

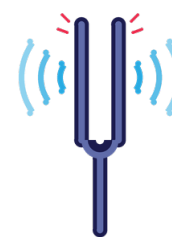
GCSE PHYSICS

Sound and Seismic Waves

OCR-style Topic Practice

Aligned to OCR Physics A (Gateway Science) J249 and OCR Physics B (Twenty First Century Science) J259

Tier: Higher



Name _____

Date _____

YOU MUST HAVE

- the Equation Sheet for GCSE Physics

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Answer all the questions.
- Write your answer to each question in the space provided.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- A scientific calculator may be used.

INFORMATION

- The total mark for this paper is **49**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).

ADVICE

- Read each question carefully before you start your answer.

These are original, independent practice questions written in the style of OCR GCSE Physics. They are not official OCR examination questions and are not endorsed by OCR.

SECTION A

Answer **all** the questions. You should spend approximately 10 minutes on this section. Write your answer to each question in the box provided.

1 Which of these is a longitudinal wave?

- A** a ripple on the surface of water
- B** light travelling through glass
- C** sound travelling through air
- D** a wave on a stretched rope

Your answer

[1]

2 Which statement describes the wavelength of a wave?

- A** the time taken for one complete wave to pass a point
- B** the number of waves passing a point each second
- C** the maximum displacement of a point from its rest position
- D** the distance from a point on one wave to the same point on the next wave

Your answer

[1]

3 A sound wave has a frequency of 500 Hz and a wavelength of 0.68 m.

What is the speed of the sound wave?

- A** 0.00136 m/s
- B** 340 m/s
- C** 500.68 m/s
- D** 735 m/s

Your answer

[1]

- 4 A sound wave passes from air into water. The speed of the wave increases.

Which row describes what happens to the frequency and the wavelength of the wave?

	Frequency	Wavelength
A	stays the same	decreases
B	increases	stays the same
C	decreases	increases
D	stays the same	increases

Your answer

[1]

- 5 Which statement describes the movement of the air particles as a sound wave passes through the air?

- A They vibrate backwards and forwards, parallel to the direction the wave travels.
- B They vibrate up and down, at right angles to the direction the wave travels.
- C They move along with the wave, from the source to the listener.
- D They do not move at all.

Your answer

[1]

- 6 Thick, soft foam is fixed to the walls of a music room to reduce echoes.

Which process at the foam mainly reduces the reflected sound?

- A reflection
- B absorption
- C refraction
- D transmission

Your answer

[1]

- 7 An ultrasound pulse is used to find the depth of a boundary inside the body. The speed of ultrasound in the body is known.

Which quantity must also be measured?

- A the amplitude of the reflected pulse
- B the frequency of the ultrasound
- C the time between sending the pulse and detecting the reflected pulse
- D the wavelength of the ultrasound

Your answer

[1]

- 8 A student stands 85 m from a large wall and claps once. The student hears the echo 0.50 s after the clap.

What is the speed of sound calculated from these results?

- A 42.5 m/s
- B 170 m/s
- C 340 m/s
- D 680 m/s

Your answer

[1]

SECTION B

Answer **all** the questions.

9 A student measures the speed of sound in air using two microphones and a data logger.

Fig. 9.1 shows the equipment. The loudspeaker makes a short click. The data logger records the time between the click reaching microphone A and reaching microphone B.

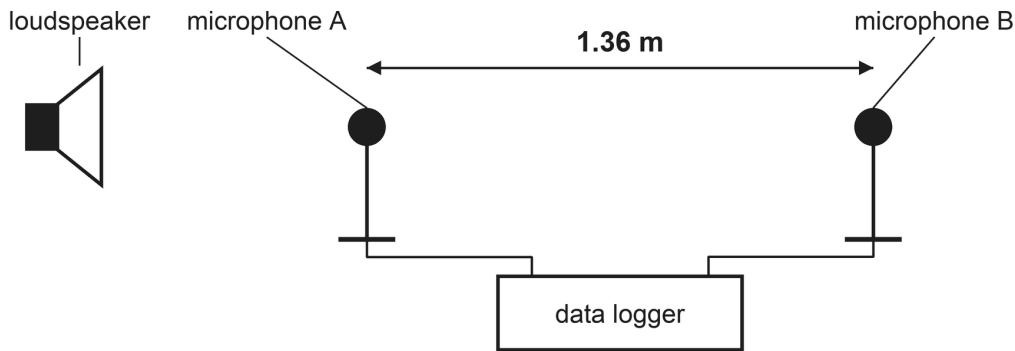


Fig. 9.1

The student repeats the measurement four times. Table 9.1 shows the results.

Table 9.1

Measurement	1	2	3	4
Time in ms	4.0	4.1	5.2	3.9

(a) Identify the anomalous result in Table 9.1.

[1]

(b) Calculate the mean time.

Do **not** include the anomalous result.

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Mean time = ms [2]

- (c) The distance between microphone A and microphone B is 1.36 m.

Calculate the speed of sound in air.

Use the Equation Sheet.

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Speed of sound = m/s [3]

- (d) Explain why the student uses a data logger rather than a stopwatch to measure the time.

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[2]

- 10** A loudspeaker under the water in a swimming pool produces a sound with a frequency of 750 Hz.

The speed of sound in water is 1500 m/s. The speed of sound in air is 340 m/s.

- (a) Calculate the wavelength of the sound in the water.

Use the Equation Sheet.

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.....

Wavelength = m [2]

- (b) Some of the sound passes from the water into the air above the pool.

State the frequency of the sound in the air.

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[1]

- (c) Calculate the wavelength of the sound in the air.

Use the Equation Sheet.

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Wavelength = m [2]

- (d) Explain why the frequency of the sound does not change when it passes from the water into the air.

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[2]

11 The ear detects sound waves.

- (a) Describe how the ear converts sound waves in the air into signals that travel to the brain.

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[3]

- (b) The normal range of human hearing is 20 Hz to 20 kHz.

Explain why a person cannot hear a sound with a frequency of 30 kHz.

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[2]

- (c) Music is played in a room. A person in the next room can hear the music, even when the wooden door between the rooms is closed.

Explain how the sound passes through the closed door.

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[2]

- 12** Ultrasound is sound with a frequency above 20 kHz. Doctors use ultrasound to produce images of organs inside the body.

A transducer on the skin sends a pulse of ultrasound into the body and detects the reflected pulses.

Fig. 12.1 shows the pulses from a scan of a kidney.

Pulse P is the pulse sent into the body. Pulses Q, R and S are reflected pulses. Pulse R is reflected from the front of the kidney. Pulse S is reflected from the back of the kidney.

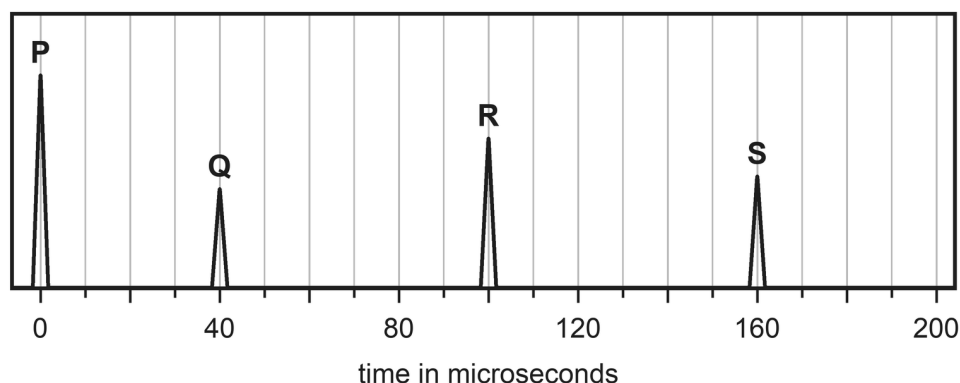


Fig. 12.1

- (a) Explain why one pulse sent into the body produces several reflected pulses.

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 [2]

- (b) The speed of ultrasound in the body is 1500 m/s.

Calculate the depth of the front of the kidney below the skin.

Use Fig. 12.1 and the Equation Sheet.

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Depth = m [3]

- (c) Calculate the thickness of the kidney.

Use Fig. 12.1 and the Equation Sheet.

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Thickness = m [2]

- (d) Suggest **one** reason why ultrasound, rather than X-rays, is used for this scan.

..... [1]

- 13** A fishing boat uses sonar to find the depth of the sea. The sonar sends pulses of ultrasound down into the sea and detects the echoes.

The speed of sound in sea water is 1500 m/s.

- (a) An echo from the seabed is detected 0.24 s after the pulse is sent.

Calculate the depth of the sea below the boat.

Use the Equation Sheet.

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Depth = m [3]

- (b) The echo from a seabed of soft mud is much weaker than the echo from a seabed of rock. Suggest why.

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..... [2]

- 14*** Earthquakes produce seismic waves. Seismometers at stations around the world detect the waves.

There are two types of seismic wave:

P-waves are longitudinal. They can travel through solids and liquids.

S-waves are transverse. They can travel through solids, but not through liquids.

Both types of wave change speed, and can change direction, when they pass into a different material.

Table 14.1 shows which waves from one earthquake were detected at five stations. The angle is measured at the centre of the Earth, from the earthquake to the station.

Table 14.1

Station	Angle from the earthquake	P-waves detected?	S-waves detected?
A	30°	yes	yes
B	80°	yes	yes
C	120°	no	no
D	150°	yes	no
E	180°	yes	no

Scientists think that the Earth has a solid mantle around a core.

Use the information and Table 14.1 to explain what the results suggest about the Earth's core.

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[6]

END OF QUESTION PAPER

Mark scheme

Annotations: ✓ = one mark. / separates alternatives. () words not needed for the mark. ALLOW = an acceptable alternative. IGNORE = neither gains nor loses the mark. DO NOT ACCEPT = does not gain the mark. ECF = error carried forward.

Question	Answer	Marks	AO element	Guidance
1	C ✓	1	1.1	A, B and D are transverse waves
2	D ✓	1	1.1	A is the period; B is the frequency; C is the amplitude
3	B ✓	1	2.2	wave speed = frequency × wavelength = $500 \times 0.68 = 340$ m/s A: wavelength ÷ frequency; D: frequency ÷ wavelength; C: frequency + wavelength
4	D ✓	1	1.1	the frequency is set by the source and does not change; the speed increases, so the wavelength increases
5	A ✓	1	1.1	B describes a transverse wave; C: the wave travels, not the air; D: the particles vibrate
6	B ✓	1	2.1	the soft foam absorbs sound energy, so less sound is reflected back into the room A: reflection is the process that the foam reduces C: refraction is a change of direction as a wave changes speed; it does not reduce echoes D: sound transmitted into the foam is then absorbed there, so absorption is the process that reduces the echo
7	C ✓	1	1.1	depth = $\frac{1}{2} \times \text{speed} \times \text{time}$, so the time for the pulse to travel there and back is needed
8	C ✓	1	2.2	the sound travels $2 \times 85 = 170$ m in 0.50 s: $170 \div 0.50 = 340$ m/s B: the distance was not doubled; A: 85×0.50 ; D: the distance was doubled twice
9(a)	5.2 (ms) ✓	1	3.1a	ALLOW measurement 3

Question	Answer	Marks	AO element	Guidance
9(b)	$(4.0 + 4.1 + 3.9) \div 3 \checkmark$ $= 4.0 \text{ (ms)} \checkmark$	2	2.2 $\times$ 2	award 2 marks for a correct answer with no working award 1 mark for 4.3 (ms), from including the anomalous result
9(c)	$4.0 \text{ ms} = 0.0040 \text{ s} \checkmark$ $\text{speed} = 1.36 \div 0.0040 \checkmark$ $= 340 \text{ (m/s)} \checkmark$	3	2.2 $\times$ 3	award 3 marks for a correct answer with no working ECF from 9(b) award 2 marks for 0.34 (m/s), from using the time in ms
9(d)	the time is very short / only a few milliseconds $\checkmark$ a stopwatch depends on human reaction time, which is much longer than the time being measured / a data logger measures (short times) more precisely $\checkmark$	2	1.2 $\times$ 2	ALLOW the data logger starts and stops automatically when the sound reaches each microphone for the second marking point IGNORE "more accurate" without a reason
10(a)	$\text{wavelength} = 1500 \div 750 \checkmark$ $= 2.0 \text{ (m)} \checkmark$	2	2.2 $\times$ 2	award 2 marks for a correct answer with no working ALLOW 2 (m)
10(b)	750 Hz $\checkmark$	1	1.1	ALLOW "the same as in the water"
10(c)	$\text{wavelength} = 340 \div 750 \checkmark$ $= 0.45 \text{ (m)} \checkmark$	2	2.2 $\times$ 2	award 2 marks for a correct answer with no working ALLOW 0.453 (m) ECF from 10(b)
10(d)	the frequency is set by the source (of the sound) $\checkmark$ each vibration arriving at the boundary produces one vibration on the other side / the number of waves passing each second is the same in both materials $\checkmark$	2	1.1 $\times$ 2	DO NOT ACCEPT the frequency changes because the speed changes
11(a)	the sound waves make the ear drum vibrate $\checkmark$ the small bones (in the middle ear) pass the vibrations on to the inner ear / cochlea $\checkmark$ the vibrations are converted into electrical signals, which travel along the (auditory) nerve to the brain $\checkmark$	3	1.1 $\times$ 3	ALLOW ossicles / hammer, anvil and stirrup for the small bones the marking points must be in a sensible sequence
11(b)	30 kHz is above the upper limit of human hearing / above 20 kHz $\checkmark$ the ear drum and small bones only transmit vibrations over a limited range of frequencies $\checkmark$	2	1.1 2.1	ALLOW "the parts of the ear do not respond to frequencies this high" for the second marking point DO NOT ACCEPT the sound is too quiet

Question	Answer	Marks	AO element	Guidance
11(c)	the sound waves (in the air) make the door vibrate / the vibrations are transmitted through the (solid) door ✓ the vibrating door makes the air on the other side vibrate, producing sound waves ✓	2	2.1 ×2	DO NOT ACCEPT "the air passes through the door"
12(a)	the ultrasound is partially reflected at each boundary between different tissues / materials ✓ the rest is transmitted, so it reaches further boundaries, which reflect more pulses ✓	2	1.1 ×2	ALLOW "some of the ultrasound passes through each boundary" for the second marking point
12(b)	time for pulse R = 100 μs (= 0.000 10 s) ✓ distance travelled = 1500 × 0.000 10 = 0.15 (m) ✓ depth = 0.15 ÷ 2 = 0.075 (m) ✓	3	3.1a 2.2 ×2	award 3 marks for a correct answer with no working award 2 marks for 0.15 (m), from not halving ALLOW 7.5 cm if the unit is changed
12(c)	time between R and S = 160 – 100 = 60 μs ✓ thickness = $\frac{1}{2} \times 1500 \times 0.000\ 060 = 0.045$ (m) ✓	2	3.1a 2.2	award 2 marks for a correct answer with no working award 1 mark for 0.09 (m), from not halving ALLOW 4.5 cm if the unit is changed
12(d)	ultrasound is non-ionising / does not damage cells / is safe / ultrasound can show soft tissue (boundaries) ✓	1	1.1	ALLOW "X-rays are ionising / can damage cells" IGNORE "ultrasound is cheaper"
13(a)	distance travelled = 1500 × 0.24 ✓ = 360 (m) ✓ depth = 360 ÷ 2 = 180 (m) ✓	3	2.2 ×3	award 3 marks for a correct answer with no working award 2 marks for 360 (m), from not halving
13(b)	the mud absorbs more of the (energy of the) ultrasound / the rock reflects more ✓ so less ultrasound is reflected back to the boat ✓	2	2.1 3.2a	ALLOW "more of the ultrasound is transmitted into the mud" for the first marking point

Question	Answer	Marks	AO element	Guidance
14*	Level 3 (5–6 marks) Uses both sets of observations. S-waves are detected at 30° and 80° but not at 120°, 150° or 180°, so the S-wave shadow region begins between 80° and 120°; S-waves cannot travel through liquids, so at least part of the core is liquid. P-waves are absent at 120° but detected at 150° and 180°: they change speed and direction at the core boundary (refraction), giving a P-wave shadow region. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. Level 2 (3–4 marks) Explains one set of observations in terms of the properties of the waves, or describes both patterns with limited explanation. There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence. Level 1 (1–2 marks) Simple statements about the waves or the core, or describes some results from Table 14.1. The information is basic and communicated in an unstructured way. 0 marks No response or no response worthy of credit.	6	2.1 ×2 3.1a ×2 3.2a ×2	Indicative scientific points may include: AO2.1 application • S-waves reach A and B (30°, 80°) through the solid mantle only • no S-waves at C, D, E (120°, 150°, 180°): their paths pass through a liquid • so at least part of the core is liquid • P-waves reach D and E, so they travel through the core AO3.1a / AO3.2a analysis and conclusions • the S-wave shadow region begins between 80° and 120°; the data do not locate it more precisely • no P-waves at C, but P-waves again at D and E • P-waves refract (change speed and direction) at the core boundary, leaving a P-wave shadow region • more stations would locate the boundaries more precisely The indicative points are not a checklist. Credit other relevant, correct points. ALLOW "the outer core is liquid" as extra knowledge; it is not required for Level 3. Interpret the table only at the resolution given: no real-world angles are required. An answer saying S-waves are not detected because they are too weak or too slow cannot reach Level 3.

Specification coverage

The questions in this paper have been mapped to relevant content and/or assessment skills in both OCR Physics A (Gateway Science) J249 and OCR Physics B (Twenty First Century Science) J259. For teachers; not part of the student paper.

Question	Gateway J249	Twenty First Century J259	AO	Marks
1	P5.1e, P5.1j	P1.3.3, P1.3.4	AO1.1	1
Question 1 total				1
2	P5.1a, P5.1b	P1.3.1, P1.3.5	AO1.1	1
Question 2 total				1
3	P5.1c, P5.1d	P1.3.6	AO2.2	1
Question 3 total				1
4	P5.1f	P1.4.9	AO1.1	1
Question 4 total				1
5	P5.1e, P5.1k	P1.3.2, P1.3.3	AO1.1	1
Question 5 total				1
6	P5.1g	P1.4.4	AO2.1	1
Question 6 total				1
7	P5.2i	P1.4.8	AO1.1	1
Question 7 total				1
8	P5.1j, PM2.1i	P1.3.7	AO2.2	1
Question 8 total				1
9(a)	WS1.3g	laS2.9	AO3.1a	1
9(b)	WS1.3c	laS2.8	AO2.2 ×2	2
9(c)	P5.1j, PM2.1i, WS1.4e	P1.3.7, laS2.5	AO2.2 ×3	3
9(d)	WS1.2c	laS1.2	AO1.2 ×2	2
Question 9 total				8
10(a)	P5.1c, P5.1d	P1.3.6	AO2.2 ×2	2
10(b)	P5.1f	P1.4.9	AO1.1	1
10(c)	P5.1d, P5.1f	P1.3.6, P1.4.9	AO2.2 ×2	2
10(d)	P5.1f	P1.4.9	AO1.1 ×2	2
Question 10 total				7
11(a)	P5.1h	P1.4.6, P1.4.7	AO1.1 ×3	3
11(b)	P5.1i	P1.4.7	AO1.1, AO2.1	2
11(c)	P5.1h	P1.4.6	AO2.1 ×2	2
Question 11 total				7
12(a)	P5.1g, P5.2i	P1.4.8	AO1.1 ×2	2

Question	Gateway J249	Twenty First Century J259	AO	Marks
12(b)	P5.2i, PM2.1i	P1.4.8, IaS2.11	AO3.1a, AO2.2 ×2	3
12(c)	P5.2i, PM2.1i	P1.4.8, IaS2.11	AO3.1a, AO2.2	2
12(d)	P5.2i	P1.4.8	AO1.1	1
Question 12 total				8
13(a)	P5.1g, PM2.1i	P1.4.8	AO2.2 ×3	3
13(b)	P5.1g	P1.4.4, P1.4.8	AO2.1, AO3.2a	2
Question 13 total				5
14	P5.1e, WS1.3e	P1.3.10, P1.4.8, IaS2.11	AO2.1 ×2, AO3.1a ×2, AO3.2a ×2	6
Question 14 total				6
Paper total				49

Assessment objectives in this paper

Assessment objective	Marks
AO1 knowledge and understanding	17 (35%)
AO2 applying knowledge and understanding	24 (49%)
AO3 analysing, interpreting and evaluating	8 (16%)
Total	49