024 P2 V2 Q4

4 **(a)** Fig. 4.1 shows light passing through a triangular glass prism.

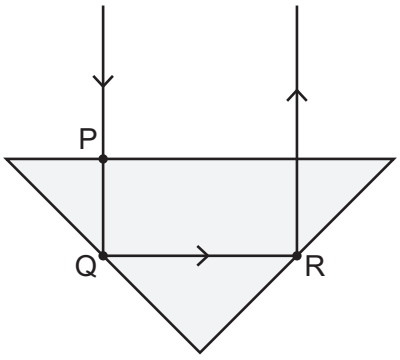

Fig. 4.1

(i) State the value of the angle of incidence at point P.

angle of incidence = ... ° [1]

(ii) Draw the normal and the angle of incidence at point R.

Label the angle of incidence. [2]

(iii) State **two** conditions needed so that no light refracts from the glass into the air at point Q.

1 .....

.....

2 .....

.....

[2]

(b) Information is sent across the internet using pulses of visible light through long, thin glass fibres and electrical signals through copper wires.

(i) State the name of **one** other type of electromagnetic radiation used to transmit information through long, thin glass fibres.

..... [1]

(ii) Suggest **two** advantages of using glass fibres rather than copper wires to transmit information from the internet.

1 .....

.....

2 .....

.....

[2]

[Total: 8]

11. Question | 5054 Oct-Nov 2024 P2 V1 Q4

4 A student directs a beam of white light from a filament lamp towards a glass prism in a dark room.

Fig. 4.1 shows the beam of white light incident on the left-hand side of the glass prism.

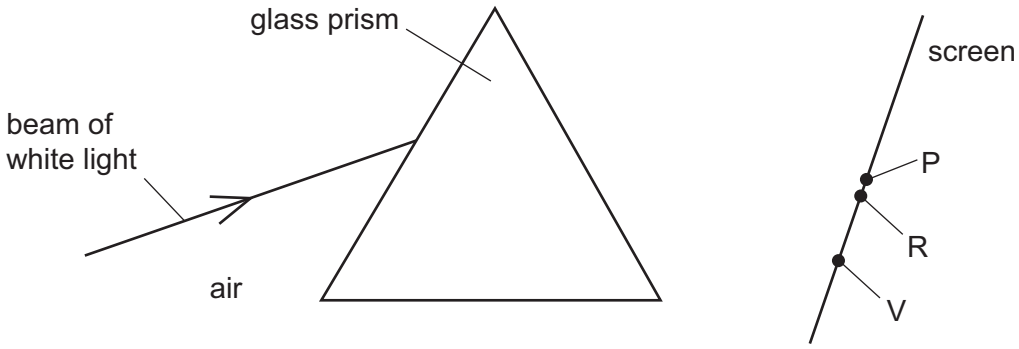

Fig. 4.1

A screen is placed to the right of the glass prism. Red light is observed at point R on the screen and violet light is observed at point V.

(a) Draw on Fig. 4.1 to show the paths of the red light and the violet light between the left-hand side of the prism and the screen at point R and point V. [2]

(b) State what these observations show about the change in speed of red light and change in speed of violet light as each enters the glass from the air.

.....

.....

..... [2]

(c) Five other colours of light appear on the screen between the red light at point R and the violet light at point V.

(i) State the names of the five colours and list them in the correct order from red to violet.

red ..... **violet** [2]

(ii) State how the frequency and the wavelength of the coloured light change going from red light to violet light.

frequency .....

wavelength .....
[1]

(d) On Fig. 4.1, point P is shown immediately next to point R.

No light is observed at point P, but a detector at point P registers radiation reaching the detector.

State which region of the electromagnetic spectrum is detected at point P.

..... [1]

[Total: 8]

12. Question | 5054 Oct-Nov 2024 P2 V1 Q5

5 Ultrasound is a longitudinal wave which cannot be heard by humans as the frequency of ultrasound is too high.

(a) Ultrasound waves **cannot** travel in a vacuum.

Explain why.

.....

.....

..... [2]

(b) Describe how a longitudinal wave differs from a transverse wave.

.....

.....

.....

..... [2]

(c) An ultrasound transmitter used for a medical scan produces an ultrasound wave of frequency 8.4 MHz.

In soft human tissue, ultrasound travels at 1500 m / s.

(i) Calculate the wavelength of this ultrasound wave in soft human tissue.

wavelength = ... m [3]

(ii) The ultrasound wave passes from the soft tissue into bone where the speed of the ultrasound wave is greater than 1500 m / s.

State what happens to the frequency and to the wavelength of the ultrasound wave as it passes into the bone.

frequency .....

wavelength .....
[2]

[Total: 9]

13. Question part 1/2 | 5054 Oct-Nov 2024 P2 V2 Q5

5 Some glass lenses are converging lenses, and others are diverging lenses.

(a) Draw the cross-section of a diverging lens.

[1]

(b) Fig. 5.1 shows the cross-section of a converging lens, the principal axis and the two principal focuses (focal points) F_1 and F_2 on a full-scale grid.

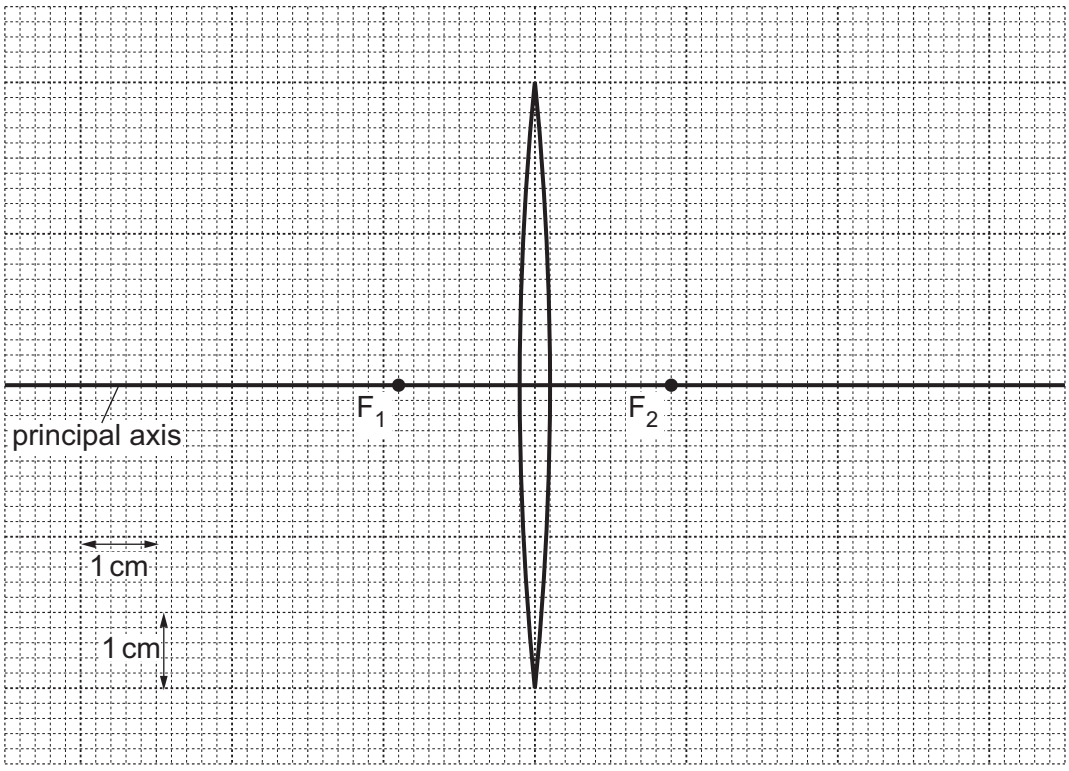

Fig. 5.1

13. Question part 2/2 | 5054 Oct-Nov 2024 P2 V2 Q5

A student places an object of height 2.1 cm at a distance of 3.0 cm from the centre of the lens.

(i) Using Fig. 5.1, determine the focal length of the lens.

focal length = ... cm [1]

(ii) On Fig. 5.1, draw a vertical arrow of height 2.1 cm that is 3.0 cm from the centre of the lens and label the arrow **O**. The arrow is the object. [1]

(iii) On Fig. 5.1, draw **two** rays from the tip of the object arrow to find the tip of the image.

Draw another arrow to show the image. [3]

(iv) Using the image marked on Fig. 5.1 in **(b)(iii)**, determine the linear magnification produced.

magnification = ... [2]

(v) Explain whether the image of the object is real or virtual.

.....

..... [1]

[Total: 9]

14. Question part 1/2 | 5054 May-June 2025 P2 V1 Q5

5 **(a)** Fig. 5.1 is a diagram showing the arrangement of air particles as a longitudinal wave passes through them.

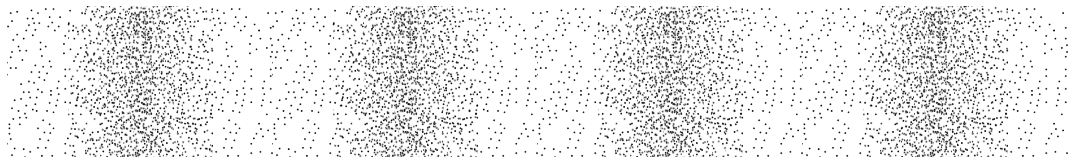

Fig. 5.1

(i) On Fig. 5.1, mark the centre of a compression with the letter C, and mark the centre of a rarefaction with the letter R. [1]

(ii) Describe the difference between a compression and a rarefaction.

.....

.....

..... [1]

(b) In a ripple tank, a water wave is produced by a wooden bar moving up and down on the surface of water.

(i) The wooden bar makes 45 complete oscillations in 1.0 minute.

Calculate the frequency of the wave produced.

frequency = ...Hz [1]

(ii) The frequency of the water wave is increased by moving the wooden bar up and down more quickly.

State what happens to the speed and what happens to the wavelength of the wave produced.

speed .....

wavelength .....
[2]

14. Question part 2/2 | 5054 May-June 2025 P2 V1 Q5

(iii) The crests of the water wave move into the shallow region shown in Fig. 5.2.

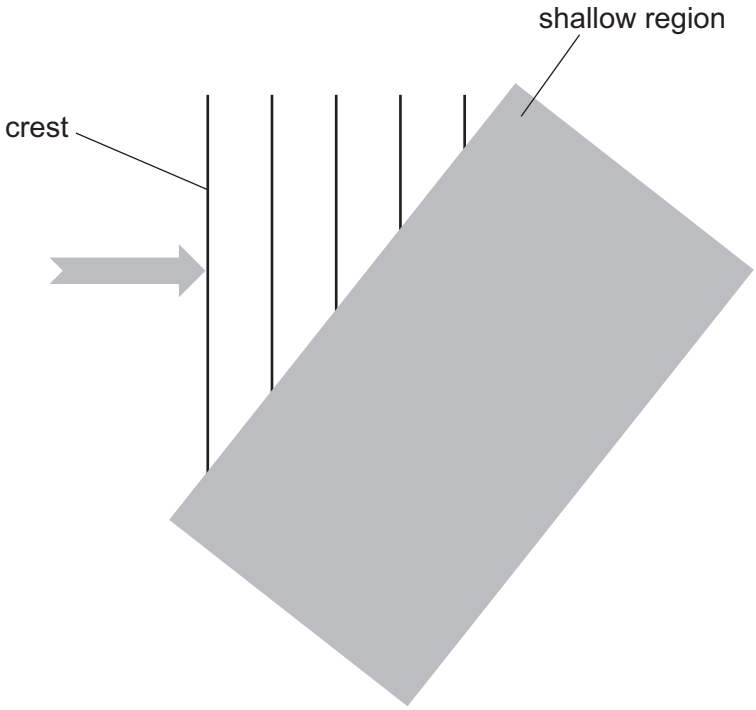

Fig. 5.2

On Fig. 5.2, draw the crests in the shallow region. [2]

(c) Describe what is meant by the diffraction of a water wave.

.....

.....

..... [1]

[Total: 8]

15. Question part 1/2 | 5054 May-June 2025 P2 V2 Q4

4 A sound wave from a vibrating tuning fork is displayed on the oscilloscope shown in Fig. 4.1. The sound wave is detected using a microphone.

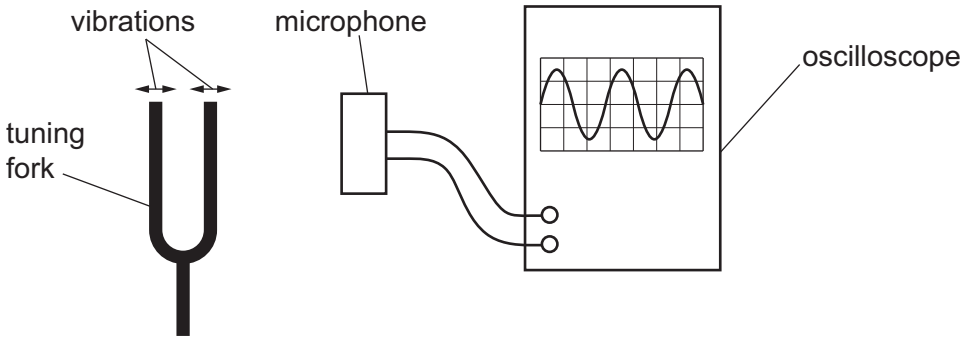

Fig. 4.1

(a) Describe the motion of the air particles as the sound wave passes from the tuning fork to the microphone.

.....

.....

..... [2]

(b) Fig. 4.2 shows the trace seen on the oscilloscope when the tuning fork vibrates.

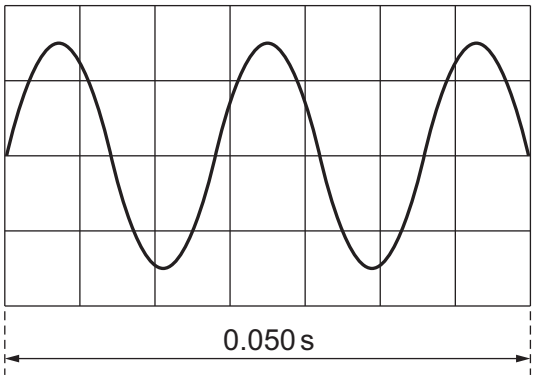

Fig. 4.2

The frequency of the sound is constant.

(i) State what is meant by 'frequency'.

.....

..... [1]

(ii) The trace shown on Fig. 4.2 is produced in 0.050 s.

Calculate the frequency of the sound wave.

frequency = ... Hz [2]

(iii) A student near the tuning fork observes the trace and listens to the sound. He notices that the amplitude of the trace decreases.

State how the sound heard by the student changes.

..... [1]

(iv) The tuning fork is replaced by a new tuning fork that produces a sound wave of half the frequency. The controls on the oscilloscope are not changed.

On Fig. 4.3, draw the trace obtained with the new tuning fork. The trace obtained with the original tuning fork is shown.

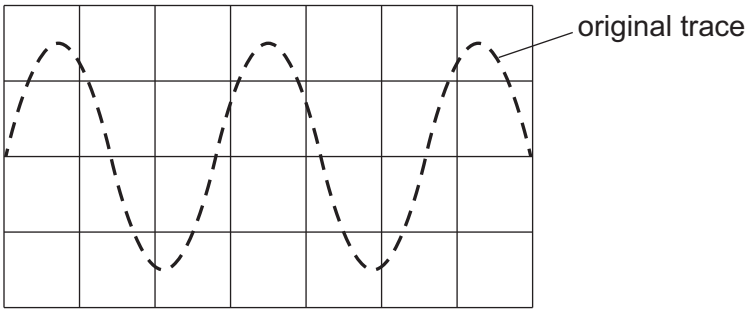

Fig. 4.3

[1]

(c) Fig. 4.4 shows three adjacent wavefronts of the sound wave as the wavefronts move towards a gap in a wall created by an open door.

Another student, standing at P on the other side of the wall, hears the sound.

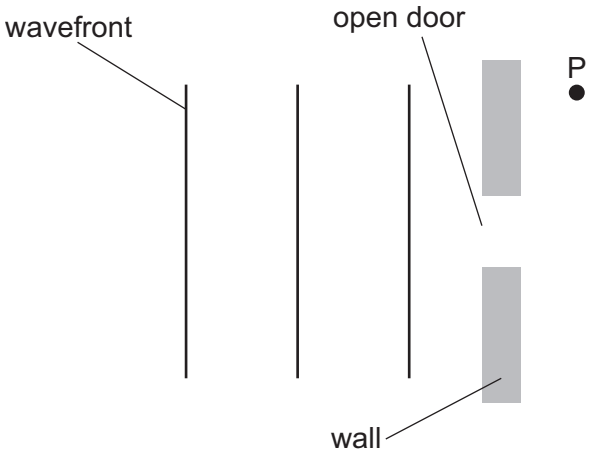

Fig. 4.4

(i) On Fig. 4.4, draw the three wavefronts after they pass through the gap. [2]

(ii) State the name of the process involved as the wavefronts pass through the gap and reach P.

..... [1]

[Total: 10]

16. Question part 1/2 | 5054 Oct-Nov 2025 P2 V1 Q4

4 Fig. 4.1 shows a ray of light striking the left-hand surface of a thin glass converging lens.

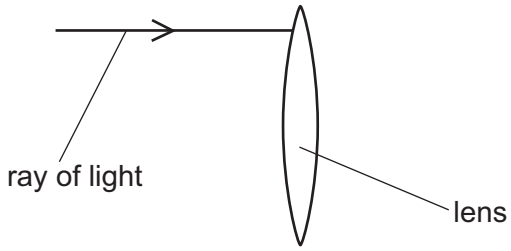

Fig. 4.1

(a) Explain why the ray refracts and changes direction as it enters the glass.

.....

.....

.....

..... [2]

(b) Explain what is meant by:

(i) the principal focus (focal point) of a lens

.....

.....

.....

..... [2]

(ii) the focal length of a lens.

.....

..... [1]

(c) An object O of height 1.8 cm is placed at a point 2.2 cm to the left of the centre of the lens.

Fig. 4.2 is a full-scale diagram that shows the converging lens, its principal axis and its two principal focuses, F_1 and F_2.

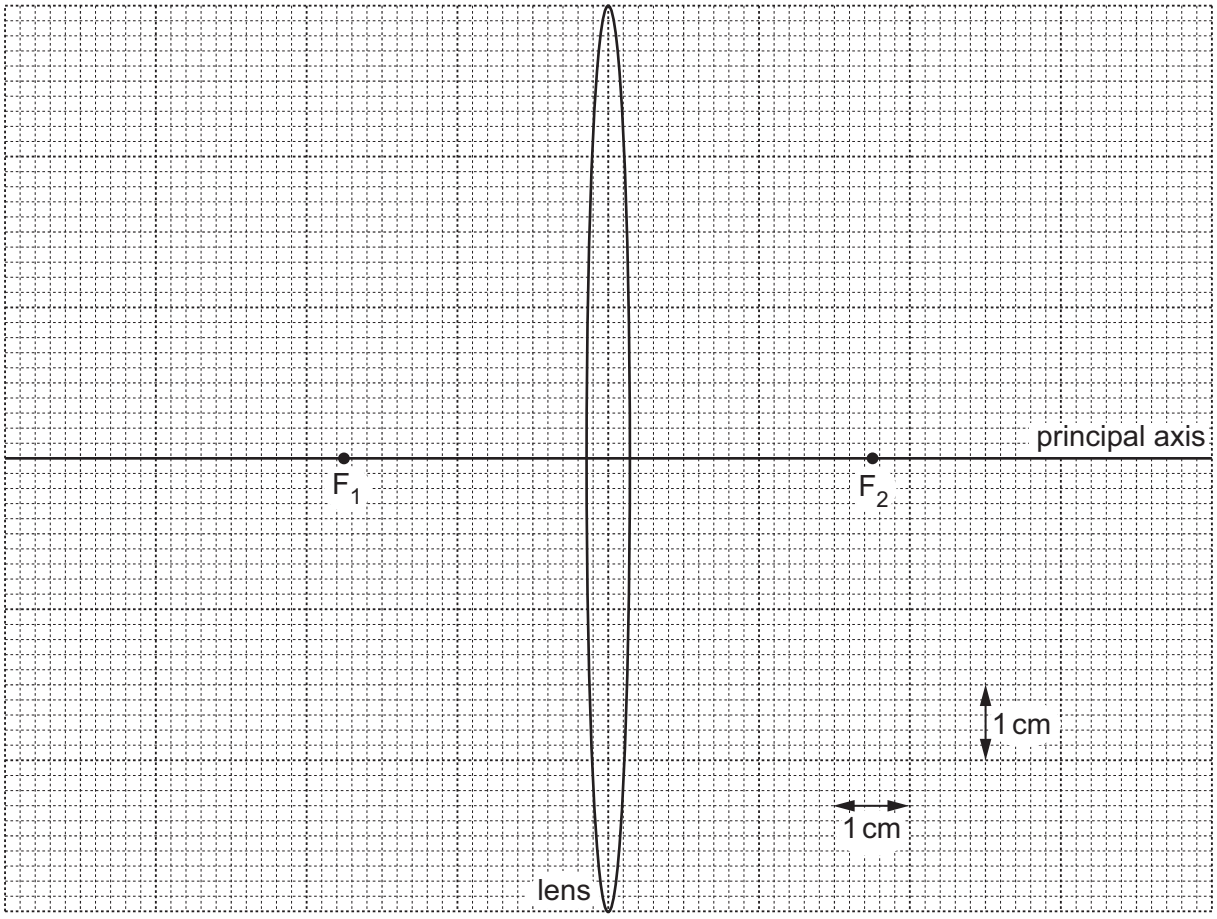

Fig. 4.2

(i) On Fig. 4.2, draw an arrow to represent the height and position of object O. The arrow should start on the principal axis. [1]

(ii) On Fig. 4.2, draw **two** rays from the tip of the arrow drawn in **(c)(i)** to locate the position of the tip of the image I of object O.

Draw an arrow to represent the image I of the object O. Label the image I. [3]

(iii) State whether the image I of the object O is a real or a virtual image, and explain your answer.

.....

.....

..... [1]

[Total: 10]

17. Question part 1/2 | 5054 Oct-Nov 2025 P2 V2 Q5

5 The microwave region is one region of the electromagnetic spectrum.

(a) Fig. 5.1 represents the electromagnetic spectrum divided into the seven main regions.

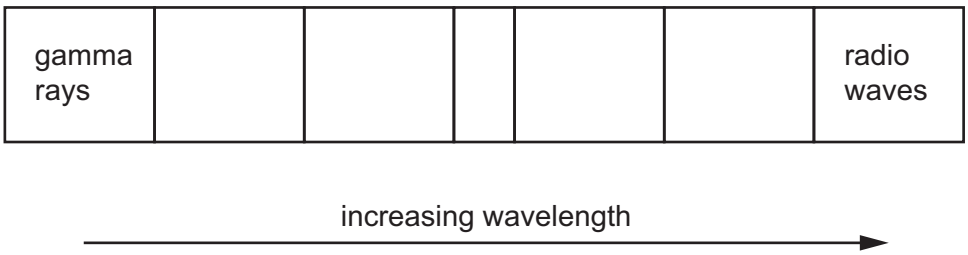

Fig. 5.1

The regions are arranged from left to right in order of increasing wavelength.

On Fig. 5.1:

- indicate the microwave region by marking it with the letter M
- indicate the ultraviolet region by marking it with the letters UV.

[1]

(b) The frequency of the microwaves used by some satellite television systems is 12 GHz.

(i) The speed of microwaves in a vacuum is 3.0×10^8 m/s.

Calculate the wavelength of these microwaves in a vacuum.

wavelength = ... m [3]

(ii) Describe how microwaves are used in satellite television systems.

.....

.....

.....

..... [2]

17. Question part 2/2 | 5054 Oct-Nov 2025 P2 V2 Q5

(c) All microwave ovens have a switch that turns the oven off when the door is opened.

Suggest why it is important for a microwave oven to switch off when the door is opened.

.....

.....

.....

..... [2]

[Total: 8]

18. Question part 1/2 | 5054 May-June 2026 P2 V1 Q4

4 **(a)** All electromagnetic waves transfer energy.

State **two** other properties that are the same for all electromagnetic waves.

1 .....

.....

2 .....

..... [2]

(b) Figure 4.1 shows an X-ray image of healthy teeth.

The detector used to create the image is placed inside the mouth, behind the teeth.

A source of X-rays is placed outside the mouth, in front of the teeth.

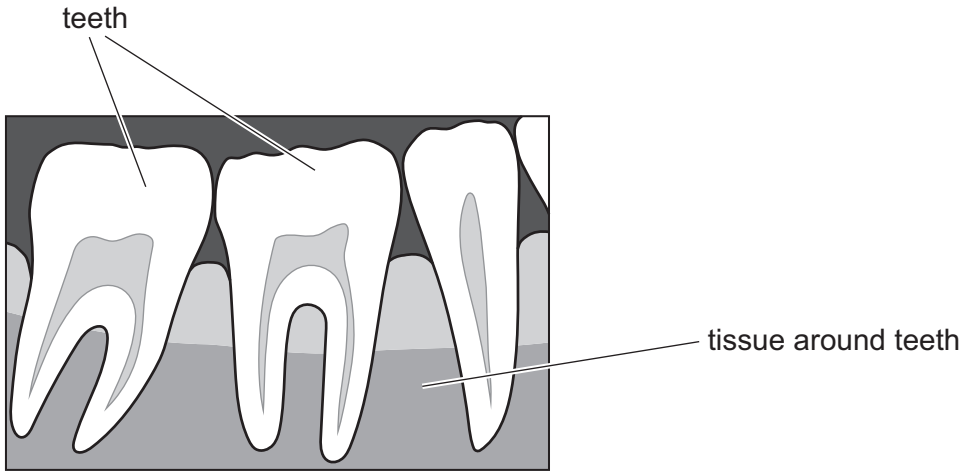

Figure 4.1

Explain why the X-rays produce an image that shows white teeth, grey tissue around the teeth and a black background.

.....

.....

.....

.....

..... [2]

18. Question part 2/2 | 5054 May-June 2026 P2 V1 Q4

(c) Ultrasound is another type of wave used in hospitals to produce medical images.

A scanner placed on the skin of a patient emits an ultrasound wave.

(i) The ultrasound wave causes a motion of the particles in the tissue of the patient.

Describe this motion.

.....

.....

..... [2]

(ii) The ultrasound wave is reflected from a bone in the patient and arrives back at the scanner 8.0×10^{-5} s after it was emitted.

The speed of ultrasound in the patient is 1500 m / s.

Calculate the distance between the scanner and the bone.

distance = ... m [2]

(iii) Some of the ultrasound passes through the patient and emerges into the air.

The speed of ultrasound in air is smaller than the speed of ultrasound in the patient.

State and explain the change in wavelength as ultrasound travels from the patient into the air.

change in wavelength .....

explanation .....

.....

.....

.....

[2]

[Total: 10]

19. Question part 1/2 | 5054 May-June 2026 P2 V1 Q5

5 Figure 5.1 shows a ripple tank used by a student.

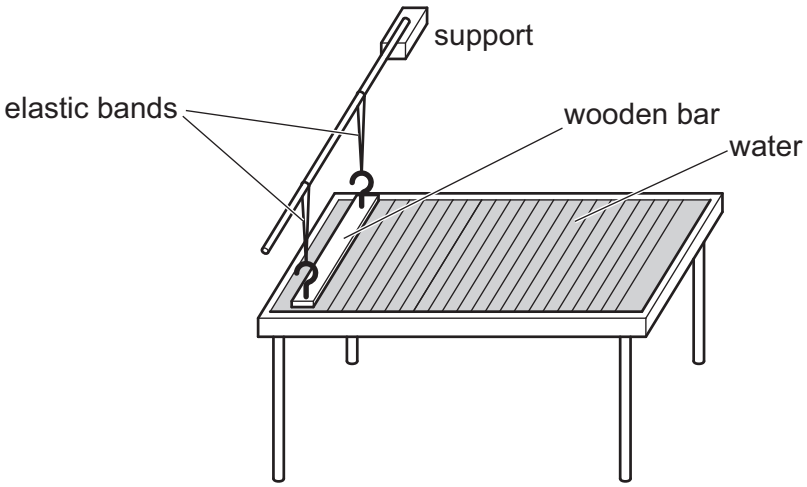

Figure 5.1

(a) (i) Describe how the student uses the apparatus to create a wave.

.....

.....

..... [1]

(ii) Describe how the student can demonstrate diffraction of the wave using the ripple tank. You should refer to any other apparatus needed.

.....

.....

.....

..... [1]

(iii) The unit of frequency is the hertz (Hz).

Describe how the student can determine the frequency of the wave in the ripple tank in Hz.

.....

.....

.....

..... [2]

19. Question part 2/2 | 5054 May-June 2026 P2 V1 Q5

(b) Figure 5.2 shows a side view of the wave on the surface of the water. The diagram also shows the surface of the water before it is disturbed by the wave.

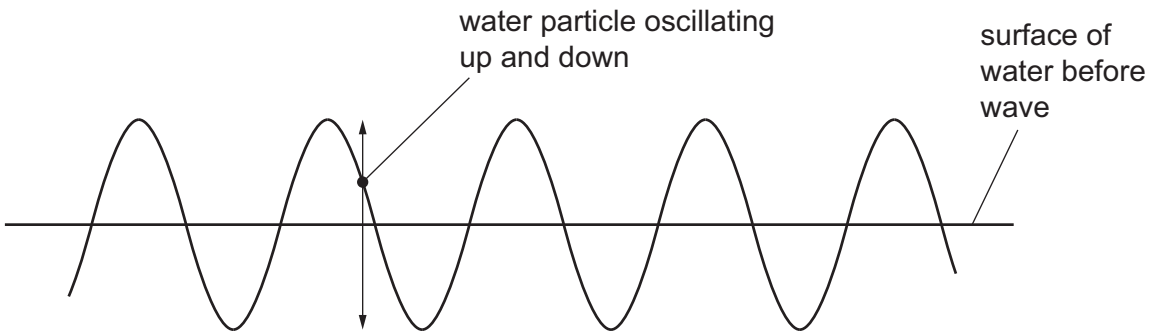

Figure 5.2

A water particle on the surface of the water oscillates up and down.

(i) On Figure 5.2, mark and label the amplitude of the wave. [1]

(ii) The frequency of the wave is 2.0 Hz.

Calculate the time taken for the water particle to move from the top of the wave to the bottom of the wave.

time = ... s [2]

(iii) Describe how the speed of the particle changes as it moves from the top of the wave to the bottom of the wave.

.....

.....

..... [2]

[Total: 9]

20. Question part 1/2 | 5054 May-June 2026 P2 V2 Q5

5 A student uses a glass block and two identical glass prisms to demonstrate the action of a converging lens.

Figure 5.1 shows three parallel rays of red light incident on the glass block and the two prisms.

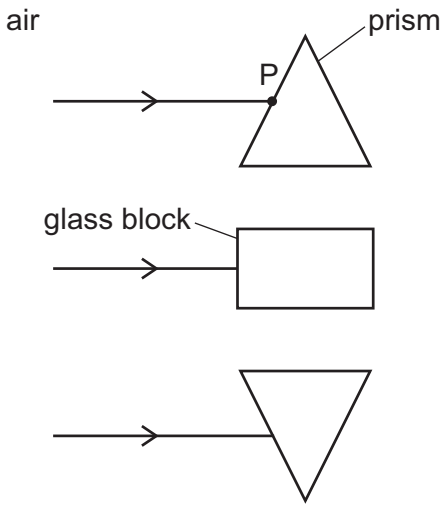

Figure 5.1

(a) (i) On Figure 5.1, draw and label the normal to the prism at point P. [1]

(ii) Complete Figure 5.1 to show how the rays of light travel through and out of both prisms and the glass block. [2]

(iii) The action of a diverging lens is also demonstrated using the two identical glass prisms and the glass block.

On Figure 5.2, draw the prisms arranged so that they demonstrate the action of a diverging lens.

Show the rays of light travelling through the prisms and the glass block.

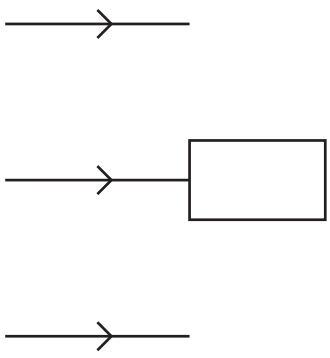

Figure 5.2

[2]

(b) Figure 5.3 shows a converging lens, an object and two rays of light from the top of the object. The principal focus (focal point) on each side of the lens is labelled F.

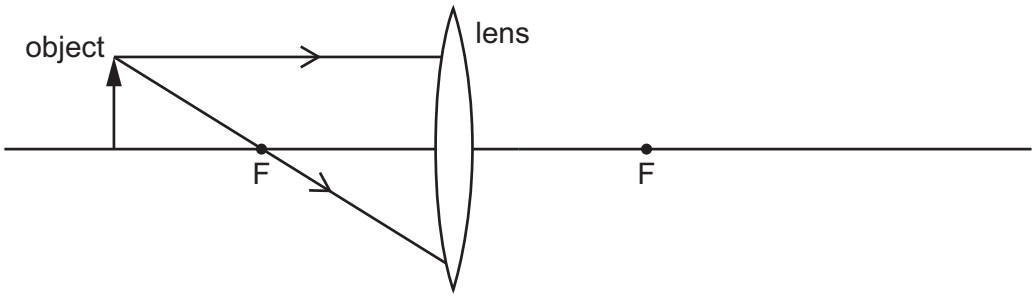

Figure 5.3

Continue the paths of both rays to show where the image of the object is formed. Draw and label the image. [2]

(c) Figure 5.4 shows the electromagnetic spectrum.

radio waves	microwaves	infrared	visible light	ultraviolet	X-rays	gamma rays

Figure 5.4

State **two** properties of electromagnetic waves that change from one end of the spectrum to the other end, and describe how these properties change from one end to the other.

1 .....

.....

2 .....

.....

[2]

[Total: 9]