



Waves

FREE Online Physics GCSE Course

physicswithkate.com

Name _____ Date _____

TIME ALLOWED

55 minutes

TOTAL MARKS

50 DOUBLE AWARD · **59** PHYSICS

YOU WILL NEED

a ruler, a pencil, a black or blue pen and a calculator

Instructions

- **Physics:** answer **all** questions (55 minutes).
- **Double Award (Science):** answer Questions 1–6 (45 minutes). Skip Question 7.
- Write your answers in the spaces provided, in black or blue ink. Draw diagrams in pencil.
- In calculations, show clearly how you work out your answer.

Information

- The marks for each question are shown in brackets.
- Physics is out of 59 marks. Double Award (Science) is out of 50 marks.
- Question 7 (sound) is **Physics only**.

Your score

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Total	%
Out of	10	10	8	7	12	3	9	50 / 59	100
Your mark									

Marking your test

The full mark scheme is at the back of this booklet. Try every question first, then mark your answers in a different colour.

1 Question 1
10 marks

Different types of electromagnetic wave are used in hospitals.

(a) (i) Which of these properties is the same for all electromagnetic waves?

Tick (✓) **one** box.

A amplitude

☐

B frequency

☐

C speed in free space

☐

D wavelength in free space

☐

(1)

(ii) Draw a line linking each type of electromagnetic wave with its use.

type of EM wave	use
gamma rays	heating food for patients
microwaves	imaging broken bones
x-rays	with medical tracers

(2)

(b) A scanner uses one type of wave to produce an image of a broken wrist.

(i) The type of wave emitted by the scanner is

Tick (✓) **one** box.

A infrared

☐

B microwaves

☐

C sound

☐

D X-rays

☐

(1)

(ii) An image of the bone is seen because the waves from the scanner are

Tick (✓) **one** box.

A absorbed by the bone

☐

B reflected by the bone

☐

C refracted by the bone

☐

D transmitted by the bone

☐

(1)

- (iii) Name **one** type of wave that is used in cancer treatment and explain what it does during the treatment.

Type of wave _____

(2)

- (c) Gamma radiation is used in hospitals even though it can be dangerous.

- (i) Explain the risks to patients and doctors of using gamma radiation.

(2)

- (ii) State **one** way of reducing the risks to a doctor who uses gamma radiation.

(1)

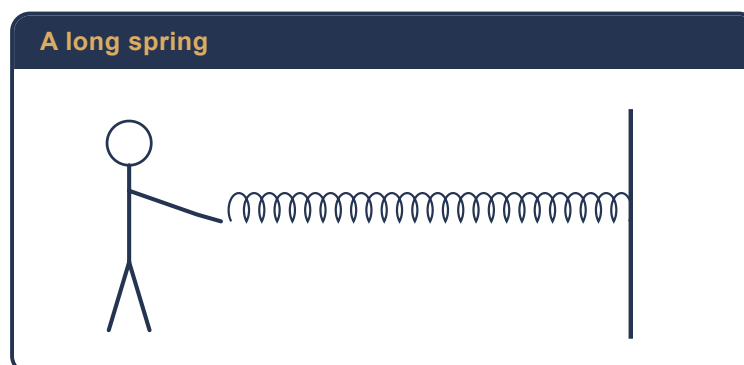
Total for this question: 10 marks

2 Question 2

10 marks

A teacher demonstrates different types of wave.

- (a) He uses a spring to demonstrate longitudinal waves.



- (i) Draw arrows on the diagram to show the directions in which the teacher moves his hand.

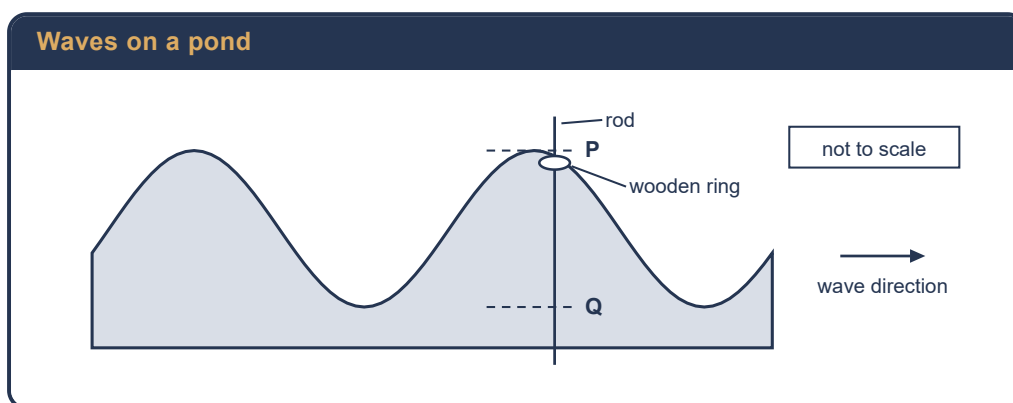
(1)

Waves · Topic Test

- (ii) Give an example of a longitudinal wave.

(1)

- (b) The teacher then demonstrates transverse waves. He fixes a vertical rod in a pond and places a small wooden ring on the rod. The ring floats on the water and moves up and down the rod as waves go past.



- (i) On the diagram, draw a line to show one wavelength. Label your line with the letter W.

(1)

- (ii) The distance from P to Q is 5.0 cm. Determine the amplitude of the wave.

Amplitude = _____ cm
(1)

- (iii) The wooden ring reaches point P every 15 s. Calculate the frequency of the wave. Give the unit.

Frequency = _____ unit _____
(3)

- (iv) Explain how the movement of the wooden ring demonstrates that this wave is transverse.

(2)

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- (v) The wave shown is a water wave. Give a different example of a transverse wave.

(1)

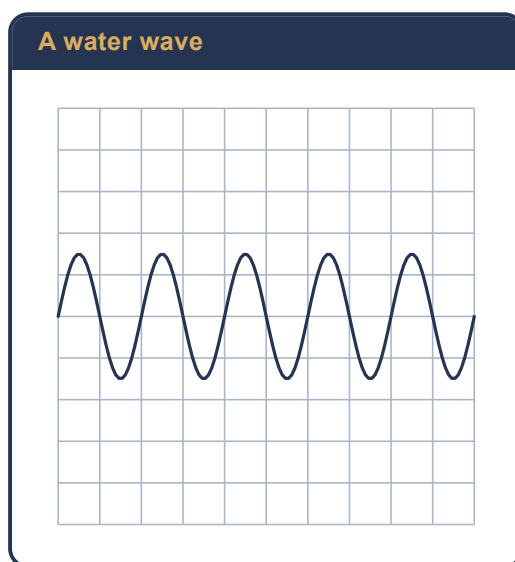
Total for this question: 10 marks

3 Question 3

8 marks

Waves can travel on water, through air or in a vacuum.

- (a) The diagram shows the side view of a wave on the surface of water. Each square on the grid represents $1\text{ cm} \times 1\text{ cm}$.



- (i) State the wavelength of the wave shown.

Wavelength = _____ cm
(1)

- (ii) On the grid, sketch the trace of a wave travelling at the same speed, but with a larger amplitude and a lower frequency.

(2)

- (b) (i) State the equation linking wave speed, frequency and wavelength.

(1)

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- (ii) The speed of radio waves is 300 000 000 m/s. A radio wave has a frequency of 31 MHz. Calculate the wavelength of this radio wave.

Wavelength = _____ m
(3)

- (c) A sound wave and a radio wave have the same wavelength. State why they have different frequencies.

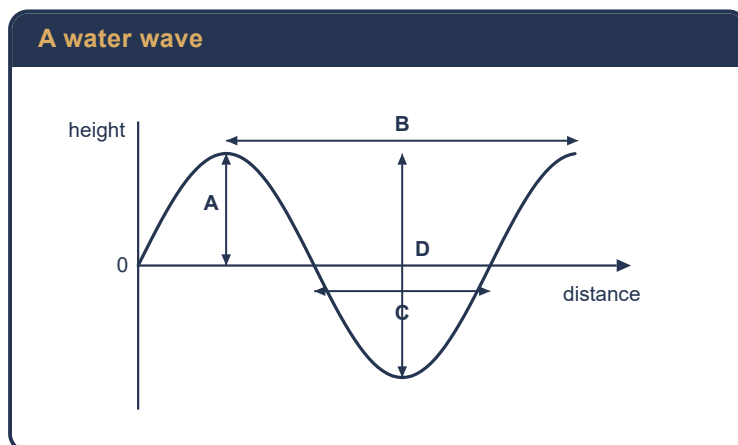
(1)

Total for this question: 8 marks

4 Question 4

7 marks

The diagram shows part of a water wave.



- (a) (i) Which letter represents the wavelength?

Tick (✓) **one** box.

A ☐	B ☐	C ☐	D ☐
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(1)

- (ii) Which letter represents the amplitude?

Tick (✓) **one** box.

A ☐	B ☐	C ☐	D ☐
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(1)

Waves · Topic Test

- (b) A student writes some sentences about electromagnetic waves. His teacher circles a mistake in each sentence. In the table, write a suitable correction for each mistake. The first one has been done for you.

Sentence	Correction
Electromagnetic waves travel at 3×10^2 m/s in a vacuum.	10^8
Sound waves are electromagnetic.	
Infra-red waves are the most harmful to people.	
Gamma waves are used for heating up food.	
Radio waves have the highest frequency.	
Gamma waves have a very long wavelength.	

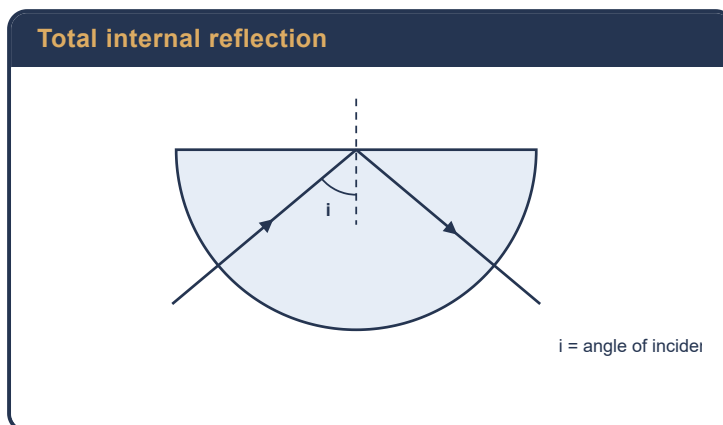
(5)

Total for this question: 7 marks

5 Question 5

12 marks

A student watches a demonstration of the total internal reflection of light in a semicircular glass block.



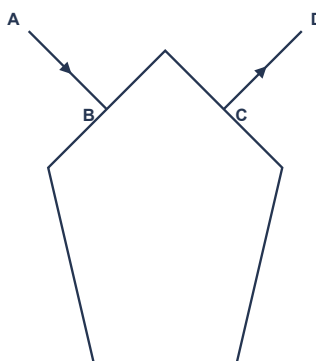
- (a) He takes notes, but some of his notes are wrong. Place a tick (✓) or a cross (X) in the table to show which statements are right or wrong. The first one has been done for you.

Notes about the total internal reflection of light	Right or wrong
the angle of incidence equals the angle of reflection	✓
light changes speed when it is internally reflected	
every ray entering the semicircular glass block is reflected by total internal reflection	
if $i = 0$ then the ray does not deviate	
the refractive index of glass is bigger than the refractive index of air	

(2)

- (b) Jewellers cut jewels so that total internal reflection is more likely. Light enters a jewel along the normal AB and leaves along the normal CD as shown. Between B and C there are **two** total internal reflections.

Complete the path of the light through the jewel.



(3)

Waves · Topic Test

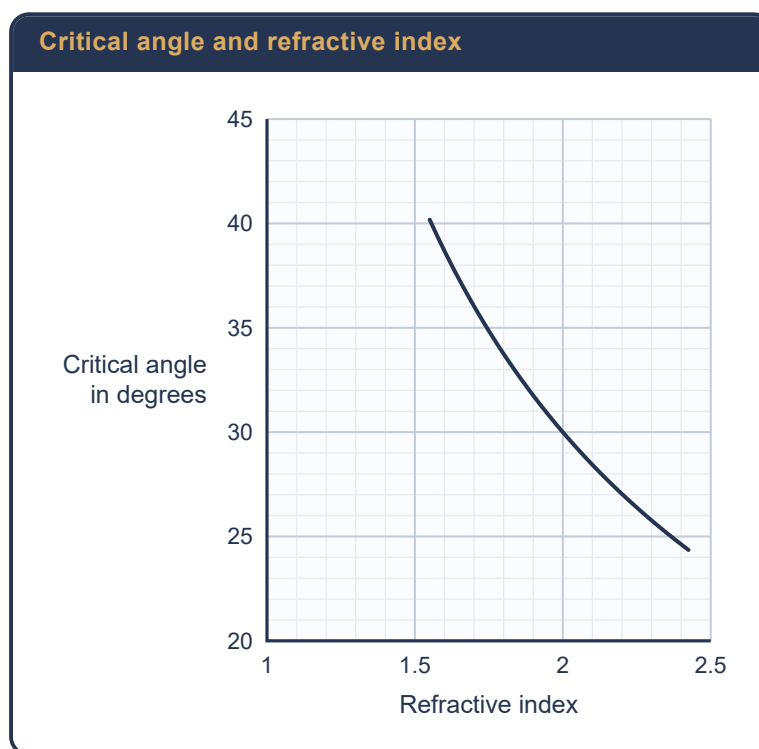
- (c) (i) Show, by calculation, that the critical angle for a refractive index of 1.5 is about 42° .

(3)

- (ii) Explain why the quantity called refractive index has no unit.

(2)

- (d) The graph shows how critical angle varies with refractive index.



- (i) Add the point $(1.5, 42^\circ)$ to the graph.

(1)

- (ii) How can you tell that the point $(1.5, 42^\circ)$ is **not** anomalous?

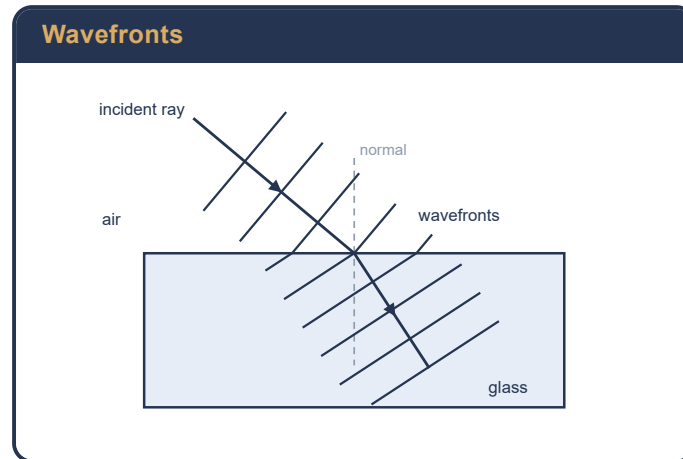
(1)

Total for this question: 12 marks

6 Question 6

3 marks

The diagram shows changes to light waves passing from air into glass.



(a) The effect shown in the diagram is

Tick (✓) **one** box.

A diffraction ☐

B dispersion ☐

C reflection ☐

D refraction ☐

(1)

(b) State **two** ways in which the light waves change as they pass into the glass.

1

2

(2)

Total for this question: 3 marks

7 Question 7

Physics only

9 marks

Physics only. Double Award (Science) students: skip this question.

(a) Which statement about sound waves is correct?

Tick (✓) **one** box.

A sound waves cannot be reflected ☐

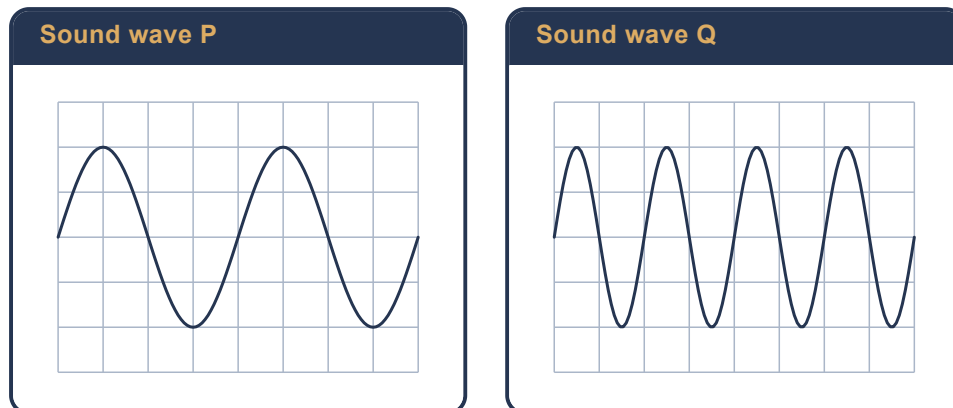
B sound waves are electromagnetic ☐

C sound waves are longitudinal ☐

D sound waves are transverse ☐

(1)

- (b) A microphone is connected to a data logger, which displays each sound wave as a graph. The graphs have the same scales. In the horizontal direction: 1 square = 0.001 s.



- (i) The amplitude of sound wave Q is

Tick (✓) **one** box.

A larger than the amplitude of sound wave P

☐

B smaller than the amplitude of sound wave P

☐

C the same as the amplitude of sound wave P

☐

D zero

☐

(1)

- (ii) The frequency of sound wave P is 250 Hz. Find the time period of sound wave P.

Time period = _____ s

(1)

- (iii) Find the frequency of sound wave Q.

Frequency = _____ Hz

(1)

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- (c) Two students investigate the speed of sound waves in air. They use a stopwatch that shows times to the nearest 0.1 s. They use an outdoor running track as their measure of distance. The track is straight and 100 m long.

Describe what else they must do to obtain a value for the speed of sound.

(5)

Total for this question: 9 marks

END OF TEST

Now mark your answers using the mark scheme that follows.

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MARK SCHEME

Waves · Topic Test

[1] in the Mark column means one mark for that line.

accept / allow notes (gold) are other answers that also score.

reject / do not accept notes (red) are answers that do not.

1 Question 1 — mark scheme

Spec 3.10, 3.12, 3.13

10 marks

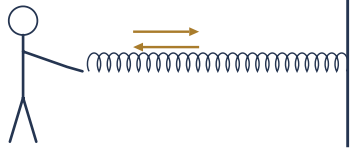
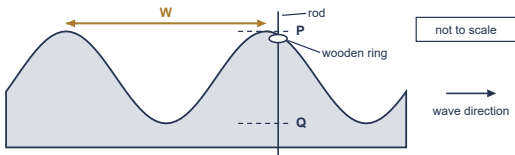
PART	ANSWER	MARK
(a)(i)	C speed in free space	1
(a)(ii)	gamma rays → with medical tracers; microwaves → heating food for patients; x-rays → imaging broken bones	2
	type of EM wave gamma rays microwaves x-rays use heating food for patients imaging broken bones with medical tracers all lines correct = 2 marks; any correct line = 1 mark	
(b)(i)	D X-rays	1
(b)(ii)	A absorbed by the bone	1
(b)(iii)	X-rays or gamma rays allow γ ; do not allow UV	1
	damages / kills the cancer cells, e.g. kills, mutates, ionises, destroys the cells independent mark	1
(c)(i)	any two of: - a sensible risk for either, e.g. increased risk of cancer / mutation, damage to healthy cells - a further detail, e.g. the radiation is ionising, gamma has (the) highest energy - the relative risk: the patient is exposed only for a short time, the doctor has continual (low-level) exposure	2
(c)(ii)	any sensible method, e.g. use it for a limited time; work at a distance / in another room ignore protective clothing, lead shielding, lead apron	1

Total: 10 marks

2 Question 2 — mark scheme

Spec 3.2, 3.3, 3.6

10 marks

PART	ANSWER	MARK
(a)(i)	arrows in opposite directions, (roughly) parallel to the length of the spring  allow a double-headed arrow ignore arrow length	1
(a)(ii)	any suitable example, e.g. sound, ultrasound, seismic P-waves ignore waves in a slinky	1
(b)(i)	a suitable horizontal line labelled W, e.g. peak to peak, trough to trough, between adjacent points in phase  judge by eye: it should start and finish at suitable points	1
(b)(ii)	2.5 cm do not allow 5/2; allow 2½	1
(b)(iii)	substitution into $f = 1 \div T$: $f = 1 \div 15$ no mark for the equation itself	1
	0.067 allow 0.07, 0.0667; condone 0.06, 0.066 -1 for a power-of-ten error	1
	Hz allow s^{-1}	1
(b)(iv)	the ring oscillates perpendicular / at right angles to the direction the wave travels allow the direction of energy transfer reject the second mark if it describes a longitudinal wave	1
(b)(v)	any suitable example, e.g. any named EM wave, light, seismic S-waves, a wave on a rope	1

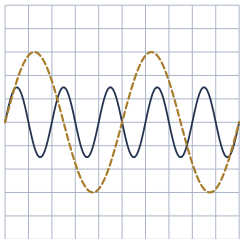
Total: 10 marks

Waves · Topic Test

3 Question 3 — mark scheme

Spec 3.3, 3.5, 3.7

8 marks

PART	ANSWER	MARK
(a)(i)	2 cm 5 complete waves across 10 squares	1
(a)(ii)	a sketched wave (at least 1 cycle) with a larger amplitude 	1
	the shape of the wave and the position of the axis do not matter	
	a sketched wave (at least 1 cycle) with a longer wavelength same speed, lower frequency, so longer wavelength	1
(b)(i)	wave speed = frequency × wavelength allow $v = f \lambda$ and rearrangements	1
(b)(ii)	conversion to Hz: 31 MHz = 31 000 000 Hz allow 10^6 seen at any stage	1
	substitution and rearrangement: wavelength = $300\,000\,000 \div 31\,000\,000$	1
	9.7 m allow answers that round to 9.7 (9.677)	1
(c)	any one of: the two waves travel at different speeds; they travel the same distance (one wavelength) in different times ignore references to transverse / longitudinal or the EM spectrum	1

Total: 8 marks

4 Question 4 — mark scheme

Spec 3.3, 3.10–3.13

7 marks

PART	ANSWER	MARK
(a)(i)	B	1
(a)(ii)	A	1

(b) one mark for each correction:

5

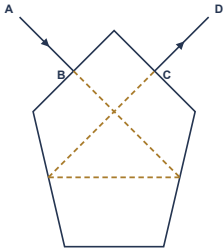
Sentence	Correction
Electromagnetic waves travel at 3×10^2 m/s in a vacuum.	10^8
Sound waves are electromagnetic.	any EM wave, e.g. radio, microwaves, infrared, visible light, ultraviolet, X-rays, gamma
Infra-red waves are the most harmful to people.	gamma
Gamma waves are used for heating up food.	microwaves or infrared
Radio waves have the highest frequency.	gamma
Gamma waves have a very long wavelength.	radio

Total: 7 marks

5 Question 5 — mark scheme

Spec 3.15, 3.16, 3.18, 3.21, 3.22

12 marks

PART	ANSWER	MARK
(a)	light changes speed when internally reflected: X · every ray is totally internally reflected: X · if $i = 0$ the ray does not deviate: ✓ · the refractive index of glass is bigger than air's: ✓ 3 or 4 correct = 2 marks; 2 correct = 1 mark	2
(b)	only two internal reflections attempted	1
		
	a horizontal line between the first and second reflections horizontal by eye	1
	the ray does not change direction as it leaves at C ignore arrows	1
(c)(i)	$\sin c = 1 \div n$	1

substitution: $\sin c = 1 \div 1.5 (= 0.667)$

1

$c = 41.8^\circ$

1

the value must be given to at least 3 significant figures

allow the reverse argument for a maximum of 2 marks: $\sin 42^\circ = 0.669$, so $n = 1.49 \approx 1.5$

(c)(ii) any **two** of:

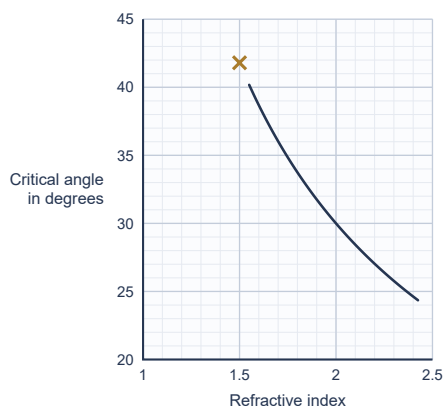
2

- $n = \sin i \div \sin r$ (or speed in air $\div$ speed in glass)
- refractive index is (only) a number / a ratio
- a sine is a number / a ratio

allow "the units cancel out"

(d)(i) point plotted at $(1.5, 42^\circ)$

1



no tolerance

(d)(ii) it fits the trend / it lies on an extension of the line

1

Total: 12 marks

6 Question 6 — mark scheme

Spec 3.9, 3.14

3 marks

PART	ANSWER	MARK
(a)	D refraction	1
(b)	any two of: ● the waves slow down ● the waves change direction / bend ● the wavelength decreases (wavefronts closer together) <i>allow "light" for waves; do not allow "curved"</i>	2

Total: 3 marks

7

Question 7 — mark scheme

Physics only · Spec 3.6, 3.23, 3.25P, 3.26P, 3.27P

9 marks

PART	ANSWER	MARK
(a)	C sound waves are longitudinal	1
(b)(i)	C the same as the amplitude of sound wave P	1
(b)(ii)	0.004 s <i>1 ÷ 250, or 4 squares × 0.001 s; allow 4 ms</i>	1
(b)(iii)	500 Hz <i>Q's period is 2 squares = 0.002 s; accept "double P"; allow error carried forward from (ii)</i>	1
(c)	any five of: - a way to make a loud enough sound, e.g. wooden blocks, a starting pistol - speed = distance ÷ time - do it in still air (no wind) - repeat and average - check / reset the stopwatch to zero - a clear visual signal when the sound is made, e.g. the smoke from a pistol (light travels much faster than sound) - time the interval between seeing the signal and hearing the sound, over the 100 m - reaction time could be a problem <i>ignore measuring the distance; ignore a bald "clap"</i> <i>allow "repeat and remove anomalies"</i>	5

Total: 9 marks

END OF MARK SCHEME
