Topical Practice
IGCSE
PHYSICS
Paper 4

Chapters 9 - 10

EDITION • Volum • STUDENT

## **CONTENTS**

Chapter	Topic	Pages
9	<ul><li>SOUND AND WAVES</li><li>General Wave Properties</li><li>Sound</li></ul>	3 - 23
10	<ul> <li>LIGHT AND WAVES</li> <li>Reflection and Refraction of Light</li> <li>Thin Converging Lens</li> <li>Dispersion</li> <li>Electromagnetic Spectrum</li> </ul>	24 - 48
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## **Chapter 10: Sound and Waves**

1 Fig. 5.1 shows a view from above of waves on the surface of water in a water tank.

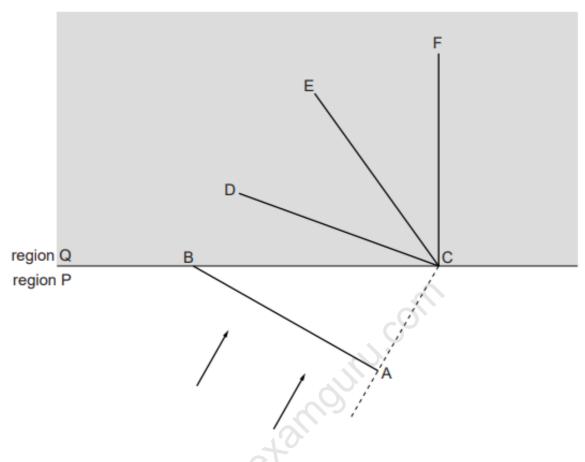


Fig. 5.1

The wavefront AB is travelling in region P towards region Q, where the water is shallower and the waves travel more slowly.

- (a) Some time later, the wavefront has moved into region Q.
  - CD, CE and CF are suggested positions of the new wavefront.

(i) State which is the correct position of the new wavefront.

- (ii) Evolain your anguer to (i)
- (ii) Explain your answer to (i).

3

(b) Fig. 5.2 shows the waves after a change is made to the way the tank is set up, and the experiment is repeated.

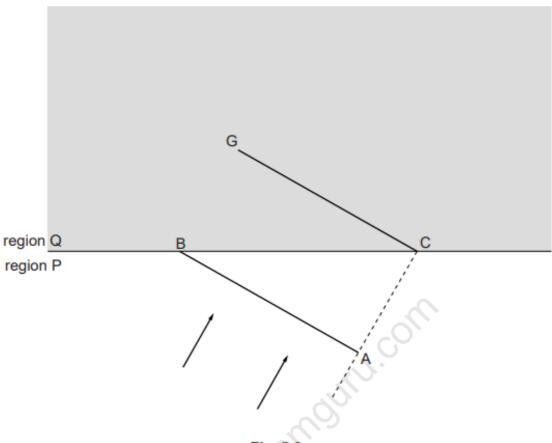


Fig. 5.2

The wave from position AB in region P now moves to position CG in region Q.
State the change that has been made and explain your reasoning.
change
explanation
[2]

[Total: 6]

2	(a)	A wave passes along the surface of the water in a ripple tank. Describe the motion of a molecule on the surface as the wave passes.
		[1]
	(b)	Fig. 7.1 shows a view from above of water waves approaching a narrow gap in a barrier.

The water on both sides of the barrier has the same depth.

direction of water waves

Fig. 7.1

- (i) On Fig. 7.1, sketch the pattern of waves in the region to the right of the barrier. [2]
   (ii) State the process by which waves arrive at point P to the right of the barrier.
- (c) The waves approaching the barrier in Fig. 7.1 have a wavelength of 1.4 cm and travel at a speed of 12 cm/s.

Calculate the frequency of the waves.

frequency =		[2]	
-------------	--	-----	--

[Total: 6]

3 (a) Fig. 5.1 shows an aerial view of wavefronts passing from the open sea into an outer harbour.

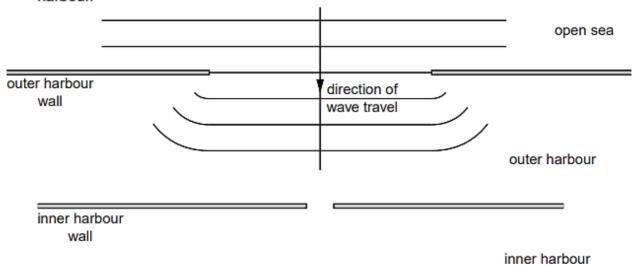


Fig. 5.1

- (i) The wavefronts in the outer harbour are curving at their ends.

  Name the process that is occurring at the entrance to the harbour.

  [1]
- (ii) On Fig. 5.1, carefully complete the wave pattern as the wavefronts progress through the outer harbour and into the inner harbour. Show the rest of the wave pattern in the outer harbour and three wavefronts in the inner harbour. [3]
- (b) Fig. 5.2 shows an aerial view of wavefronts in deep water approaching a region of shallow water where they travel more slowly.

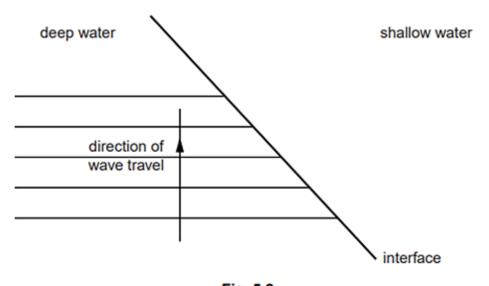


Fig. 5.2

		(i)	Name the process that occurs as the wavefronts pass from deep to shallow water.
			[1]
		(ii)	Complete Fig. 5.2 to show possible positions of the five wavefronts in the shallow water. [2]
			[Total: 7]
4 (a	a)	Stat	te the range of frequencies of sound which can be heard by a healthy human ear.
			[1]
(t	<b>o</b> )	Con	npressions and rarefactions occur along the path of sound waves.
		Stat	te, in terms of the behaviour of molecules, what is meant by
		(i)	a compression,
		(ii)	a rarefaction.
			[2]
(0	;)	Sta	te the effect on what is heard by a listener when there is
		(i)	an increase in the amplitude of a sound,
			[1]
		(ii)	a decrease in the wavelength of a sound.
			[1]

(d)	A student carries out an experiment to find the speed of sound in air.
	He stands facing a high cliff and shouts. He hears the echo 1.9s later

He then walks 250 m further away from the cliff and shouts again, hearing the echo 3.5 s

Calculate the speed of sound given by this experiment.

5 (a) Draw a straight line from each wave to the most appropriate speed on the right.

light in air

sound in air

sound in water

wave speed

> 15m/s  $(1.5 \times 10 \,\mathrm{m/s})$

> > 300 m/s  $(3 \times 10^2 \text{m/s})$

1500 m/s  $(1.5 \times 10^3 \text{m/s})$ 

1500000m/s  $(1.5 \times 10^{6} \text{m/s})$ 

3000000m/s  $(3 \times 10^8 \text{m/s})$ 

150000000m/s  $(1.5 \times 10^9 \text{m/s})$ 

[3]

(b) Fig. 6.1 shows a railway-line testing-team checking a continuous rail of length 120m. The diagram is not to scale.

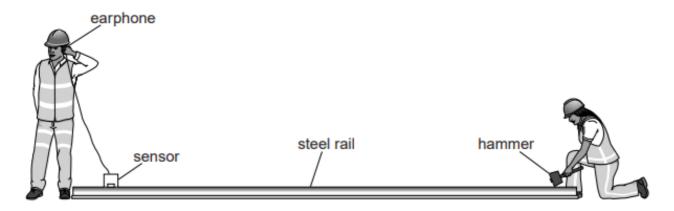


Fig. 6.1 (not to scale)

One tester strikes one end of the rail with a hammer. The other tester hears the sound transmitted through the air and transmitted through the rail. He hears the two sounds at different times.

The speed of sound in steel is 5000 m/s.

Calculate the time difference, using your value from (a) for the speed of sound in air.

time	difference =		[4	·]
------	--------------	--	----	----

[Total: 7]

6 (a) Fig. 7.1 shows the surface of water in a tank.

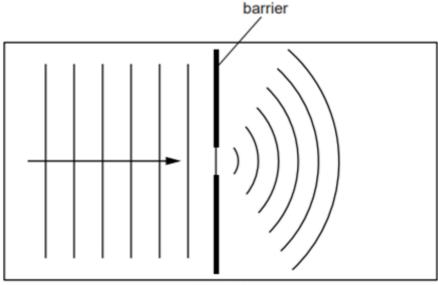


Fig. 7.1

Straight wavefronts are produced at the left-hand end of the tank and travel towards a gap in a barrier. Curved wavefronts travel away from the gap.

(i) Name the process that causes the wavefronts to spread out at the gap.

.....[1]

(ii) Suggest a cause of the reduced spacing of the wavefronts to the right of the barrier.

.....[1]

(iii) State how the pattern of wavefronts to the right of the barrier changes when the gap is made narrower.

.....[1]

(b) Fig. 7.2 shows a wave travelling, in the direction of the arrow, along a rope.

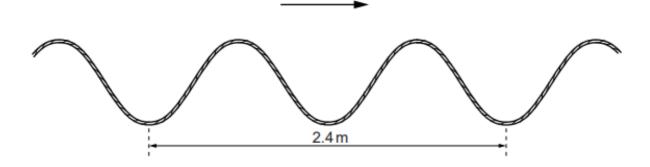


Fig. 7.2

(i) Explain why the wave shown in Fig. 7.2 is described as a transverse wave.

		Ca	alculate the frequency of the wave.
			frequency =[3]
			[Total: 7]
7 (a)	Sta		ow a longitudinal wave differs from a transverse wave.
	••••		
			[2]
(b)	As	ounc	I wave of frequency 7.5 kHz travels through a steel beam at a speed of 6100 m/s.
	(i)	Cal	culate the wavelength of this sound wave in the steel beam.
			Let
			65
			wavelength =[2]
	(ii)	The	e sound wave passes from the end of the beam into air.
		Sta	te
		1.	the effect on the speed of the sound,
			[1]
		2.	the effect on the wavelength of the sound.
			[1]
			[Total: 6]

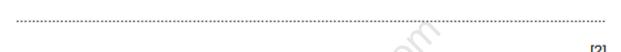
(ii) The speed of the wave along the rope is 3.2 m/s.

8 (a) Draw a straight line from each quantity on the left-hand side to a speed on the right-hand side which is typical for that quantity.

| 30 m/s | 300 m/s | 3000 m/s | 30000 m/s | 300000 m/s |

[2]

(b) Explain why sound waves are described as longitudinal.



(c) Fig. 8.1 shows how the displacement of air molecules, at an instant of time, varies with distance along the path of a sound wave.

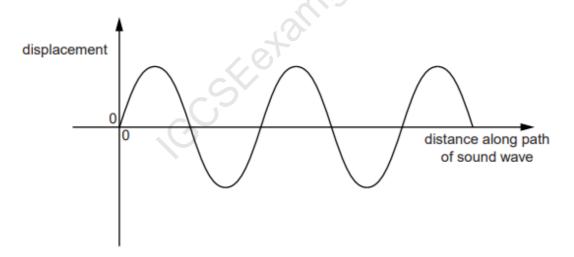


Fig. 8.1

- (i) On Fig. 8.1, sketch two cycles of a sound wave that has a shorter wavelength **and** a greater amplitude. [2]
- (ii) State two changes in the sound heard from this wave compared with the original wave.

1.	
2.	

[Total: 8]

[2]

9	(a)	Underline the most appropriate value below for the speed of sound in water.						
		1.5 m/s	15m/s	150 m/s	1500m/s	15000 m/s		
	(b)	Sound travels in	water as a ser	ies of compres	sions and rarefac	tions.		
		Describe what is meant by a compression and by a rarefaction.						
		compression						
		rarefaction						

(c) An echo-sounder sends out a pulse of sound to determine the depth of the sea bed. It measures the time between sending out the pulse and receiving its echo.

Fig. 7.1 shows a boat using an echo-sounder.

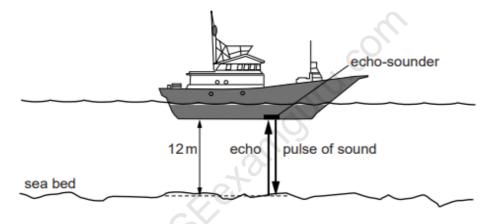


Fig. 7.1

The sea bed is 12 m below the echo-sounder.

(i) Use your value for the speed of sound in water from (a) to calculate the time between the sending out of the pulse and receiving its echo.

time =		[3	J	
--------	--	----	---	--

(ii) The boat passes over a region of the sea bed of the same depth, where the reflection of sound waves is weaker.

State whether there is an increase, a decrease or no change in the amplitude and pitch of the reflected wave.

amplitude	•••••
pitch	

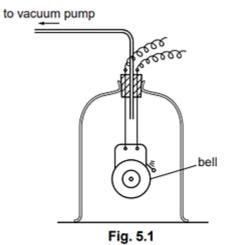
[2]

[2]

10 (a) A police car siren emits sound waves that vary in pitch. Tick **two** boxes that apply to the sound waves emitted by the siren. electromagnetic longitudinal transverse visible frequency 0.1-10 Hz frequency 100-10000 Hz frequency 100 000-1 000 000 Hz [2] (b) Fig. 7.1 is a top view of one wavefront of a water wave before it strikes a hard boundary. boundary direction of travel wavefront of wavefront Fig. 7.1 (i) Name the process that occurs as the wavefront strikes the boundary. (ii) Explain, in terms of wave theory, what occurs as the wavefront strikes the boundary.

	(iii)	State whether there is an increase, a decrease or no change in the wavelength of the wave after it strikes the boundary.
		[1]
	(iv)	The speed of the wave is 3.0 m/s and its wavelength 7.0 cm.
		Calculate the frequency of the wave.
		frequency =[2]
		[Total: 8]
11 (a)	S-w	types of seismic waves are produced by earthquakes. They are called P-waves and aves. P-waves are longitudinal and S-waves are transverse.
	(i)	Explain what is meant by the terms longitudinal and transverse.
		longitudinal
		transverse
		Total Control
		[2]
	(ii)	State another example of
		1. a longitudinal wave,
		2. a transverse wave. [2]
	(iii)	A seismic wave has a speed of 7.2km/s and a frequency of 30 Hz.
	()	
		Calculate its wavelength.
		wavelength =[2]

(b) Fig. 5.1 shows an electric bell ringing in a sealed glass chamber containing air.



A student hears the bell ringing. The air is then removed from the chamber.

	Sta	te ar	and explain any change in the sound heard by the student.	
	0.0			
	••••			
				[2]
				[Total: 8]
l2 (a)	A s	ound	nd wave in air consists of alternate compressions and rarefactions along its	s path.
	(i)	Exp	xplain how a compression differs from a rarefaction.	
	(ii)		xplain, in terms of compressions, what is meant by	
		1.	the wavelength of the sound,	
				[1]
		2.	the frequency of the sound.	
				[1]

(b)		night, bats emit pulses of sound to detect obstacles and prey. The speed of sound in air is 0 m/s.
	(i)	A bat emits a pulse of sound of wavelength 0.0085 m.
		Calculate the frequency of the sound.
	(ii)	frequency =[2] State why this sound cannot be heard by human beings.
		[1]
	(iii)	The pulse of sound hits a stationary object and is reflected back to the bat. The pulse is received by the bat 0.12s after it was emitted.
		Calculate the distance travelled by the pulse of sound during this time.
		Talugaling.
		distance =[2]
		[Total: 8]
13 (a)	Fi	g. 5.1 shows a metal strip, held in a clamp.
		metal strip  Y  clamp
		Fig. 5.1
		e end of the strip is pulled down and released, so that the strip vibrates. X and Z are the treme positions of the end of the strip during this vibration. Y is the mid-position.
	Ex	plain what is meant by
	(i)	the frequency of vibration of the strip,

(ii)	the amplitude of vibration of the	end of the strip.	
			[2]
Fig.	5.2 shows two tall buildings, A a	nd B, that are 99 m apart.	

99 m

Fig. 5.2 (not to scale)

A student stands at P so that his distance from building A is 33 m. After clapping his hands once, he hears several echoes. The speed of sound in air is 330 m/s.

Calculate the time interval between clapping his hands and hearing

(i) the first echo,

(b)

(ii) the third echo.

(c) Write down an approximate value for the speed of sound

(i) in water, speed = .....

 (d) Fig. 5.3 shows a dolphin in water emitting a sound wave of frequency 95 kHz.



Fig. 5.3 (not to scale)

Using your value from (c)(i), calculate the wavelength of this sound wave.

14 A water wave in a tank travels from a region where the speed of the wave is faster into a region where it is slower.

Fig. 6.1 is a one-quarter scale diagram that shows the wavefronts in the region where the speed is faster.

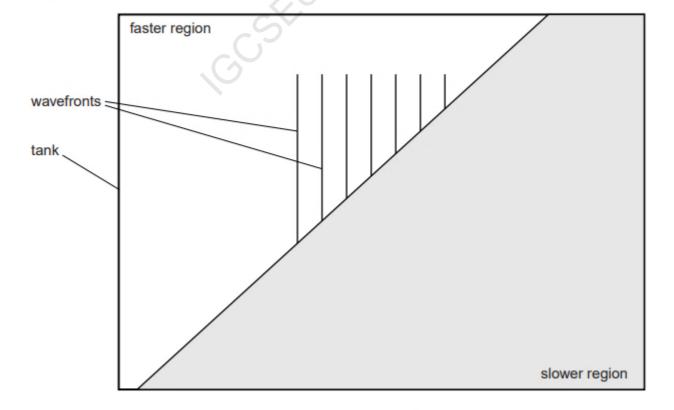


Fig. 6.1 (scale: 1.0 cm represents 4.0 cm)

	(a)	(i)	Take measurements from the scale diagram in Fig. 6.1 to determine the wavelength of the water wave as it travels in the faster region.
			wavelength =[2]
		(ii)	The speed of the wave in the faster region is 0.39 m/s.
			Calculate the frequency of the wave.
			frequency =[2]
	(b)		Fig. 6.1, draw lines that indicate the positions of the wavefronts of the water wave in the ver region.
	(c)		te what happens to the frequency of the water wave as it passes into the slower region.
		••••	[1]
15	A d	olphi	[Total: 7] n produces a sound wave in water of frequency 7800 Hz.
10	Fig.	. 6.1 oden	represents rarefactions of the sound wave travelling in the water and hitting the side of a ship at an angle.  Water Wood  A B Wood  Greetion of wave travel  Fig. 6.1  The what is meant by a rarefaction.
			[1]

(b)		Fig. 6.1, two rarefactions A and B are labelled. The distance between rarefaction A and faction B is $0.76\text{m}$ .
	Det	ermine
	(i)	the wavelength in water of the sound wave,
		wavelength =[1]
	(ii)	the time taken for the rarefaction at A to reach the point where rarefaction B is now positioned.
		time =[2]
(c)	The	sound wave passes from the water into the wood where the speed of sound is greater.
	Stat	te what happens to
	(i)	the frequency,

(d) On Fig. 6.1, sketch the positions in the wood of the three incomplete rarefactions. [2]

16 Sound from a loudspeaker is travelling in air towards a solid wall.

(ii) the wavelength.

Fig. 7.1 shows compressions of the incident sound wave and the direction of travel of the wave.

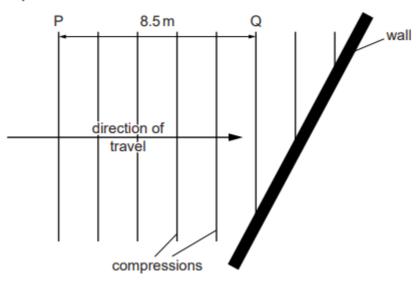


Fig. 7.1

[Total: 8]

(a)	State what is meant by a compression.			
	[1]			
(b)	The distance from point P to point Q is 8.5m. It takes 25ms for the compression at P to reach Q.			
	For this sound wave, determine			
	(i) the wavelength,			
	wavelength =[1]			
	(ii) the frequency.			
	frequency =[2]			
	frequency =[2]			
(c)	As it strikes the wall, the sound reflects.			
	Complete Fig. 7.1 to show the positions of three compressions of the reflected sound wave. [2]			
(d)	The loudspeaker is immersed in water, where it continues to produce sound of the same frequency.			
	State and explain how the wavelength of the sound wave in water compares with the wavelength determined in (b)(i).			
	[2]			
	[Total: 8]			

17 A sound wave, travelling in air, approaches a solid barrier with a gap in the middle. Fig. 6.1 represents the compressions and rarefactions of the sound wave. The compressions are labelled A, B and C.

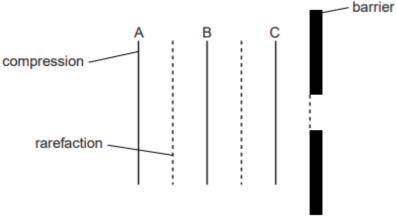


	Fig. 6.1
(a)	State how a compression differs from a rarefaction.
(b)	The speed of sound in air is 340 m/s. The frequency of the sound is 850 Hz.
	For this wave, determine
	(i) the wavelength,
	wavelength =[2]
	(ii) the time that elapses before compression A reaches the barrier.
	time =[2]

(c) On Fig. 6.1, draw the shape and positions of compressions B and C as compression A

reaches the barrier. [2]

(d) Sound waves can also travel in water.

State how the speed of sound in water compares with the speed of sound in air.

.....[1]

[Total: 8]

## **Chapter 9: Light and Waves**

- 1 Figs. 4.1 and 4.2 show a semi-circular glass block as rays of blue light are directed into the block at different angles. The rays are directed towards the centre C of the semi-circle so that no refraction occurs as the rays enter the block.
  - (a) At the angle shown in Fig. 4.1, no refracted ray emerges from the block at C.

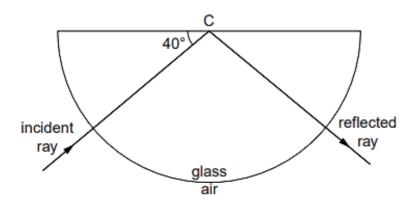


Fig. 4.1

(i) Determine the angle of reflection at C.

angle of reflection = .....

(ii) State the type of reflection occurring at C.

[2]

(b)

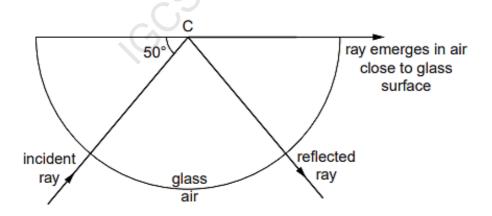


Fig. 4.2

Calculate the refractive index of the glass.

refractive index = ......[3]

(c) The experiment in (b) is now repeated with red light.

On Fig. 4.3, draw and label the paths of the reflected and refracted rays of red light. The dashed lines show the paths taken by the blue light in (b).

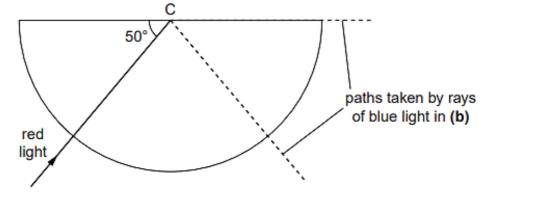


Fig. 4.3 [2]

(d) Fig. 4.4 shows a 45° – 45° – 90° prism used in an optical instrument. Part of the path of a ray of light passing through the instrument is also shown. Light leaves the instrument along path B.

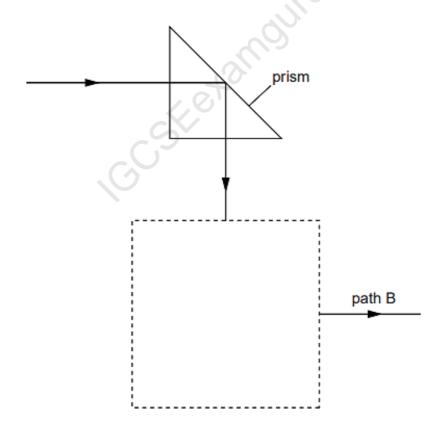


Fig. 4.4

In the dashed box, draw another  $45^{\circ} - 45^{\circ} - 90^{\circ}$  prism and complete the path of the light through this box. [2]

[Total: 9]

A laser produces a ray of blue light of wavelength $4.0 \times 10^{-7}$ m (0.00000040 m).
(a) (i) State the speed of light in a vacuum.
speed =[1]
(ii) Calculate the frequency of the light produced by the laser.
frequency =
(b) The ray of blue light passes from air into a glass block. Fig. 6.1 shows the ray making an angle of 35° with the side of the block.
ray
air 35°
glass
Let
Fig. 6.1  (i) State the angle of incidence of the ray of blue light on the glass.
(i) State the dright of molderies of the ray of blac light of the glass.
angle of incidence =[1]
(ii) Glass has a refractive index of 1.5.
Calculate the angle of refraction of the light in the glass.
angle of refraction =[2]
[Total: 6]

2

3 A converging lens has a focal length of 7.0 cm. An object of height 2.0 cm is placed 3.0 cm from the centre of the lens. Fig. 7.1 is a full-scale grid that shows the arrangement of the object, the lens and the two principal foci (focal points).

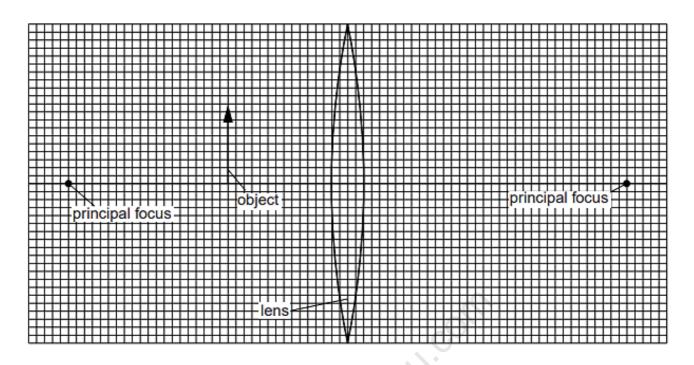


Fig. 7.1

(a)	(1)	By drawing on Fig. 7.1, show now the lens forms an image of the object.	[၁]
	(ii)	State two features of the image.	
		1	
		2	 [2]
(b)	(i)	Determine the height of the image.	[-]
		height =	[1]
	(ii)	State the name of one device where a lens is used in the way shown in Fig. 7.1.	
			[1]
		lTotal	: 71

- 4 A small object is placed 3.0 cm from the centre of a convex lens of focal length 6.0 cm. An enlarged image is observed from the other side of the lens.
  - (a) On Fig. 7.1, draw a ray diagram to show the formation of this image.

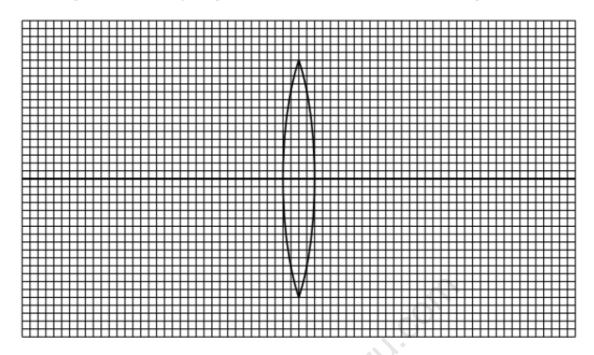


Fig. 7.1

(b) (i)	) State why this type of image is called <i>virtual</i> .	[3]
(ii)	) State the common name given to a convex lens used in this manner.	
()		[1]
		[Total: 5]

5	(a)		ay of light in air travels across a flat boundary into glass. The angle of incidence is . The angle of refraction is 29°.
		(i)	In the space below, draw a labelled diagram to illustrate this information. [3]
		(ii)	Calculate the refractive index of the glass.
			refractive index =
	(b)		refractive index =
		Sta	te and explain what happens to this ray.
			[2]
			[Total: 7]

6	The	frec	quency of the monochromatic light produced by a laser is 4.7 × 10 <sup>14</sup> Hz.
	A ray of light from the laser passes from a vacuum, where the speed of light is $3.0 \times 10^8  \text{m}_{\odot}$ into a fibre-optic cable.		
	(a)	Sta	te
		(i)	what is meant by monochromatic,
			[1]
		(ii)	the frequency of light from the laser in the fibre-optic cable.
			[1]
	(b)	The	speed of light in the fibre-optic cable is $2.0 \times 10^8  \text{m/s}$ .
		Cal	culate
		(i)	the refractive index of the material from which fibre-optic cable is made,
		(ii)	refractive index =[2] the wavelength of light from the laser in the fibre-optic cable.
			wavelength =[2]

7 (a) Fig. 6.1 shows two rays from a point object P incident on a water surface.

An observer sees the image of P produced by reflection at the surface of the water.

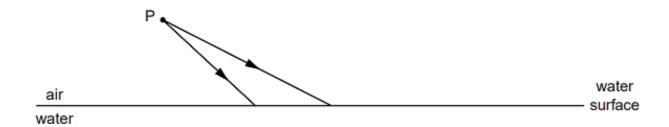


Fig. 6.1

On Fig. 6.1, draw the reflected rays and complete the diagram to locate the position of the image. Label the position of the image I. [2]

(b) Fig. 6.2 shows two rays from a point object Q incident on another water surface.

An observer sees the image of Q produced by refraction at the surface of the water.

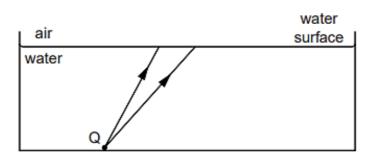


Fig. 6.2

On Fig. 6.2, draw possible refracted rays and complete the diagram to locate a possible position of the image. Label the position of the image J. You do not need to calculate any angles. [2]

31

(c)	The refractive index of water is 1.33.
	Calculate the critical angle.
	critical angle =[2]
(d)	Describe, with a diagram, a medical use of optical fibres.
	[3]
	[Total: 9]

8 Fig. 7.1 shows the principal axis PQ of a converging lens and the centre line XY of the lens.

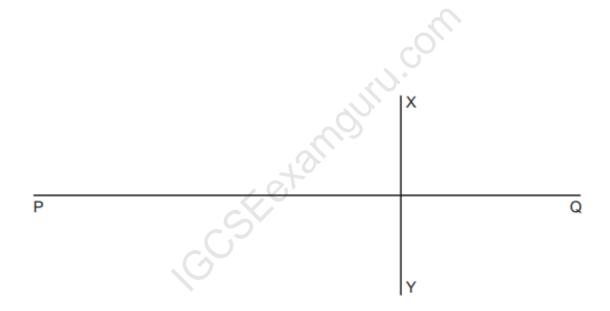


Fig. 7.1

An object 2.0 cm high is placed 2.0 cm to the left of the lens. The converging lens has a focal length of 3.0 cm.

(a)	On Fig. 7.1, draw a full-scale	diagram t	to find th	e distance	of the	image	from	the	lens,
	and the height of the image.								

distance of image from the lens =	
height of image =	
	[5]

(b) State and explain whether the image in (a) is real or virtual.

[1]

[Total: 6]

**9** A ray of light from a laser passes from air into a clear, semi-circular, plastic block. Fig. 7.1 shows the ray entering the block.

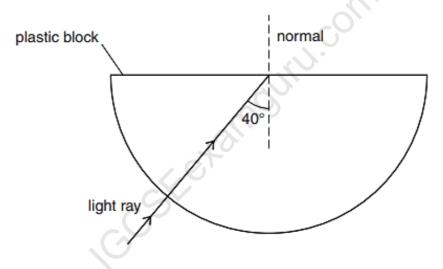


Fig. 7.1

The ray continues in the same direction and meets the middle of the opposite surface at an angle of 40° to the normal. The refractive index of the plastic is 1.5.

(a) The ray continues into the air.

Calculate the angle between the normal and the path taken by the light after it leaves the block.

(b)	The frequency of the light produced by this laser is $3.8 \times 10^{14}\text{Hz}$ and its wavelength in the plastic block is $5.3 \times 10^{-7}\text{m}$ (0.000 53 mm).				
	Cal	alculate			
	(i)	the speed of light in this plastic,			
			speed =[2		
	(ii)		speea =[2		
	. ,				
			COLL		
			speed =[2		
		:	speed =[2		
(c)	Ехр	plain why the ray does not change direction	on as it enters the plastic block.		
		137			
		/ (7)			
			ro.		

10 (a) Fig. 7.1 shows a ray diagram of a converging lens forming the image I of the object O.

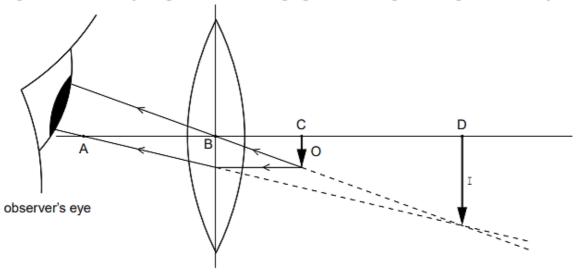


Fig. 7.1

[Total: 9]

(i) Put a tick in **two** boxes in the following list to describe the image formed by the lens in Fig. 7.1.

description	place <b>two</b> ticks in this column
real	
virtual	
magnified (enlarged)	
same size	
diminished (smaller)	

(ii) Which length, on Fig. 7.1, is the focal length of the lens? Circle one of the lengths below.

AB

ċ

BC

BD

CD

[3]

(b) In this question, you will apply the laws of reflection for a plane mirror to a curved mirror.

This mirror is shown in Fig. 7.2. The normal at any point on this mirror is the line from that point to the point C.

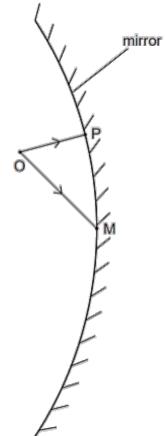


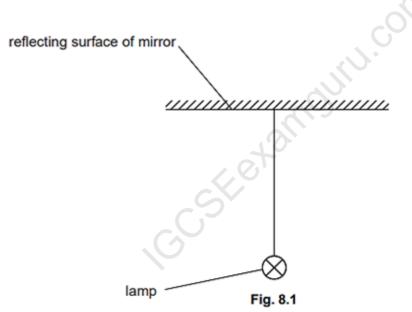
Fig. 7.2

Two rays have been drawn from the object O.

On Fig. 7.2,

(i)	draw the normal to the mirror at M,	[1]
(ii)	draw the ray reflected from M,	[1]
(iii)	draw the ray reflected from P,	[1]
(iv)	extend the reflected rays back to the right of the mirror and locate the image.	
	Label this image I.	[2]
	По	al: 8

11 A lamp in a large room is suspended below a horizontal mirror that is fixed to the ceiling. Fig. 8.1 is a scale diagram of the lamp and mirror.



An image of the lamp is formed by the mirror.

(a)	(i)	On Fig. 8.1, draw two rays from the centre of the lamp that strike the mirror. Use these rays to locate the image. Label the image I. [3]
	(ii)	State <b>two</b> characteristics of this image.
		1
(b)	Sug	2[2] ggest an advantage of positioning a mirror above the lamp.
		[1]
		[Actor]

12 (a) Fig. 6.1 shows a ray of light incident on the surface of a glass block.

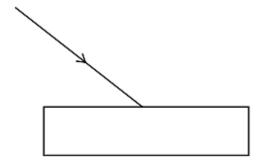


Fig. 6.1

On Fig. 6.1, accurately draw the reflected ray.

[2]

(b) Fig. 6.2 shows a ray of light incident on a glass prism.

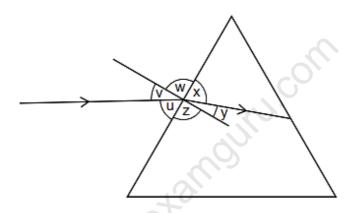


Fig. 6.2

Put **one tick only** in each line of the table to indicate which of the angles labelled in Fig. 6.2 are the angle of incidence and the angle of refraction.

	u	v	w	x	у	z
angle of incidence						
angle of refraction						

[2]

(c) The refractive index of water is 1.33. A ray of light passes from water into air. The angle of incidence at the water-air interface is 30°.

Calculate the angle of refraction.

angle of refraction = ......[3]

(d) Fig. 6.3 shows rays of violet and red light incident on a prism. The dashed line shows the path taken by the ray of violet light in the prism.

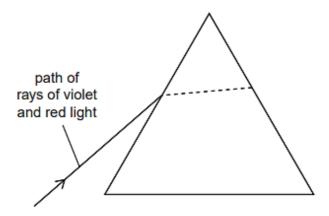


Fig. 6.3

On Fig. 6.3, draw and label the path that the ray of red light takes in the prism. A calculation is not required. [2]

[Total: 9]

- 13 Light enters a glass fibre from air at an angle of incidence of 62°. The angle of refraction in the glass is 36°.
  - (a) The speed of light in air is  $3.0 \times 10^8$  m/s.

Determine the speed of light in the glass fibre.

	speed =[4]
b)	Describe how glass fibres are used in communications technology.
	[3]

14 Fig. 11.1 shows part of the path of a ray of light PQ travelling in an optical fibre.

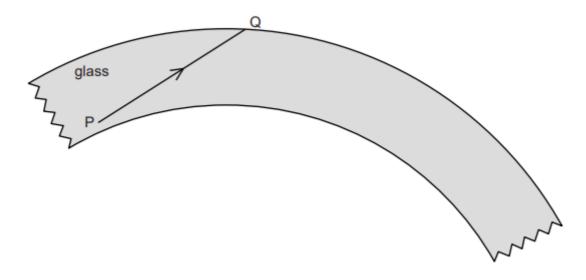


Fig. 11.1

- (a) On Fig. 11.1, carefully complete the path of the ray of light, until it leaves this section of the optical fibre. [2]
- (b) The material of an optical fibre has a refractive index of 1.52.

	Cal	culate the critical angle.
		CKE tall
		critical angle =[2]
(c)	(i)	State what sort of reflection takes place within an optical fibre.
		[1]
	(ii)	Explain your answer.

[Total: 6]

15 (a) Fig. 6.1 shows an object O placed in front of a plane mirror M. Two rays from the object to the mirror are shown.

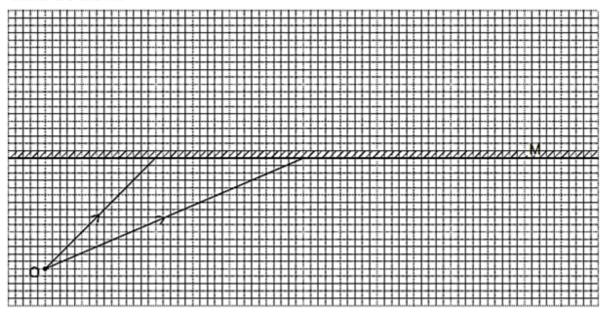


Fig. 6.1

- (i) On Fig. 6.1, for one of the rays shown,
  - 1. draw the normal to the mirror,
  - mark the angle of incidence. Label this angle X.
- (ii) On Fig. 6.1, draw

[2]

- the reflected rays for both incident rays,
- 2. construction lines to locate the image of O. Label this image I.

[2]

(b) In Fig. 6.2, circular wavefronts from a point source in a tank of water strike a straight barrier.

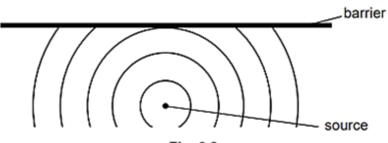


Fig. 6.2

(i) The reflected wavefronts seem to come from a single point.

On Fig. 6.2, mark a dot to show the position of this point. Label this point C.

[1]

(ii) Draw, as accurately as you can, the reflected circular wavefronts.

[2]

[Total: 7]

......

16 A glass, converging lens is used as a magnifying glass to observe a red ant.

(a) Fig. 6.1 shows the lens, the principal axis, and the two principal focuses F<sub>1</sub> and F<sub>2</sub>.

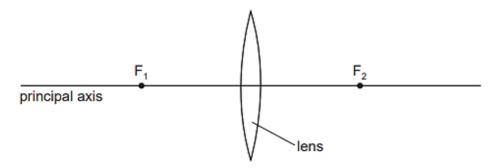


Fig. 6.1

- On Fig. 6.1, mark a point on the principal axis, labelled A, to indicate a suitable position for the ant.
  - On Fig. 6.1, mark a point on the principal axis, labelled E, to indicate a suitable position for the observer's eye.

								[1]
(ii)	Tick o		boxes to	indicate v	where, on t	he principal a	kis, the image o	
		to the le	ft of F <sub>1</sub>					
		betweer	n F <sub>1</sub> and th	ne lens	-0	<i>)</i> ,		
		within th	ne lens		allie			
		betweer	n the lens	and F <sub>2</sub>	Lo			
		to the ri	ght of F <sub>2</sub>	3				[1]
(iii)	Under glass.		words in	the list th	at describe	the image p	roduced by the	
	dim	inished	inve	erted	real	upright	virtual	[2]
(i)	The rec	l light fron	n the ant p	oasses int	to the lens.			[2]
	As the I	light enter	s the lens	, state wh	nat happens	s to		
	1. its	waveleng	th,					
								[1]
	2. its	frequency	<b>/</b> .					
								[1]
(ii)	State h air.	ow the wa	avelength	of violet	light in air (	differs from the	e wavelength of	red light in
								[1]

(b)

17	The	e refra	active index <i>n</i> of glass in air is 1.5.
	(a)	(i)	State the equation that relates the speed of light in air $v_a$ , the speed of light in glass $v_g$ and $n$ .
			[1]
		(ii)	The speed of light in air is $3.0 \times 10^8 \text{m/s}$ .
			Calculate the speed of light in glass.
			speed =[1]
	(b)		nt travelling in glass strikes the edge of the glass. Fig. 6.1 shows a ray of light at an angle 1° to the normal.
			air
			glass 741°
			Fig. 6.1
		(i)	The light passes from the glass into the air.
			Calculate the angle that the ray makes with the normal in the air.
			angle =[2]
		(ii)	State what happens to light that strikes the edge of the glass at an angle to the norma
		(")	much larger than 41°.

	(c)	Describe one example of how optical fibres are used in medicine.
18	(a)	[2] Fig. 7.1 represents an object O placed in front of a converging lens.
		P Q R S

Fig. 7.1

(i) State a full description of the image I.

.....[2]

(ii) Using the letters on Fig. 7.1, identify the focal length of the lens.

[1]

(iii) On Fig. 7.1, draw an eye suitably placed to view the image I. [1]

(b) Fig. 7.2 shows an object O placed to the left of a converging lens. A principal focus of the lens is at the position marked F.

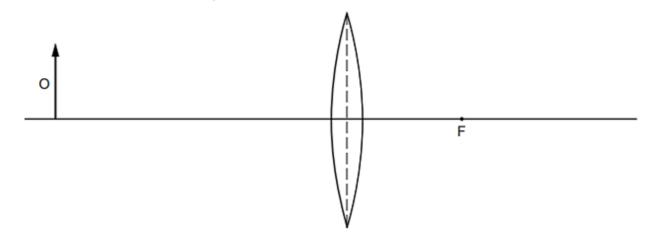


Fig. 7.2

(i) On Fig. 7.2, draw two rays to locate the image of object O. Draw the image.

(ii) On Fig. 7.2, draw one other ray from the upper tip of O to the image.

[4] Total: 91

[Total: 8]

19	(a)	The	refractive	index	of a	type	of	glass	is	1.6	
----	-----	-----	------------	-------	------	------	----	-------	----	-----	--

Calculate the critical angle for light in this type of glass.

critical angle =	.[3]	

(b) A waterproof laser is immersed in water. Fig. 7.1 shows the laser shining light up towards the horizontal surface of the water.

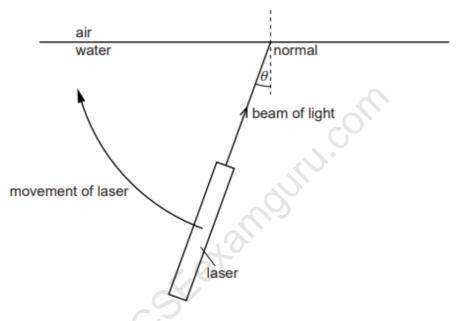


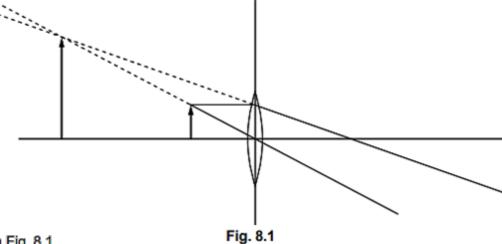
Fig. 7.1

Initially, the angle  $\theta$  is much less than the critical angle for this light in water.

The laser moves and  $\theta$  gradually increases until it is much greater than the critical angle.

Describe, for different angles of the laser, what happens to the light beam after it hits the surface.	
	4]

20 (a) Fig. 8.1 is a ray diagram of a convex lens being used as a magnifying glass to produce a virtual image.

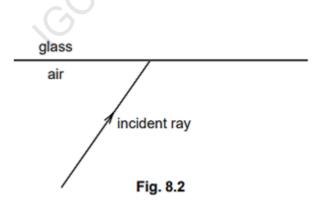


On Fig. 8.1,

- (i) label the object O,
- (ii) label the image I,
- (iii) label a principal focus F,
- (iv) put arrows on the two rays to indicate their directions.

[4]

(b) Fig. 8.2 shows a ray of light in air incident on an interface with glass. The refractive index of glass is 1.5.



On Fig. 8.2, accurately draw the ray as it travels in the glass. You will need to take a measurement from Fig. 8.2 and carry out an appropriate calculation. Show your working.

[3]

21 (a) Fig. 7.1 shows a convex lens being used to produce an image of an object.

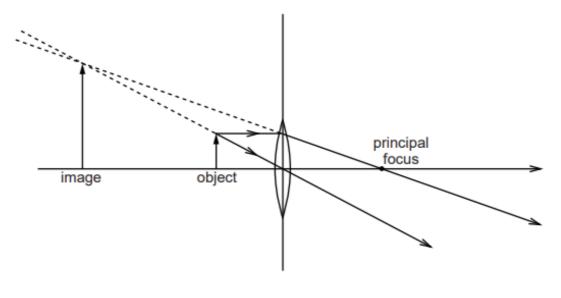


Fig. 7.1

(i) Place three ticks in the table that describe this image.

can only be formed on a screen	(,)
diminished	
enlarged	
inverted	
real	
same size	
upright	
virtual	

[3]

(ii) On Fig. 7.1, mark a letter E to indicate a possible position for an eye to be placed to observe this image. [1]

(iii) State an application in which a convex lens is used in this way.

1

(b) In the space below, draw a ray diagram to locate the image of an object of height 1.0 cm placed 5.0 cm from a convex lens of focal length 2.0 cm. Draw your diagram full size. You are advised to locate the lens roughly in the centre of the space. Label the image.

[3] [Total: 8]