Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Sound

Time allowed: 1 hour

Subject code **0625**

Physics

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 64

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 64 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 A student strikes a tuning fork on a wooden block. The tuning fork is held close to the students' ear as shown in Fig. 8.1.



Fig. 8.1

(a) Describe how the tuning fork produces sound.

..... [1]

(b) State the normal frequency range of sounds that humans can hear. Give the unit.

from ..... to ..... [2]

(c) Two students determine a value for the speed of sound in air. Fig. 8.2 illustrates the method they use.

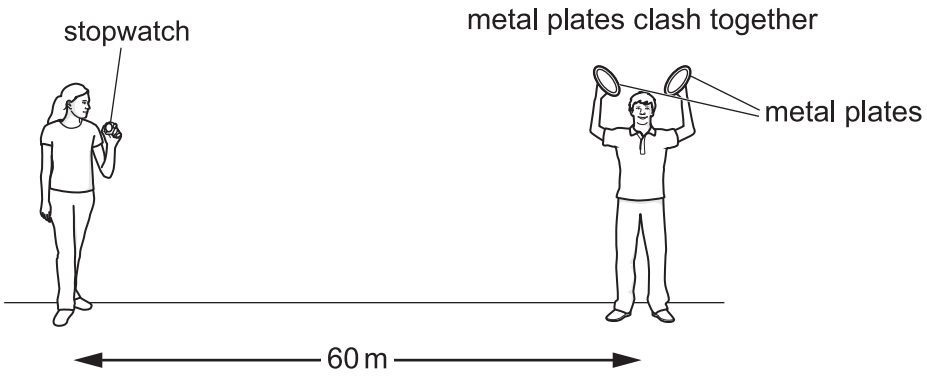


Fig. 8.2 (Not to scale)

The girl starts the stopwatch when she sees the metal plates clash together. She stops the stopwatch when she hears the sound of the clashing metal plates. The students use the time on the stopwatch to calculate the speed of sound.

The value for the speed of sound obtained by the students is different from the true value for the speed of sound in air.
Explain why the students' value is different.

.....

.....

..... [1]

[Total: 4]

Sound Click for more variations

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Reduced to 77% to fit the page (wider than A4).

1(a)	vibrations OR oscillations	
1(b)	20 to 20 000	B1
	hertz OR Hz	B1
1(c)	reaction time OR distance / time interval is too small	B1

2 A stretched string is vibrating between two fixed ends. Fig. 8.1 shows how the string is vibrating.

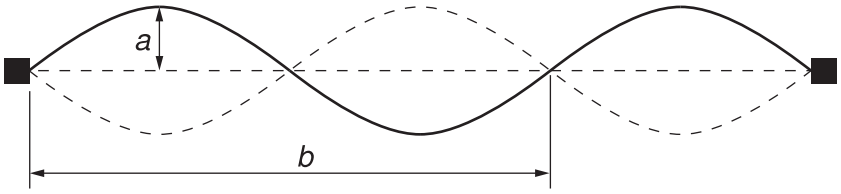


Fig. 8.1

(a) State the name of

(i) distance *a*, ... [1]

(ii) distance *b*. ..... [1]

(b) The string is causing a sound to be transmitted through the air.

(i) Describe how the string causes the sound.

.....

.....

.....

.....

..... [2]

(ii) State what happens to the sound as the distance *a* decreases.

.....

..... [1]

[Total: 5]

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Properties of waves Click for more variations

2 **(a)** **(i)** amplitude B1

(ii) wavelength B1

(b) **(i)** string moves air M1
backwards & forwards OR up & down
OR compressions & rarefactions A1

(ii) gets quieter/softer/less loud B1

[Total: 5]

3 A sound wave is a longitudinal wave.

Fig. 7.1 shows a spring being used to demonstrate a longitudinal wave.

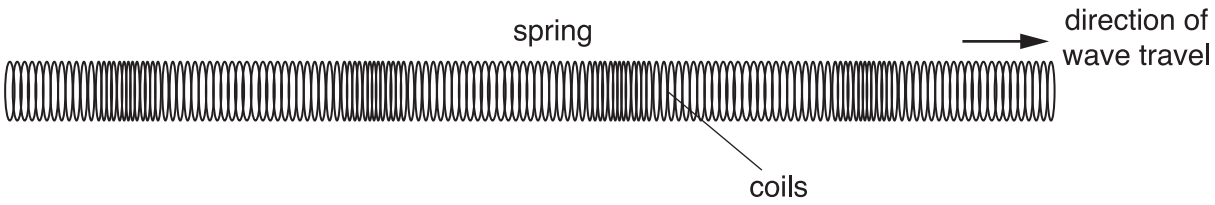


Fig. 7.1

(a) The coils of the spring vibrate.

Draw **two** arrows on Fig. 7.1 to show the directions of the vibrations. [2]

(b) Through which of these is sound **not** able to travel? Tick **one** box.

- ☐ air
- ☐ steel
- ☐ vacuum
- ☐ water

[1]

(c) **(i)** Very old people cannot hear the highest frequencies of sound that can be heard by young people.

Suggest the highest frequency that very old people can hear.

.....[2]

(ii) State the meaning of the term *ultrasound*.

.....[1]

[Total: 6]

Properties of waves Click for more variations

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3(a)	horizontal arrows by eye	**B1**
	arrows pointing in opposite directions	**B1**
3(b)	3rd box ticked *vacuum*	**B1**
3(c)(i)	value less than 20 000	**B1**
	Hz	**B1**
3(c)(ii)	sound with frequency above upper (frequency) limit of human hearing	**B1**
	Total:	**6**

4 A metal rail is 330 m long. Sound travels at 5000 m/s in the metal.

(a) Calculate the time taken for a sound to travel the length of the rail.

time taken = ... s [3]

(b) Sound in air takes 1.0 s to travel 330 m.

As shown in Fig. 6.1, a man puts his right ear against one end of the rail. Another man strikes the other end of the rail with a hammer.

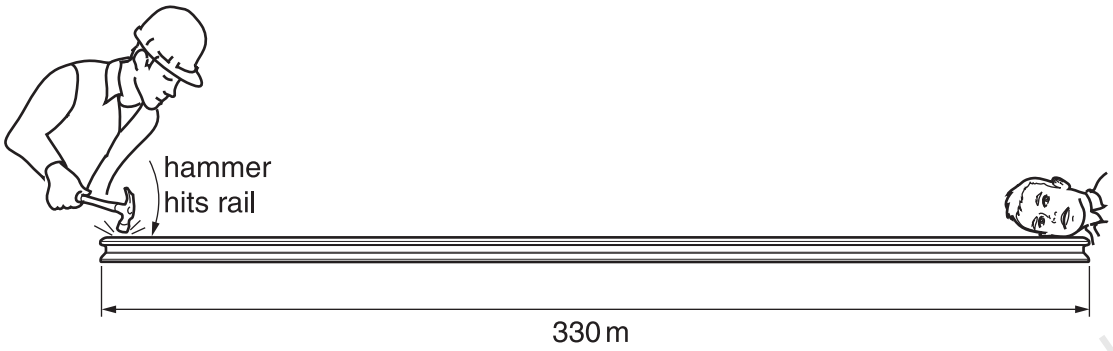


Fig. 6.1 (not to scale)

Describe and explain what each man hears.

man with hammer .....

.....

man with one ear against rail.....

.....

.....

[3]

[Total: 6]

Motion Click for more variations

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4	**(a)**	speed = distance / time in words, symbols or numbers **OR** distance / speed	C1
		330 / 5000	C1
		0.066 (s), allow 0.07 (s) (to one significant figure)	A1
	(b)	man with hammer hears one sound accept hears the sound almost instantly / first	B1
		other man hears two sounds **OR** 1 through air and 1 through rail **NOT** hears two sounds, one is an echo	B1
		any one from: hears sound through rail before sound through air calculation of time difference between sounds because (speed of sound) in metal/steel faster than (speed of) sound in air	B1

[Total: 6]

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5 A boat is using echo-sounding equipment to measure the depth of the water underneath it, as illustrated in Fig. 6.1.

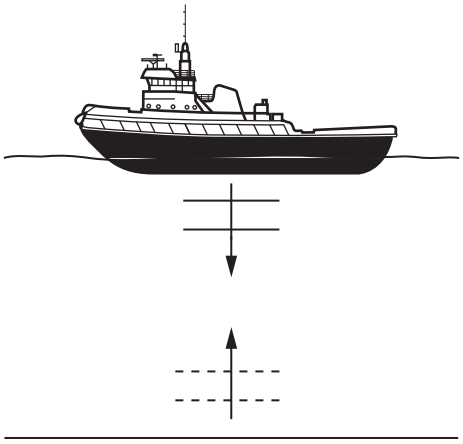


Fig. 6.1

(a) The equipment in the boat sends a short pulse of sound downwards and detects the echo after a time interval of 0.80 s.

(i) Describe how an echo is caused.

.....

.....

.....[2]

(ii) The speed of sound in water is 1500 m/s.
Calculate the distance travelled by the sound in 0.80 s.

distance travelled = ... m [3]

(iii) State the depth of water under the boat.

depth = ...m [1]

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(b) The boat is sailing away from the shore. The depth of water increases uniformly with distance from the shore.

On Fig. 6.2, sketch a graph that shows how the time interval to hear the echo might change as the distance from the shore changes.

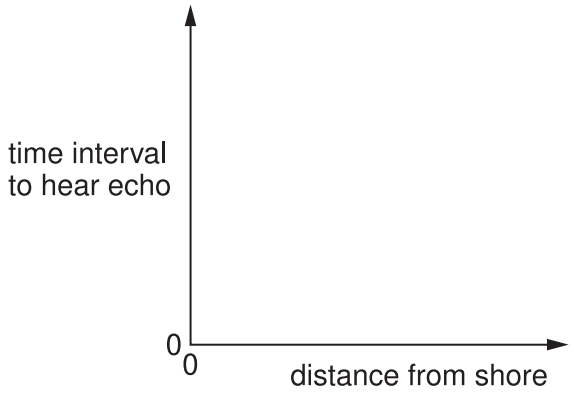


Fig. 6.2

[2]

[Total: 8]

Sound Click for more variations

5 **(a)** **(i)** reflection OR wave bounces back M1
from large object/sea bed A1

(ii) speed = distance/time in any form C1
1500 × 0.8 C1
1200 (m) A1

(iii) 600 (m) OR ½ × candidate's **(ii)**, correctly evaluated B1

(b) line with positive gradient M1
straight line OR meets horizontal axis to right of graph origin A1 [8]

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6 Ultrasound is an example of a longitudinal wave.

(a) Define the term ultrasound.

..... [1]

(b) Describe what is meant by a longitudinal wave.

.....

..... [1]

(c) Ultrasound is used to locate objects below the surface of the sea.

(i) Describe how ultrasound is used to locate an object below the surface of the sea.

You may draw a labelled diagram as part of your answer.

.....

.....

.....

.....

[3]

(ii) State **one** other use of ultrasound.

.....

..... [1]

[Total: 6]

Sound Click for more variations

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6(a)	sound with a frequency higher than 20 kHz	**B1**
6(b)	vibrations (of the wave / particles) are parallel to the direction of propagation	**B1**
6(c)(i)	(pulse of) ultrasound / sound / wave (sent into water) reflects from object	**B1**
	time to travel to object and back measured	**B1**
	depth = speed × time	**B1**

6(c)(ii)	any **one** from: • non-destructive testing of materials • medical scanning (of soft tissue)	**B1**

7 A fisherman uses high frequency sound waves to locate fish in the sea. Fig. 8.1 shows the sound waves emitted from the boat.

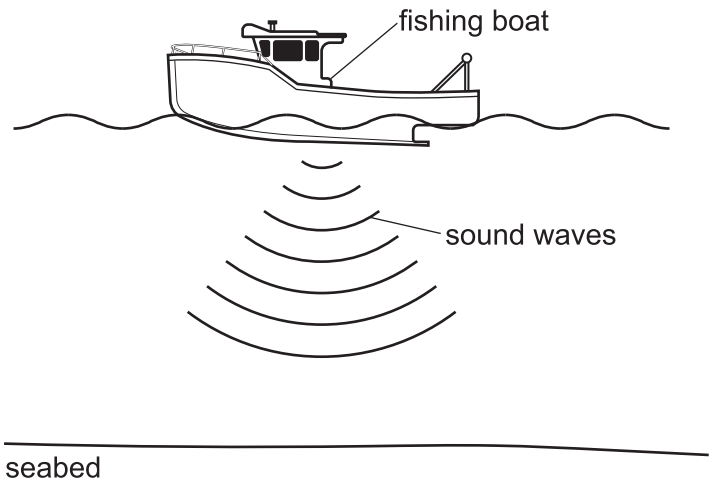


Fig. 8.1 (not to scale)

(a) State the name of sound waves which have a frequency greater than 20 kHz.

..... [1]

(b) High frequency sound waves travel from the boat through the sea water.
The speed of sound in water is 1500 m / s. The seabed is 22 m below the boat.

Calculate the time taken for the boat to receive the reflected wave from the seabed after the sound is emitted.

time = ... [3]

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(c) Fig. 8.2 shows a fish below the boat.

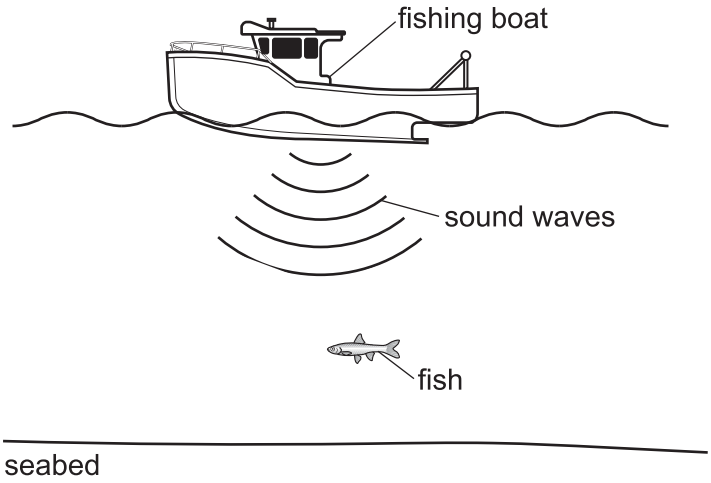


Fig. 8.2 (not to scale)

Describe and explain how the reflected sound wave received by the boat from the fish differs from the reflected sound wave received from the seabed.

.....

.....

..... [2]

[Total: 6]

Sound Click for more variations

Reduced to 78% to fit the page (wider than A4).

7(a)	ultrasound	**B1**
7(b)	0.029 s	**A3**
	(distance travelled =) 22 × 2 **OR** 44 SEEN	C1
	$v = s / t$ OR (t =) s / v OR 44 / 1500	C1
7(c)	reflected wave is weaker / has smaller amplitude	**M1**
	fish is small(er) **OR** only small part of wave reflects off fish OR most of sound goes to seabed	**A1**

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8 **(a)** **(i)** State a typical value for the speed of sound in air.

speed = ...[1]

(ii) State the range of frequencies that can be heard by a healthy human ear.

.....[1]

(b) A sound wave in air has a wavelength of 22 mm.

Fig. 6.1 represents wavefronts of this sound. These wavefronts are successive compressions.

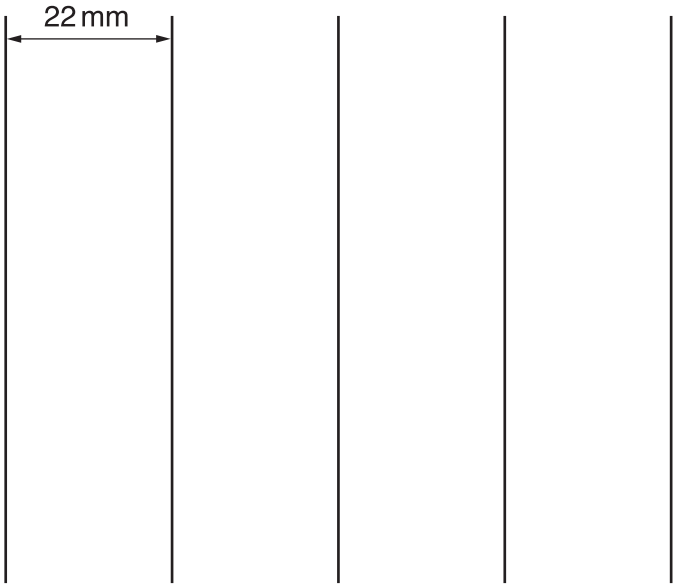


Fig. 6.1

(i) Using your value for the speed of sound in **(a)(i)**, calculate the frequency of the sound wave.

frequency = ...[2]

(ii) On Fig. 6.1, draw dotted lines to represent **three** different rarefactions. [1]

(iii) State, in terms of both molecules and pressure, what is meant by a *rarefaction*.

.....

.....

.....

.....[2]

[Total: 7]

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8(a)(i)	300 – 360 m / s	**B1**
8(a)(ii)	20 Hz – 20 kHz	**B1**
8(b)(i)	v = fλ OR (f =) v / λ OR (a)(i) / 0.022 Correct answer: e.g. 330 m / s gives 15 000 Hz	**C1** **A1**
8(b)(ii)	Vertical dotted lines midway (by eye) between each pair of compressions OR to right or left of compressions shown with correct spacing (by eye)	**B1**
8(b)(iii)	(At rarefactions) molecules have above normal separation / far apart / spread out Pressure (of air) is below normal / low OR Molecules exert below normal / low pressure	**B1** **B1**
	Total:	**7**

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9 **(a)** State the range of frequencies of sound which can be heard by a healthy human ear.

.....[1]

(b) Compressions and rarefactions occur along the path of sound waves.

State, in terms of the behaviour of molecules, what is meant by

(i) a *compression*,

.....

.....

(ii) a *rarefaction*.

.....

.....
[2]

(c) State 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 1.9 s later.

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

Calculate the speed of sound given by this experiment.

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speed = ...[3]

[Total: 8]

Sound Click for more variations

9 **(a)** 15–25 Hz to 15 000–25 000 Hz / 15–25 kHz B1

(b) **(i)** (region) where air layers/molecules/particles are pushed together/moved together/closer (than normal)
OR (region) where (air) pressure raised/air (more) compressed/more dense B1

(ii) (region) where air layers/molecules are pushed apart/far(ther) apart (than normal)
OR (region) where (air) pressure reduced/air expanded B1

(c) **(i)** (sound is) loud(er) OR volume (of sound is) increased B1

(ii) sound has a higher frequency/pitch OR higher note (heard) B1

(d) 3.5 – 1.9 OR 1.6 (s) seen OR $v = 2d/1.9$ C1
250×2 OR 500 (m) seen OR $v = (2d + 500)/3.5$ C1
(speed = 500 / 1.6 =) 312.5 m / s at least 2 sig. figs A1

[Total 8]

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10 A dolphin communicates with other dolphins underwater by emitting sounds in the range 7–15 kHz.

(a) State the value of the speed of sound in air and state how the speed of sound in water differs from the speed of sound in air.

speed of sound in air ..... m/s

speed of sound in water .....

[1]

(b) State and explain if humans with normal hearing can hear all the sounds emitted by the dolphin.

statement .....

explanation .....

.....

[2]

(c) Complete Table 5.1 to describe differences in loudness and pitch of two different dolphin sounds.

Table 5.1

Frequency /kHz	amplitude	loudness	pitch
14	large		
8	small		

[2]

(d) Complete the sentences to describe how sound is transmitted through water.

Sound waves are made of vibrating ..... which produce compressions and rarefactions. A compression is a region of ..... and a rarefaction is a region of ..... . The sound waves travel ..... to the direction of the vibrations.

[3]

[Total: 8]

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10(a)	(speed of sound in air =) 330 m / s ⩽ value ⩽ 350 m / s **AND** (speed of sound in water) is faster	**B1**
10(b)	Yes **AND** (normal) human hearing range is 20 Hz to 20 kHz (and all dolphin sounds lie in this range)	**A2**
	Yes **AND** all the dolphin sounds are in the range of human hearing	C1

10(c)	<table><tr><td>Frequency kHz</td><td>amplitude</td><td>loudness</td><td>pitch</td></tr><tr><td>14</td><td>Large</td><td>**loud**</td><td>**high**</td></tr><tr><td>8</td><td>small</td><td>**soft / quiet**</td><td>**low**</td></tr></table> one mark for each column correct	**B2**
10(d)	Particles	**B1**
10(d)	high pressure **AND** low pressure	**B1**
	Parallel	**B1**

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