Properties of Wave

(IGCSE Physics Year 2002 Oct/Nov Paper 3-Set 1)

5 **(a)** Fig. 5.1 shows the air pressure variation along a sound wave.

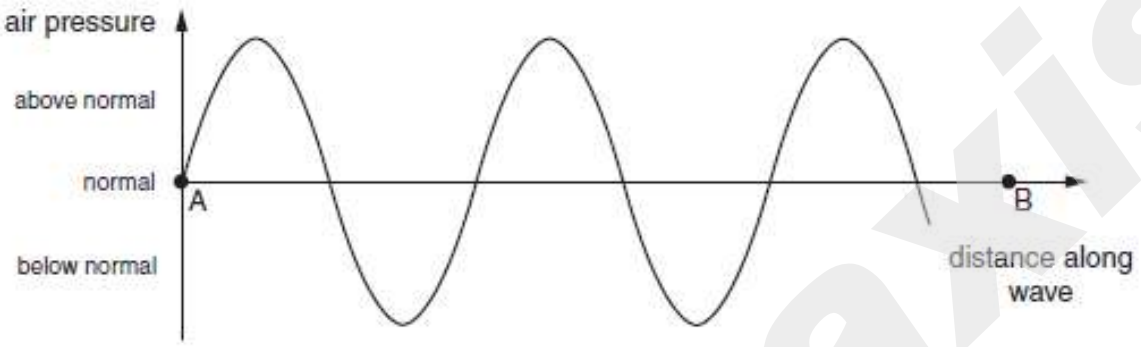

Fig. 5.1

(i) On AB in Fig. 5.1, mark one point of compression with a dot and the letter C and the next point of rarefaction with a dot and the letter R.

(ii) In terms of the wavelength, what is the distance along the wave between a compression and the next rarefaction?

.....

[3]

(b) A sound wave travels through air at a speed of 340 m/s. Calculate the frequency of a sound wave of wavelength 1.3 m.

frequency = ... [2]

6 (a) Fig. 6.1 shows the results of an experiment to find the critical angle for light in a semi-circular glass block.

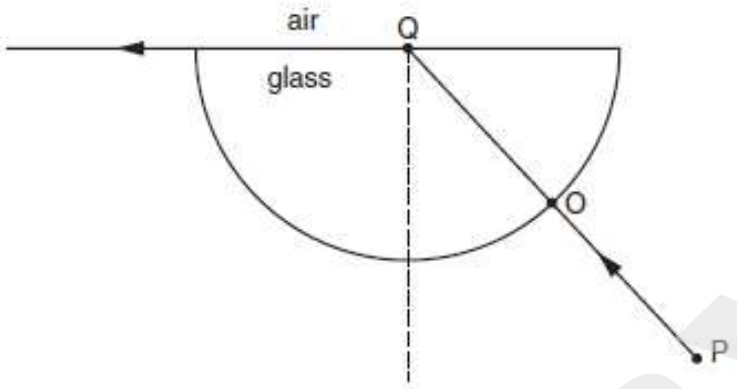

Fig. 6.1

The ray of light PO hits the glass at O at an angle of incidence of 0°.
Q is the centre of the straight side of the block.

(i) Measure the critical angle of the glass from Fig. 6.1.

critical angle = ...

(ii) Explain what is meant by the *critical angle* of the light in the glass.

.....

.....

.....

[3]

(b) Fig. 6.2 shows another ray passing through the same block.

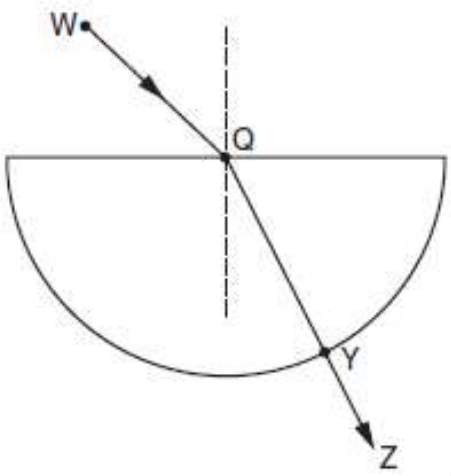

Fig. 6.2

The speed of the light between W and Q is 3.0×10^8 m/s. The speed of the light between Q and Y is 2.0×10^8 m/s.

(i) State the speed of the light between Y and Z.

speed = ...

(ii) Write down an expression, in terms of the speeds of the light, that may be used to find the refractive index of the glass. Determine the value of the refractive index.

refractive index = ...

(iii) Explain why there is no change of direction of ray QY as it passes out of the glass.

.....

(iv) What happens to the wavelength of the light as it passes out of the glass?

.....

[5]

(IGCSE Physics Year 2003 May/June Paper 3-Set 1)

6 Fig. 6.1 shows wavefronts of light crossing the edge of a glass block from air into glass.

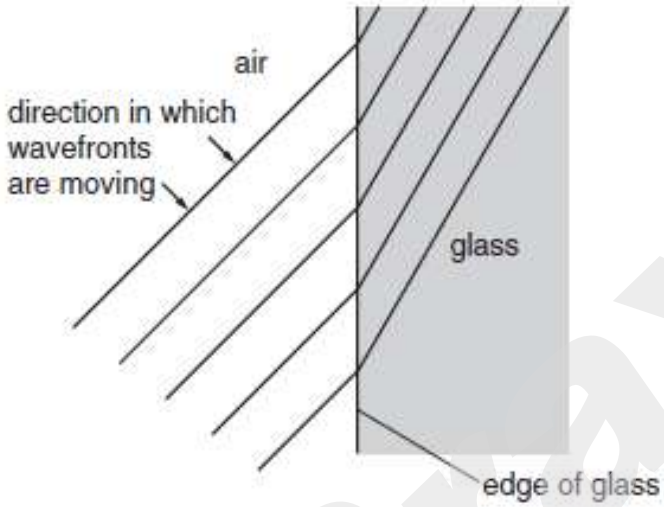

Fig. 6.1

(a) On Fig. 6.1

(i) draw in an incident ray, a normal and a refracted ray that meet at the same point on the edge of the glass block,

(ii) label the angle of incidence and the angle of refraction,

(iii) measure the two angles and record their values.

angle of incidence = ...

angle of refraction = ...

[4]

(b) Calculate the refractive index of the glass.

refractive index = ...[3]

7 In a thunderstorm, both light and sound waves are generated at the same time.

(a) How fast does the light travel towards an observer?

speed = ... [1]

(b) Explain why the sound waves always reach the observer after the light waves.

.....[1]

(c) The speed of sound waves in air may be determined by experiment using a source that generates light waves and sound waves at the same time.

(i) Draw a labelled diagram of the arrangement of suitable apparatus for the experiment.

(ii) State the readings you would take.

.....

.....

.....

(iii) Explain how you would calculate the speed of sound in air from your readings.

.....

.....

[4]

(IGCSE Physics Year 2003 Oct/Nov Paper 3-Set 1)

6 Fig. 6.1 shows the diffraction of waves by a narrow gap.

P is a wavefront that has passed through the gap.

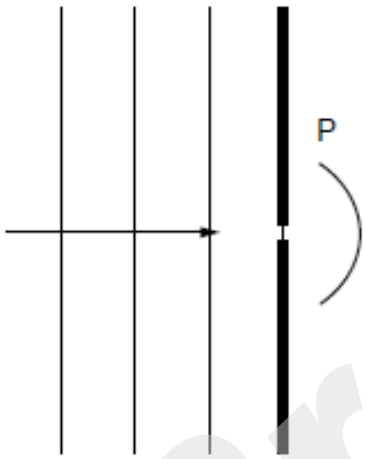

Fig. 6.1

(a) On Fig. 6.1, draw three more wavefronts to the right of the gap. [3]

(b) The waves travel towards the gap at a speed of 3×10^8 m/s and have a frequency of 5×10^{14} Hz. Calculate the wavelength of these waves.

wavelength = ... [3]

7 Fig. 7.1 is drawn to full scale. The focal length of the lens is 5.0 cm.

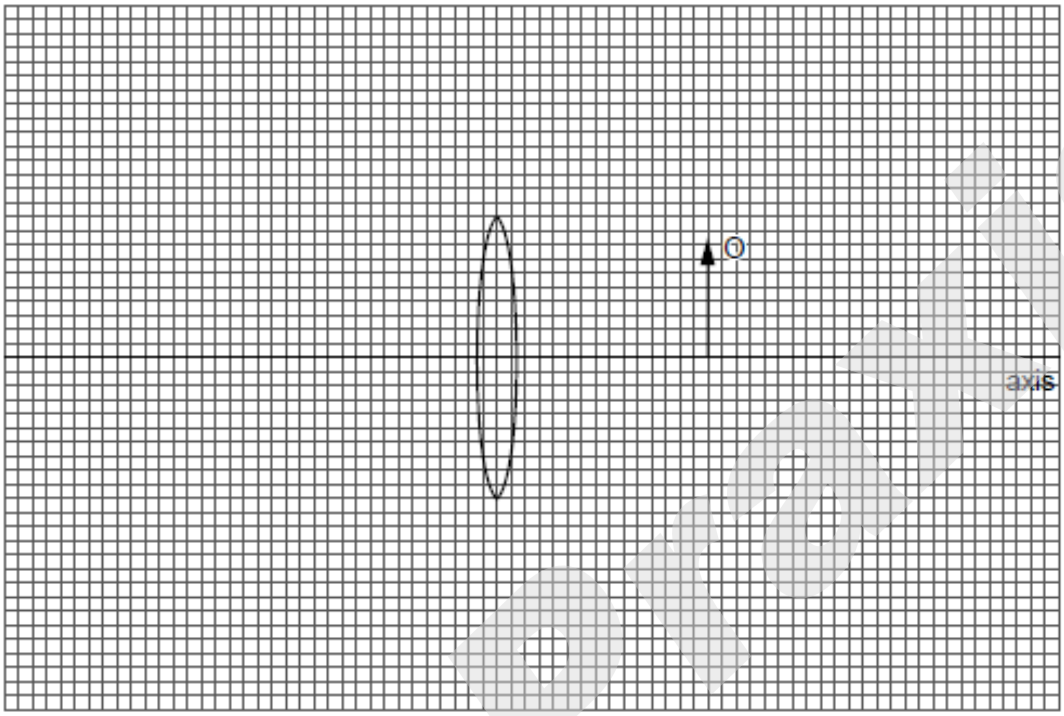

Fig. 7.1

(a) On Fig. 7.1, mark each principal focus of the lens with a dot and the letter F. [2]

(b) On Fig. 7.1, draw two rays from the tip of the object O that appear to pass through the tip of the image. [2]

(c) On Fig. 7.1, draw the image and label it with the letter I. [1]

(d) Explain why the base of the image lies on the axis.

.....

..... [1]

(e) State a practical use of a convex lens when used as shown in Fig. 7.1.

..... [1]

(IGCSE Physics Year 2004 May/June Paper 3-Set 1)

6 Fig. 6.1 shows a ray PQ of blue light incident on the side of a rectangular glass block.

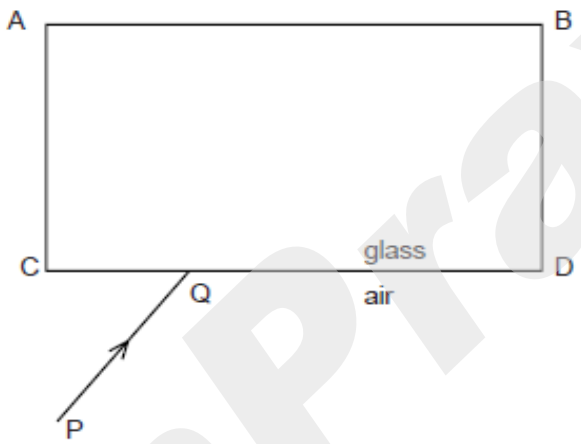

Fig. 6.1

(a) **(i)** By drawing on Fig. 6.1, continue the ray PQ through and beyond the block.

(ii) Mark the angle of incidence at CD with the letter *i* and the angle of refraction at CD with the letter *r*.

[3]

(b) The speed of light in air is 3.0×10^8 m/s and the speed of light in glass is 2.0×10^8 m/s.

(i) Write down a formula that gives the refractive index of glass in terms of the speeds of light in air and glass.

refractive index =

(ii) Use this formula to calculate the refractive index of glass.

refractive index = ...
[2]

(c) The frequency of the blue light in ray PQ is 6.0×10^{14} Hz.
Calculate the wavelength of this light in air.

wavelength = ...[2]

7 Fig. 7.1 shows the cone of a loudspeaker that is producing sound waves in air.
At any given moment, a series of compressions and rarefactions exist along the line XY.

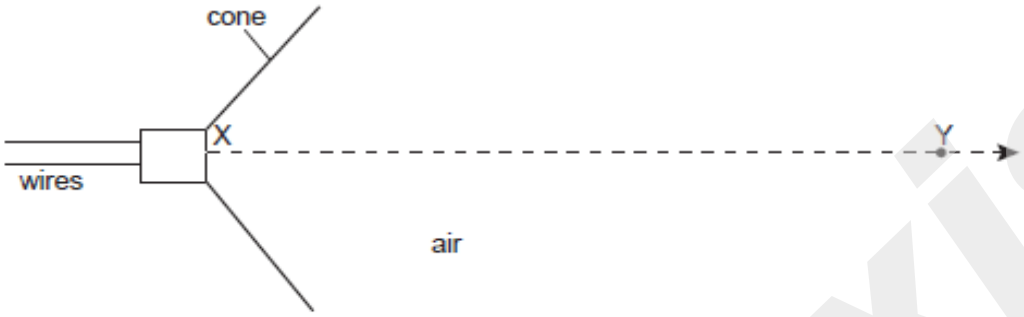

Fig. 7.1

(a) On Fig. 7.1, use the letter C to mark **three** compressions and the letter R to mark **three** rarefactions along XY. [1]

(b) Explain what is meant by

(i) a *compression*,

.....

.....

(ii) a *rarefaction*.

.....

..... [2]

(c) A sound wave is a longitudinal wave. With reference to the sound wave travelling along XY in Fig. 7.1, explain what is meant by a *longitudinal* wave.

.....

.....[2]

(d) There is a large vertical wall 50 m in front of the loudspeaker. The wall reflects the sound waves.
The speed of sound in air is 340 m/s.
Calculate the time taken for the sound waves to travel from X to the wall and to return to X.

time = ...[2]

(IGCSE Physics Year 2004 Oct/Nov Paper 3-Set 1)

6 Fig. 6.1 shows an optical fibre. XY is a ray of light passing along the fibre.

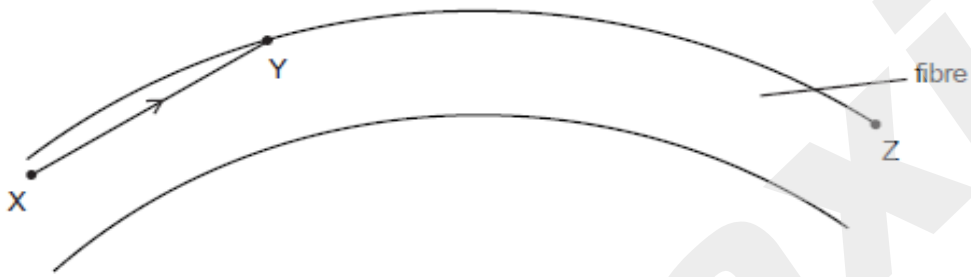

Fig. 6.1

(a) On Fig. 6.1, continue the ray XY until it passes Z. [1]

(b) Explain why the ray does **not** leave the fibre at Y.

.....

.....

.....[2]

(c) The light in the optical fibre has a wavelength of 3.2×10^{-7} m and is travelling at a speed of 1.9×10^{8} m/s.

(i) Calculate the frequency of the light.

frequency = ...

(ii) The speed of light in air is 3.0×10^{8} m/s.
Calculate the refractive index of the material from which the fibre is made.

refractive index = ...
[4]

8 Fig. 8.1 shows plane waves passing through a gap in a barrier that is approximately equal to the wavelength of the waves.

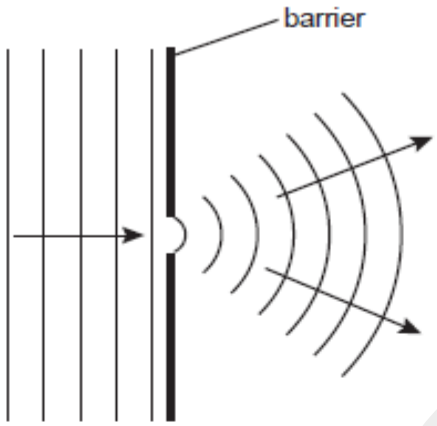

Fig. 8.1

(a) What is the name given to the wave property shown in Fig. 8.1?

.....[1]

(b) In the space below, carefully draw the pattern that would be obtained if the gap were increased to six times the wavelength of the waves. [4]

(c) The effect in Fig. 8.1 is often shown using water waves on the surface of a tank of water. These are transverse waves. Explain what is meant by a *transverse* wave.

.....

.....

.....[2]

(IGCSE Physics Year 2005 May/June Paper 3-Set 1)

6 Fig. 6.1 shows a ray of light OPQ passing through a semi-circular glass block.

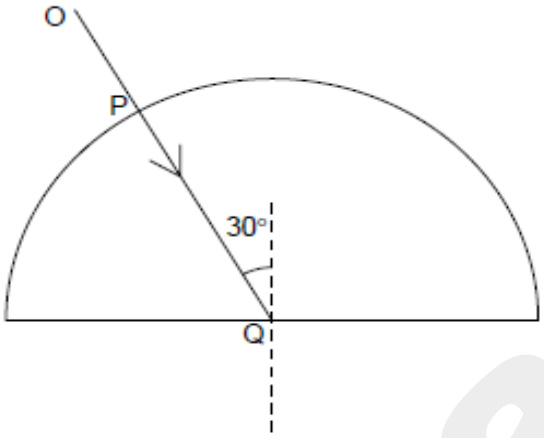

Fig. 6.1

(a) Explain why there is no change in the direction of the ray at P.

.....

..... [1]

(b) State the changes, if any, that occur to the speed, wavelength and frequency of the light as it enters the glass block.

.....

.....

..... [2]

(c) At Q some of the light in ray OPQ is reflected and some is refracted.

On Fig. 6.1, draw in the approximate positions of the reflected ray and the refracted ray. Label these rays. [2]

(d) The refractive index for light passing from glass to air is 0.67.

Calculate the angle of refraction of the ray that is refracted at Q into air.

angle = ... [3]

7 Fig. 7.1 shows the parts of the electromagnetic spectrum.

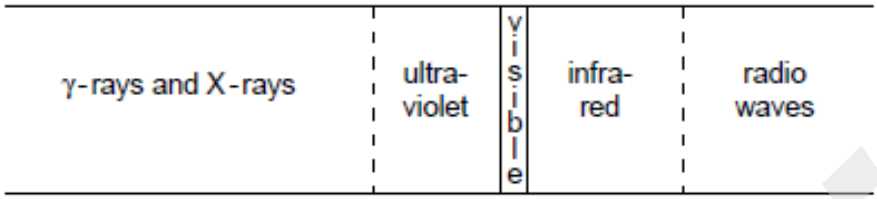

Fig. 7.1

(a) Name one type of radiation that has

(i) a higher frequency than ultra-violet,

..... [1]

(ii) a longer wavelength than visible light.

..... [1]

(b) Some γ-rays emitted from a radioactive source have a speed in air of 3.0×10^{8} m/s and a wavelength of 1.0×10^{-12} m.

Calculate the frequency of the γ-rays.

frequency = ... [2]

(c) State the approximate speed of infra-red waves in air.

..... [1]

(IGCSE Physics Year 2005 Oct/Nov Paper 3-Set 1)

6 Fig. 6.1 shows the path of a sound wave from a source X.

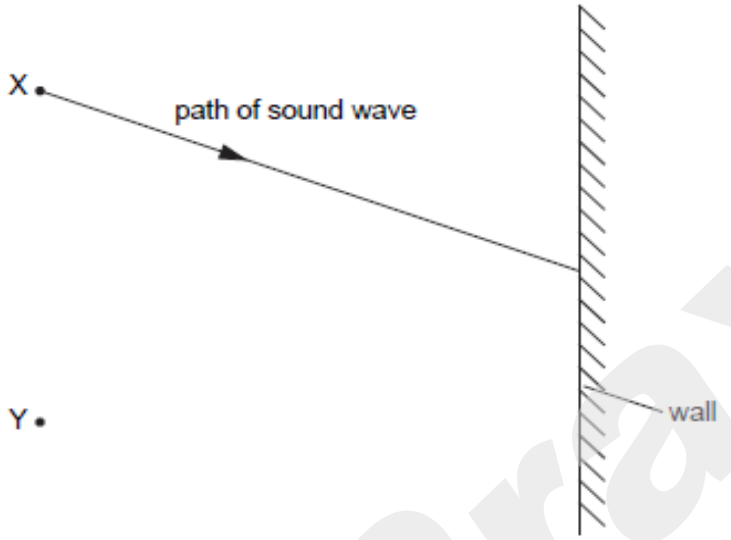

Fig. 6.1

(a) State why a person standing at point Y hears an echo.

..... [1]

(b) The frequency of the sound wave leaving X is 400 Hz. State the frequency of the sound wave reaching Y.

frequency = ... [1]

(c) The speed of the sound wave leaving X is 330 m/s. Calculate the wavelength of these sound waves.

wavelength = ... [2]

(d) Sound waves are longitudinal waves.

State what is meant by the term *longitudinal*.

.....

..... [1]

7 **(a)** Fig. 7.1 shows two rays of light from a point O on an object. These rays are incident on a plane mirror.

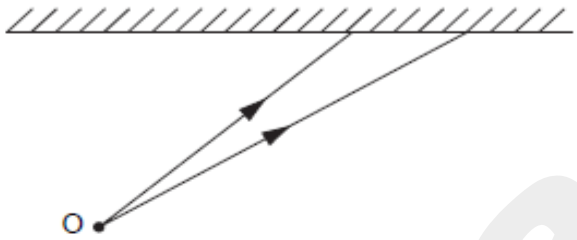

Fig. 7.1

(i) On Fig. 7.1, continue the paths of the two rays after they reach the mirror. Hence locate the image of the object O. Label the image I. [2]

(ii) Describe the nature of the image I.

.....

..... [2]

(b) Fig. 7.2 is drawn to scale. It shows an object PQ and a convex lens.

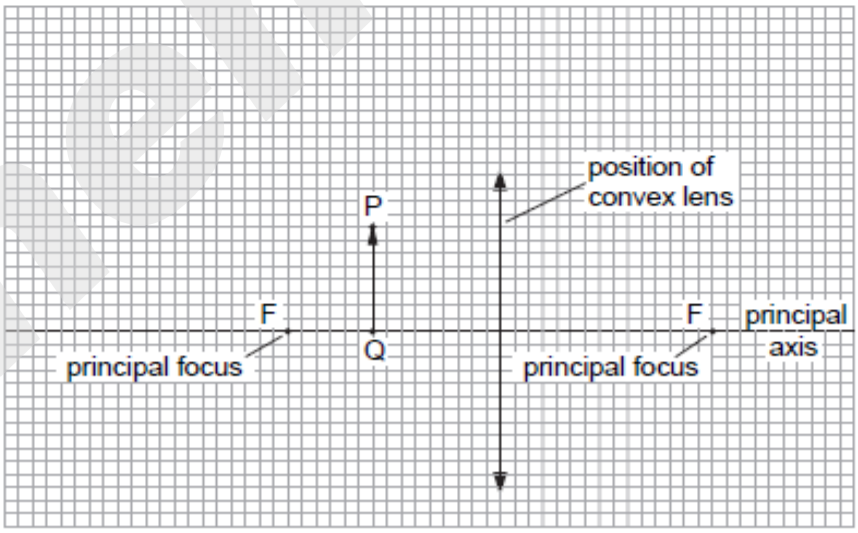

Fig. 7.2

(i) On Fig. 7.2, draw two rays from the top of the object P that pass through the lens. Use these rays to locate the top of the image. Label this point T. [3]

(ii) On Fig. 7.2, draw an eye symbol to show the position from which the image T should be viewed. [1]

(IGCSE Physics Year 2006 May/June Paper 3-Set 1)

6 Fig. 6.1 shows white light incident at P on a glass prism. Only the refracted red ray PQ is shown in the prism.

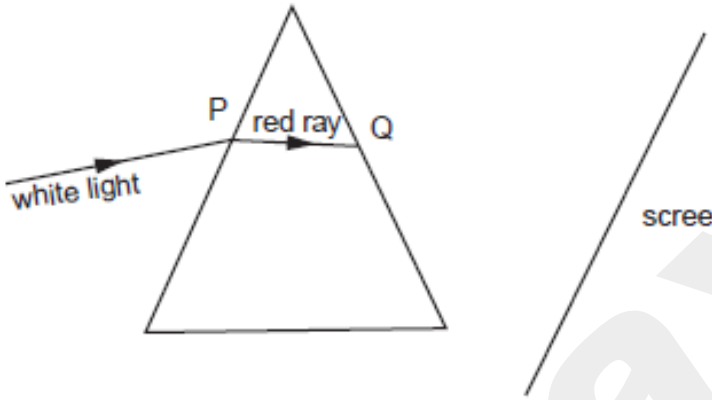

Fig. 6.1

(a) On Fig. 6.1, draw rays to complete the path of the red ray and the whole path of the violet ray up to the point where they hit the screen. Label the violet ray. [3]

(b) The angle of incidence of the white light is increased to 40°. The refractive index of the glass for the red light is 1.52.
Calculate the angle of refraction at P for the red light.

angle of refraction = ...[3]

(c) State the approximate speed of

(i) the white light incident at P, speed = ...[1]

(ii) the red light after it leaves the prism at Q. speed = ...[1]

7 Fig. 7.1 shows how the air pressure at one instant varies with distance along the path of a continuous sound wave.

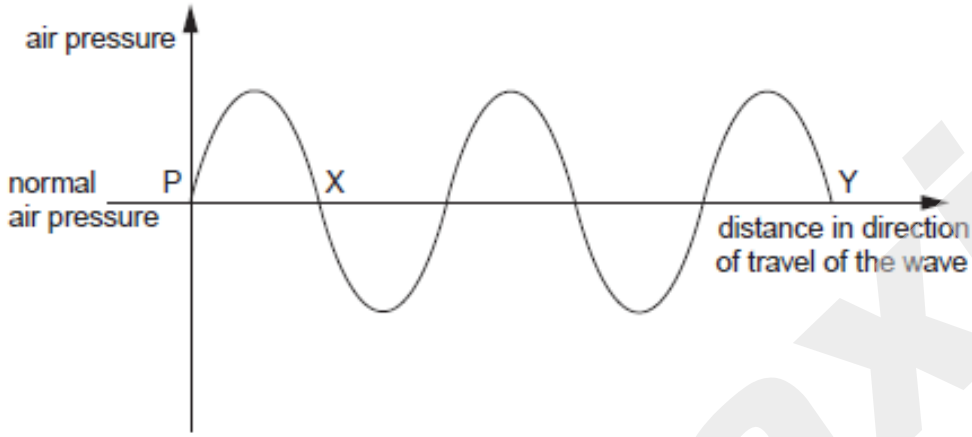

Fig. 7.1

(a) What type of waves are sound waves?

.....[1]

(b) On Fig. 7.1, mark on the axis PY

(i) one point C where there is a compression in the wave, [1]

(ii) one point R where there is a rarefaction in the wave. [1]

(c) Describe the motion of a group of air particles situated on the path of the wave shown in Fig. 7.1.

.....

.....

.....[2]

(d) The sound wave shown has speed of 340 m/s and a frequency of 200 Hz.
Calculate the distance represented by PX on Fig. 7.1.

distance = ...[2]

(IGCSE Physics Year 2006 Oct/Nov Paper 3-Set 1)

6 Fig. 6.1 shows a ray of light, from the top of an object PQ, passing through two glass prisms.

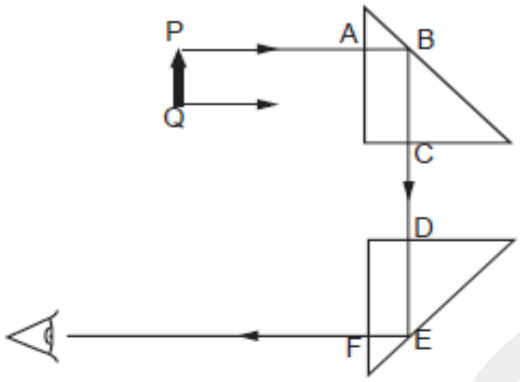

Fig. 6.1

(a) Complete the path through the two prisms of the ray shown leaving Q. [1]

(b) A person looking into the lower prism, at the position indicated by the eye symbol, sees an image of PQ.
State the properties of this image.

.....[2]

(c) Explain why there is no change in direction of the ray from P at points A, C, D and F.

.....

.....[1]

(d) The speed of light as it travels from P to A is 3×10^8 m/s and the refractive index of the prism glass is 1.5.
Calculate the speed of light in the prism.

speed = ...[2]

(e) Explain why the ray AB reflects through 90° at B and does not pass out of the prism at B.

.....

.....

.....[2]

7 Fig. 7.1 is a drawing of a student's attempt to show the diffraction pattern of water waves that have passed through a narrow gap in a barrier.

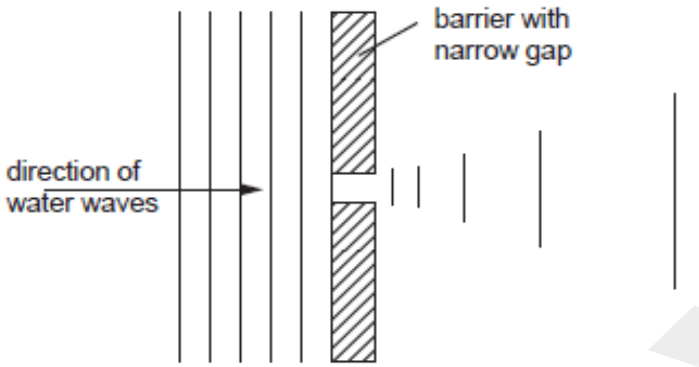

Fig. 7.1

(a) State two things that are wrong with the wave pattern shown to the right of the barrier.

1. .....

2. .....[2]

(b) In the space below, sketch the wave pattern when the gap in the barrier is made five times wider.

[2]

(c) The waves approaching the barrier have a wavelength of 1.2 cm and a frequency of 8.0 Hz.
Calculate the speed of the water waves.

speed =.....[2]

(IGCSE Physics Year 2007 May/June Paper 3-Set 1)

6 Fig. 6.1 shows a rectangular glass block ABCD.

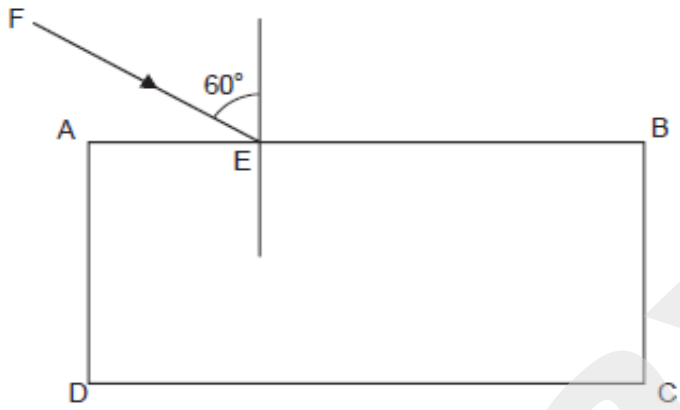

Fig. 6.1

(a) The ray FE is partly reflected and partly refracted at E.

(i) On Fig. 6.1, draw in the approximate path of the refracted ray, within and beyond the block. Label the ray *refracted ray*. [1]

(ii) On Fig. 6.1, draw in the path of the reflected ray. Label the ray *reflected ray*. [1]

(b) A second ray, almost parallel to AE, strikes the block at E and is partly refracted at an angle of refraction of 43°.

(i) State an approximate value for the angle of incidence at E.

..... [1]

(ii) State an approximate value for the critical angle for the light in the glass block.

..... [1]

(iii) Calculate an approximate value for the refractive index of the glass of the block.

refractive index = ... [2]

(c) The speed of the light along ray FE is 3.0×10^8 m/s. Calculate the speed of the refracted light in the glass block.

speed = ... [2]

7 Two students are asked to determine the speed of sound in air on the school playing fields.

(a) List the apparatus they need.

.....

.....

..... [1]

(b) List the readings that the students need to take.

.....

.....

..... [1]

(c) State how the speed of sound is calculated from the readings.

..... [1]

(d) State one precaution that could be taken to improve the accuracy of the value obtained.

.....

..... [1]

(e) The table gives some speeds.

speed/ m/s	speed of sound in air	speed of sound in water
10		
100		
1000		
10000		

Place a tick in the table to show the speed which is closest to

(i) the speed of sound in air,

(ii) the speed of sound in water.

[2]

[Total: 6]

(IGCSE Physics Year 2007 Oct/Nov Paper 3-Set 1)

6 Virtual images may be formed by both plane mirrors and by convex lenses.

Fig. 6.1 shows a plane mirror and a convex lens.

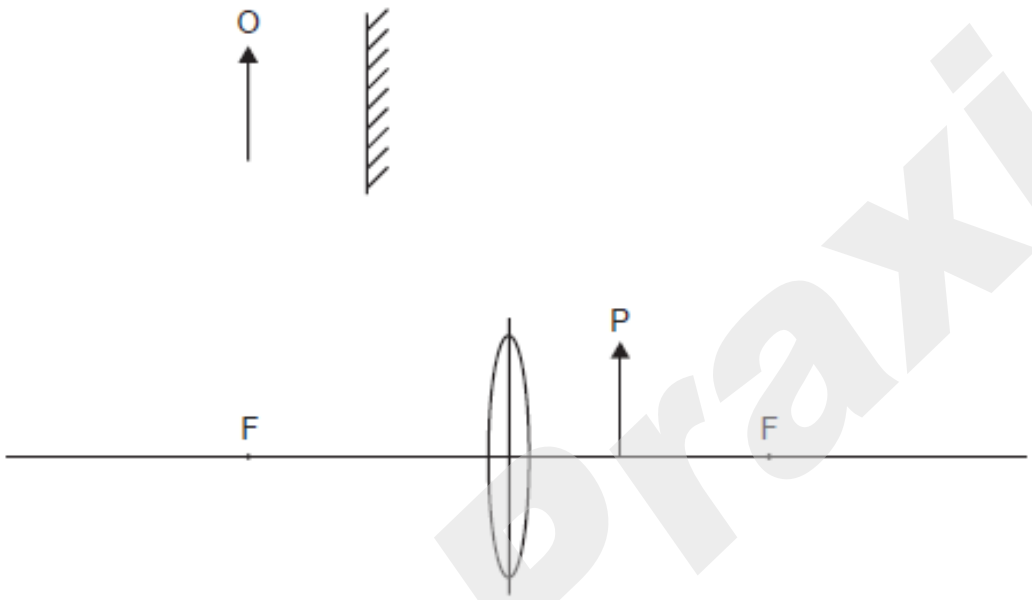

Fig. 6.1

(a) On Fig. 6.1, draw rays to locate the approximate positions of the images of the tops of the two arrow objects O and P.
Label the images. [5]

(b) Both images are virtual.

(i) What is meant by a *virtual image*?

..... [1]

(ii) State one other similarity between the two images.

..... [1]

(iii) State one difference between the two images.

..... [1]

[Total: 8]

7 **(a)** In the space below, draw a diagram to represent a sound wave.

On your diagram, mark and label

(i) two consecutive compressions and two consecutive rarefactions,

(ii) the wavelength of the wave.

[3]

(b) Fig. 7.1 shows part of the electromagnetic spectrum.

X-RAYS		INFRA– RED

Fig. 7.1

(i) On Fig. 7.1, label the positions of γ-rays, visible light waves and radio waves. [1]

(ii) State which of the three types of wave in **(i)** has the lowest frequency.

..... [1]

(iii) State the approximate value of the speed in air of radio waves.

..... [1]

[Total: 6]

(IGCSE Physics Year 2008 May/June Paper 3-Set 1)

6 Fig. 6.1 shows an object, the tip of which is labelled O, placed near a lens L.

The two principal foci of the lens are F_1 and F_2.

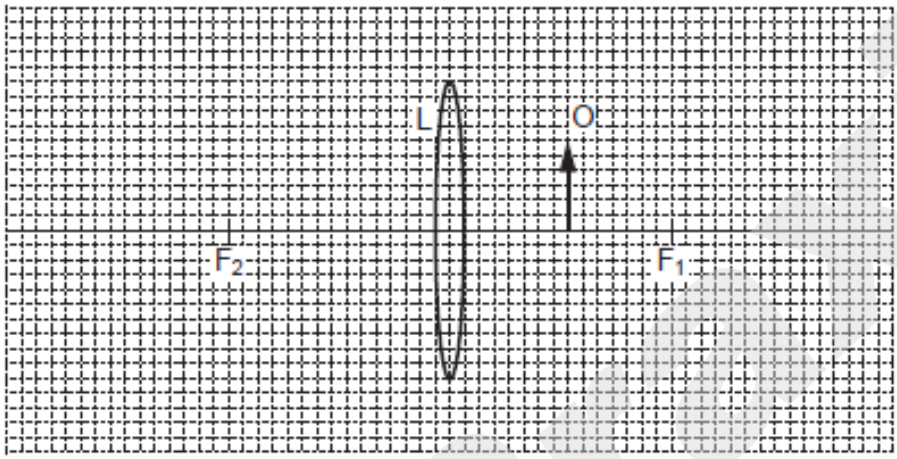

Fig. 6.1

(a) On Fig. 6.1, draw the paths of two rays from the tip of the object so that they pass through the lens and continue beyond.

Complete the diagram to locate the image of the tip of the object. Draw in the whole image and label it I. [3]

(b) Describe image I.

.....

.....

.....

..... [3]

[Total: 6]

7 Fig. 7.1 and Fig. 7.2 show wavefronts of light approaching a plane mirror and a rectangular glass block, respectively.

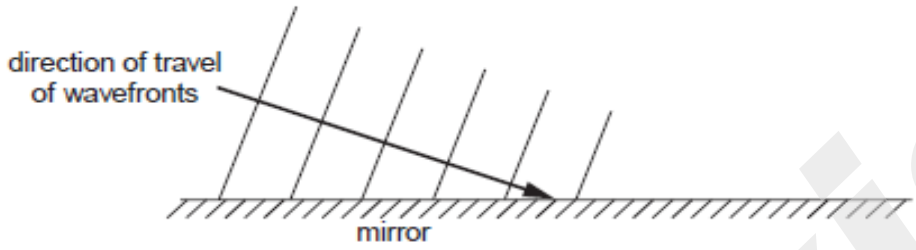

Fig. 7.1

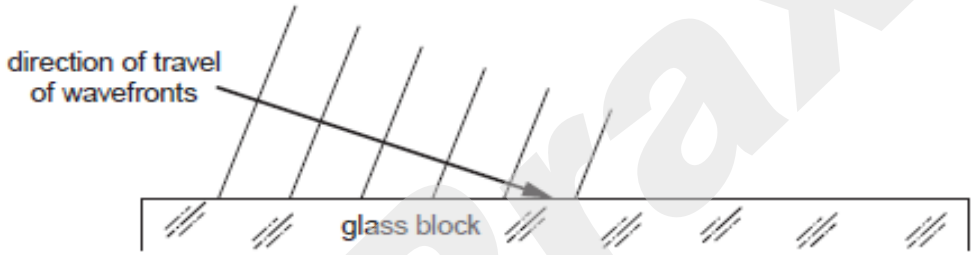

Fig. 7.2

(a) On Fig. 7.1 and on Fig. 7.2 draw wavefronts to show what happens after the waves strike the surface. [4]

(b) In Fig. 7.2, the waves approaching the block have a speed of 3.0×10^8 m/s and an angle of incidence of 70°. The refractive index of the glass of the block is 1.5.

(i) Calculate the speed of light waves in the block.

speed = ... [2]

(ii) Calculate the angle of refraction in the block.

angle = ... [2]

(IGCSE Physics Year 2008 May/June Paper 3-Set 2)

6 Fig. 6.1 shows an object, the tip of which is labelled O, placed near a lens L.

The two principal foci of the lens are F_1 and F_2.

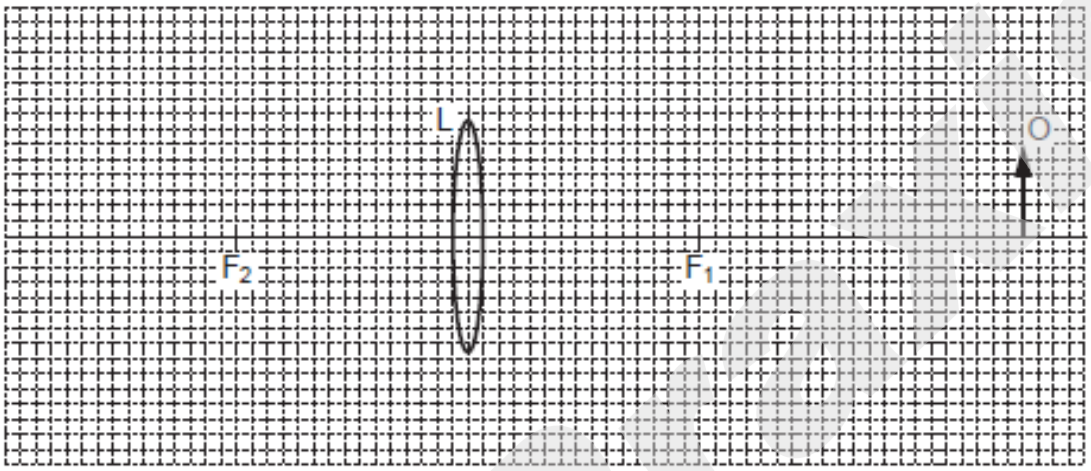

Fig. 6.1

(a) On Fig. 6.1, draw the paths of two rays from the tip of the object so that they pass through the lens and continue beyond.

Complete the diagram to locate the image of the tip of the object. Draw in the whole image and label it I. [2]

(b) State two changes to the image when the object is moved

(i) a small distance closer to the lens,

1. .....

2. ..... [2]

(ii) to a position between F_1 and the lens.

1. .....

2. ..... [2]

[Total: 6]

7 Fig. 7.1 and Fig. 7.2 show wavefronts of light approaching a plane mirror and a rectangular glass block, respectively.

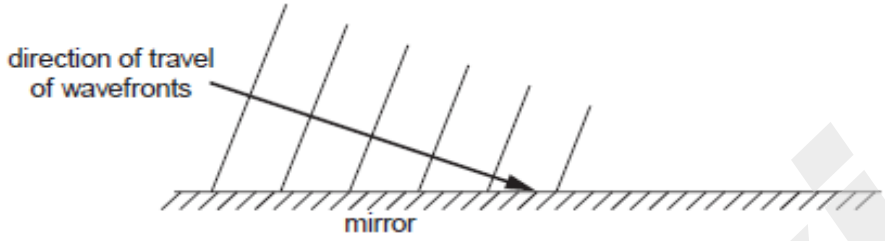

Fig. 7.1

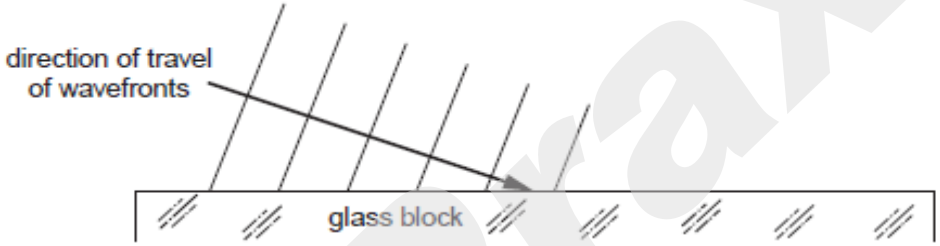

Fig. 7.2

(a) On Fig. 7.1 and on Fig. 7.2 draw wavefronts to show what happens after the waves strike the surface. [4]

(b) In Fig. 7.2, the waves approaching the block have a speed of 3.0×10^8 m/s and an angle of incidence of 70°. The refractive index of the glass of the block is 1.5.

(i) Calculate the speed of light waves in the block.

speed = ... [2]

(ii) Calculate the angle of refraction in the block.

angle = ... [2]

[Total: 8]

(IGCSE Physics Year 2008 Oct/Nov Paper 3-Set 1)

6 Fig. 6.1 shows two rays of monochromatic light, one entering the prism along the normal DE and the second one along PQ.

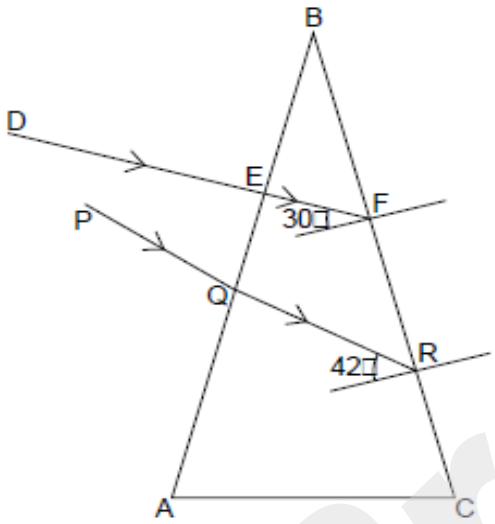

Fig. 6.1

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

..... [1]

(b) The refractive index of the glass of the prism is 1.49. The ray EF is refracted at F. Use information from Fig. 6.1 to calculate the angle of refraction at F.

angle of refraction = ... [3]

(c) On Fig. 6.1, draw in the refracted ray, starting from F. [1]

(d) State how the refraction, starting at F, would be different if the monochromatic ray were replaced by a ray of white light.

..... [1]

(e) The critical angle for the glass of the prism is just over 42°. State the approximate angle of refraction for the ray striking BC at R.

..... [1]

(f) Another monochromatic ray, not shown in Fig. 6.1, passes through the prism and strikes BC at an angle of incidence of 50°. State what happens to this ray at the point where it strikes BC.

..... [1]

7 Fig. 7.1 shows a scale drawing of plane waves approaching a gap in a barrier.

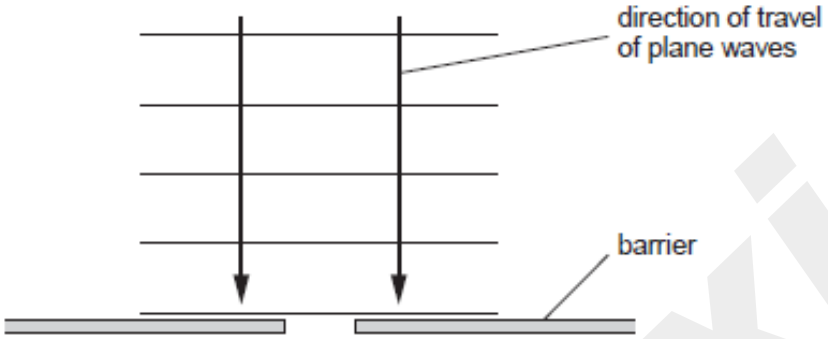

Fig. 7.1

(a) On Fig. 7.1, draw in the pattern of the waves after they have passed the gap. [3]

(b) The waves approaching the barrier have a wavelength of 2.5 cm and a speed of 20 cm/s. Calculate the frequency of the waves.

frequency = ... [2]

(c) State the frequency of the diffracted waves.

..... [1]

[Total: 6]

(IGCSE Physics Year 2008 Oct/Nov Paper 3-Set 2)

6 Fig. 6.1 shows a cross-section through a swimming pool.

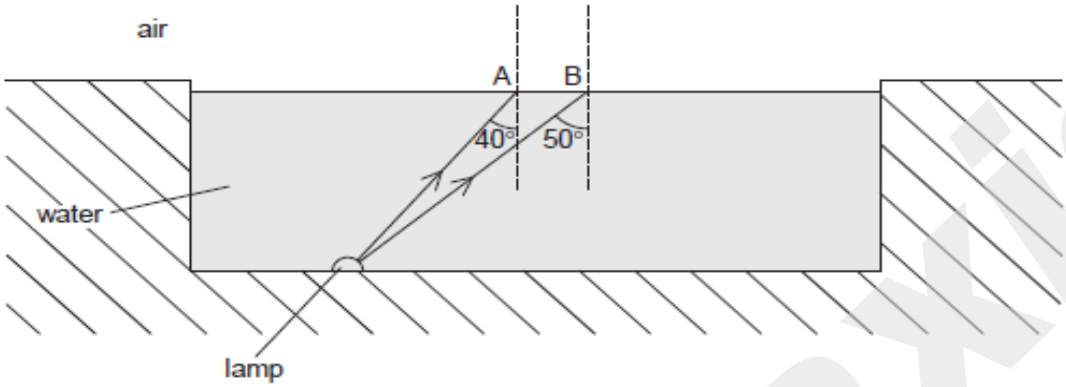

Fig. 6.1

(a) A ray of monochromatic light from a lamp at the bottom of the pool strikes the surface at A, as shown.

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

..... [1]

(ii) The water in the swimming pool has a refractive index of 1.33.

Using information from Fig. 6.1, calculate the angle of refraction at A.

angle of refraction = ... [3]

(iii) On Fig. 6.1, draw the refracted ray. [1]

(b) The critical angle for the water-air surface is 48.8°.

Another ray of monochromatic light from the lamp strikes the surface at B, as shown in Fig. 6.1.

(i) State and explain what happens to the ray after reaching B.

.....

..... [2]

(ii) On Fig. 6.1, draw this ray. [1]

[Total: 8]

7 Fig. 7.1 shows a scale drawing of plane waves approaching a gap in a barrier.

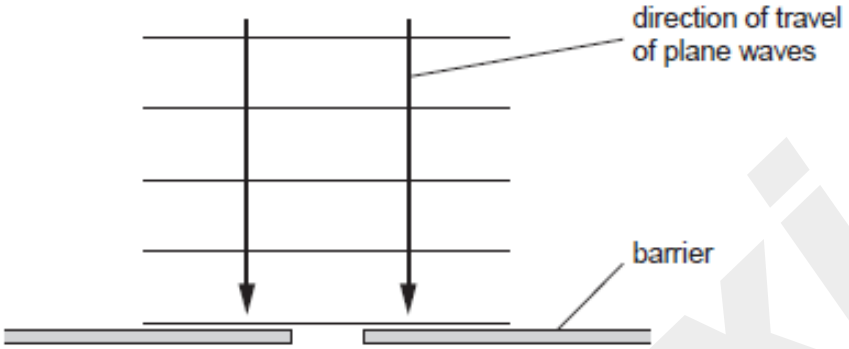

Fig. 7.1

(a) On Fig. 7.1, draw in the pattern of the waves after they have passed the gap. [3]

(b) The waves approaching the barrier have a wavelength of 2.5 cm and a speed of 20 cm/s. Calculate the frequency of the waves.

frequency = ... [2]

(c) State the frequency of the diffracted waves.

..... [1]

[Total: 6]

(IGCSE Physics Year 2009 May/June Paper 3-Set 1)

8 In an optics lesson, a Physics student traces the paths of three rays of light near the boundary between medium A and air. The student uses a protractor to measure the various angles.

Fig. 8.1 illustrates the three measurements.

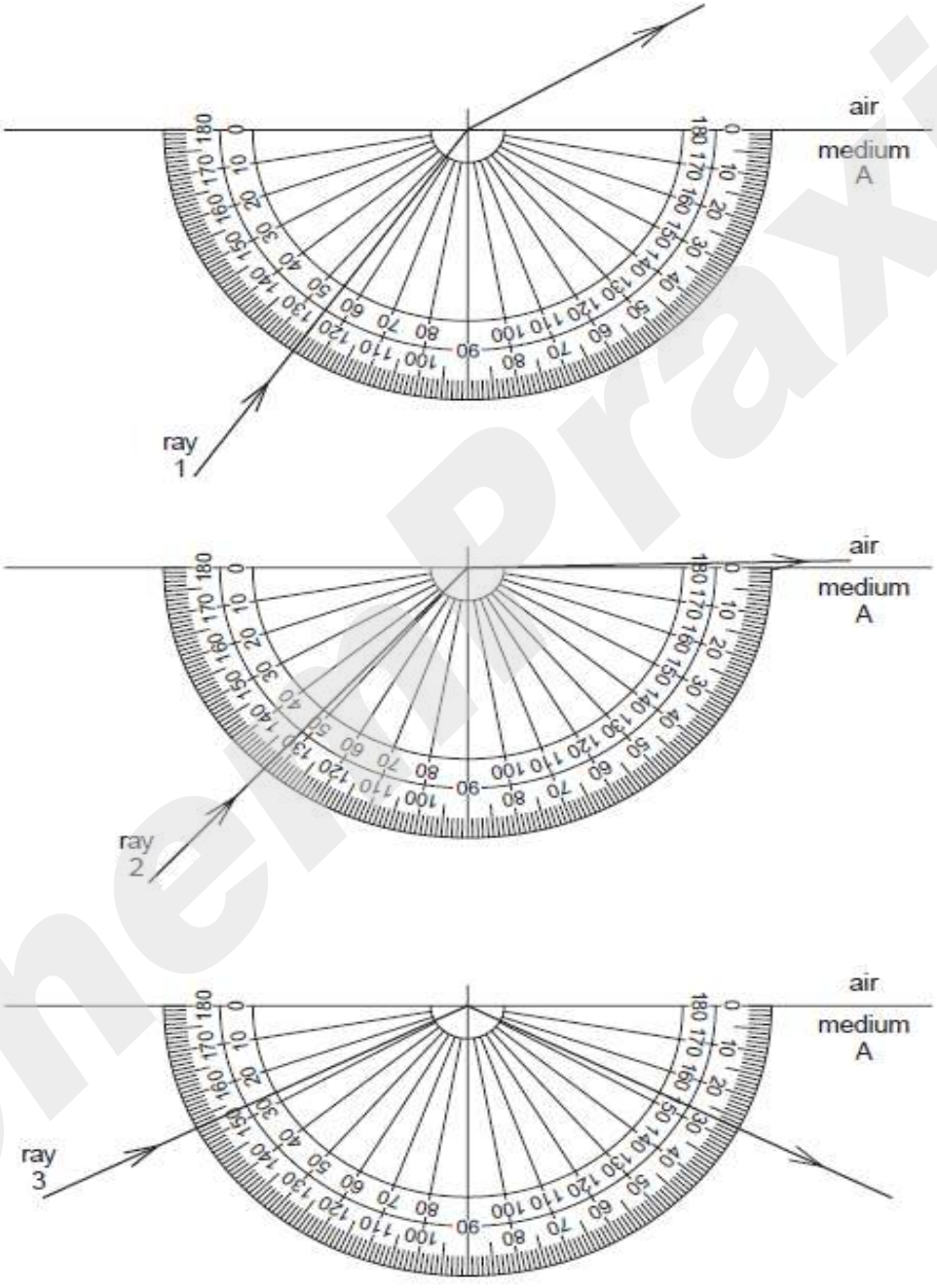

Fig. 8.1

(a) State which is the optically denser medium, A or air, and how you can tell this.

.....

..... [1]

(b) State in which medium the light travels the faster, and how you know this.

.....

..... [1]

(c) State the critical angle of medium A.

.....[1]

(d) State the full name for what is happening to ray 3.

.....[1]

(e) The refractive index of medium A is 1.49.

Calculate the value of the angle of refraction of ray 1, showing all your working.

angle of refraction = ... [2]

(f) The speed of light in air is $3.0 \square 10^8$ m/s.

Calculate the speed of light in medium A, showing all your working.

speed of light = ... [2]

[Total: 8]

(IGCSE Physics Year 2009 May/June Paper 3-Set 2)

8 In an optics lesson, a Physics student traces the paths of three rays of light near the boundary between medium A and air. The student uses a protractor to measure the various angles.

Fig. 8.1 illustrates the three measurements.

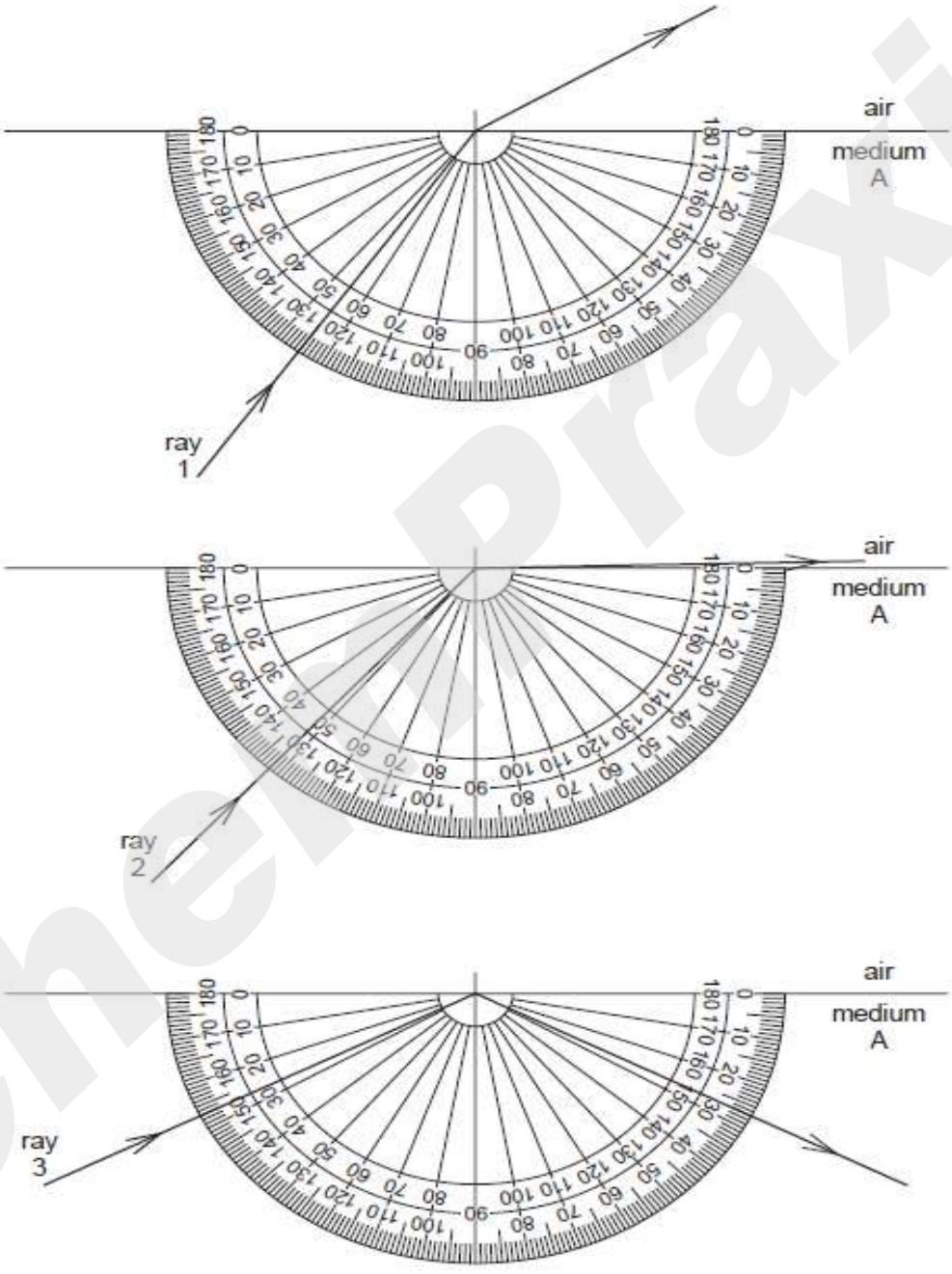

Fig. 8.1

(a) State which is the optically denser medium, A or air, and how you can tell this.

.....

..... [1]

(b) State in which medium the light travels the faster, and how you know this.

.....

..... [1]

(c) State the critical angle of medium A.

..... [1]

(d) State the full name for what is happening to ray 3.

..... [1]

(e) The refractive index of medium A is 1.49.

Calculate the value of the angle of refraction of ray 1, showing all your working.

angle of refraction = ... [2]

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

Calculate the speed of light in medium A, showing all your working.

speed of light = ... [2]

[Total: 8]

(IGCSE Physics Year 2009 Oct/Nov Paper 3-Set 1)

8 Fig. 8.1 shows a thin converging lens. The two principal foci are shown.

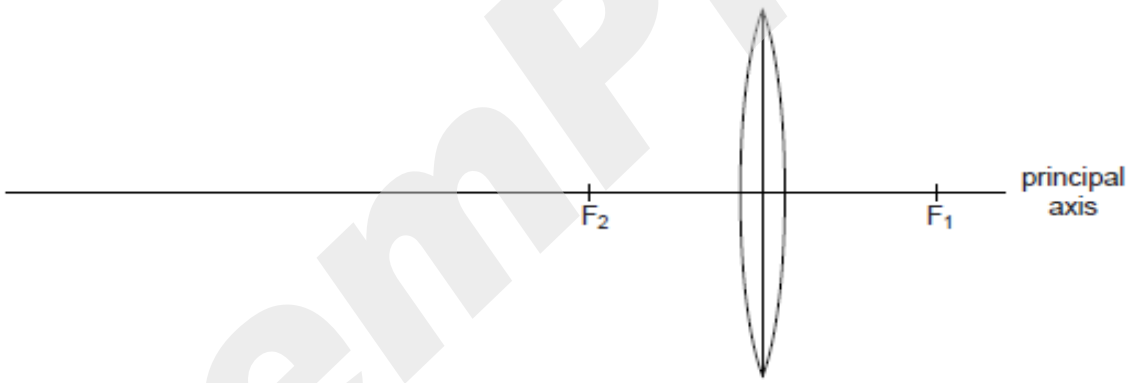

Fig. 8.1

A vertical object, 2 cm tall, is to be positioned to the left of the lens, with one end on the principal axis.

On Fig. 8.1,

(a) draw the object in a position which will produce a virtual image, labelling the object with the letter O, [1]

(b) draw two rays showing how the virtual image is formed, [2]

(c) draw in the image, labelling it with the letter I. [1]

[Total: 4]