3. Waves

3.4 Sound

Paper 3 and 4

Question Paper

Paper 3

Questions are applicable for both core and extended candidates

1 Fig. 6.1 shows some students near some rocky cliffs looking at a boat at sea. The students watch a firework display on the boat. One of the fireworks bursts and makes a loud sound.

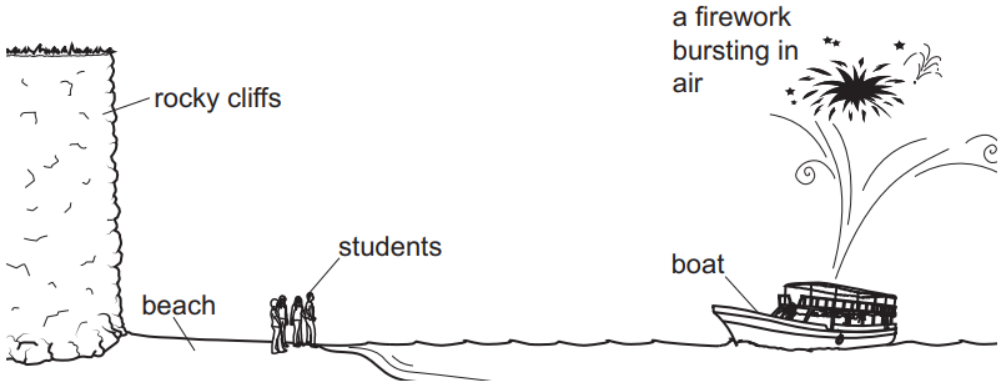


Fig. 6.1 (not to scale)

(a) The students hear a loud sound from the firework and then they hear a quieter, similar sound.

State what causes the second quieter, similar sound.

..... [1]

(b) The time from when the students see the firework burst to when they hear the first, loud sound is 1.3 s.

Calculate the distance from the firework to the students.

Use the speed of sound in air = 340 m / s.

distance to firework = ... m [3]

[Total: 4]

2 A student can hear trains passing her house.

(a) Describe the motion that a sound wave gives to air particles.

..... [1]

(b) When the student is at her house, she can hear and see the trains, as shown in Fig. 7.1.

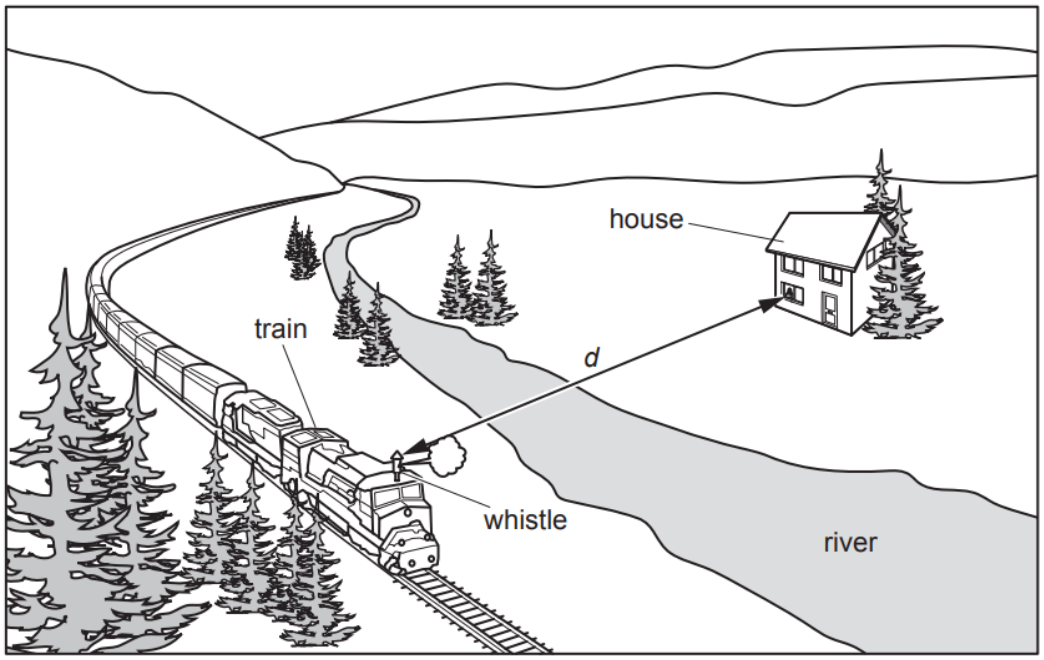


Fig. 7.1 (not to scale)

When a train whistle blows, steam comes out of the whistle.

The student measures the time interval between seeing the steam coming out of the whistle and hearing the whistle.

(i) Suggest a suitable device for measuring this time interval.

..... [1]

(ii) The time interval is 1.6 s between the steam coming out of the whistle and the student hearing the whistle.

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

Calculate the distance *d* from the whistle to the student.

distance *d* = ... m [3]

(c) State the range of audible frequencies for a healthy human ear. Include the unit.

..... [2]

[Total: 7]

3 An observer stands at P and looks into a rock quarry. A small explosion takes place at X in the quarry.

Fig. 5.1 shows the situation.

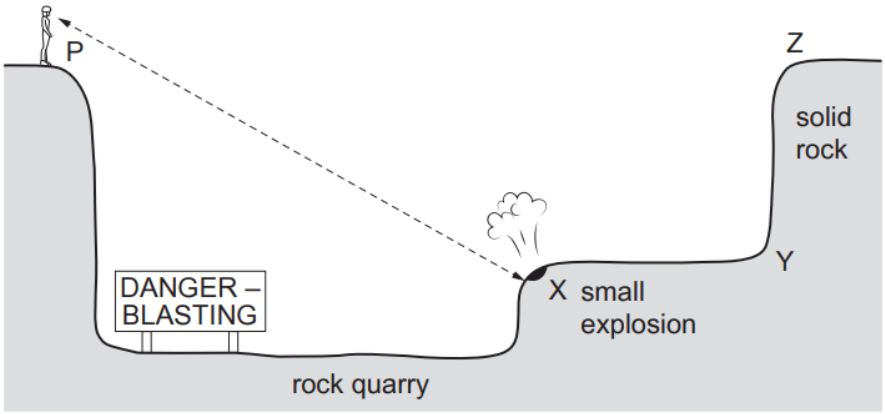


Fig. 5.1 (not to scale)

(a) The observer first hears the sound from the explosion 1.8 s after the explosion occurs. The speed of the sound is 340 m/s.

(i) Calculate the distance XP from the explosion at X to the observer at P.

distance XP = ... m [3]

(ii) The observer then hears a quieter sound from the explosion.

Suggest how the quieter sound waves reach the observer.

.....

..... [2]

(b) Before the explosion, a warning siren produces a sound. The wavelength of the sound is 0.28 m.

The speed of the sound is 340 m/s.

Calculate the frequency of the sound.

frequency = ... Hz [3]

[Total: 8]

4 **(b)** Two students, A and B, use echoes to measure the speed of sound.
Student A has two blocks of wood that make a loud sound when banged together. Student B has a stop-watch. They stand 120 m from a school wall as shown in Fig. 6.2.

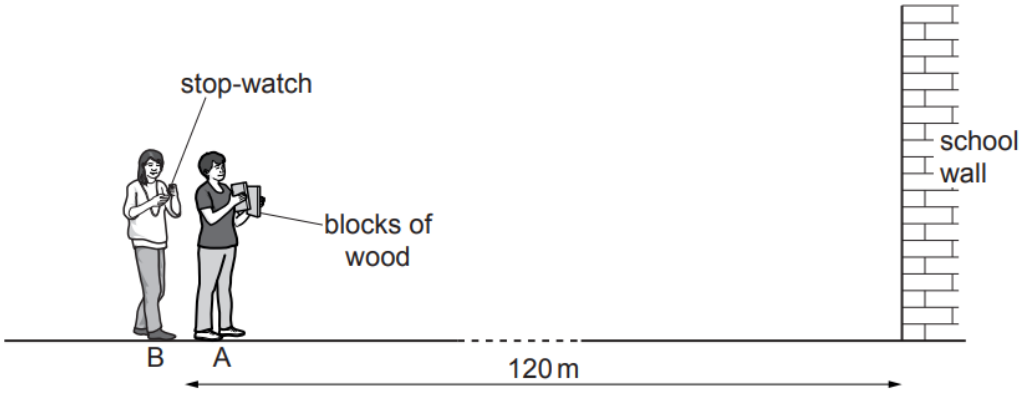


Fig. 6.2 (not to scale)

Describe how the students use the arrangement in Fig. 6.2 to determine the speed of sound in air.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 7]

5 **(a)** A loudspeaker is producing a sound.

Choose words from the box to complete the sentences about sound.

amplitude	frequency	speed	wavelength

(i) To increase the loudness of the sound, increase the ..... of the sound wave. [1]

(ii) To increase the pitch of the sound, increase the ..... of the sound wave. [1]

(b) Two students determine the speed of sound in air.
The students stand together, 80 m from a large brick wall as shown in Fig. 8.1.

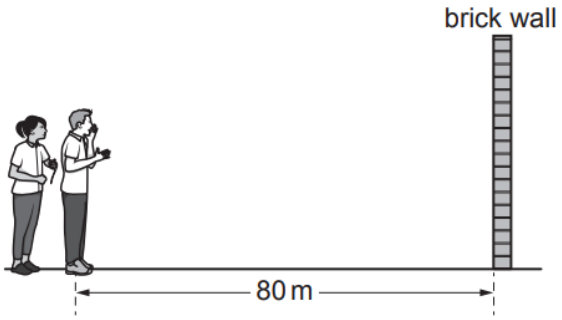


Fig. 8.1 (not to scale)

One student shouts and as he shouts the other student starts a stop-watch. She stops the stop-watch when she hears the echo of the shout.
The reading on the stop-watch is 0.56 s.

(i) State the **total** distance the sound travels during the 0.56 s.

distance = ... m [1]

(ii) Calculate the speed of sound in air using the measurements given in part **(b)**.

speed of sound = ... m/s [3]

(iii) The students' value for the speed of sound is **not** accurate.

Suggest **two** ways of improving the students' experiment.

1. .....

2. .....
[2]

[Total: 8]

6 Fig. 8.1 represents the pressure at one instant along part of a sound wave.

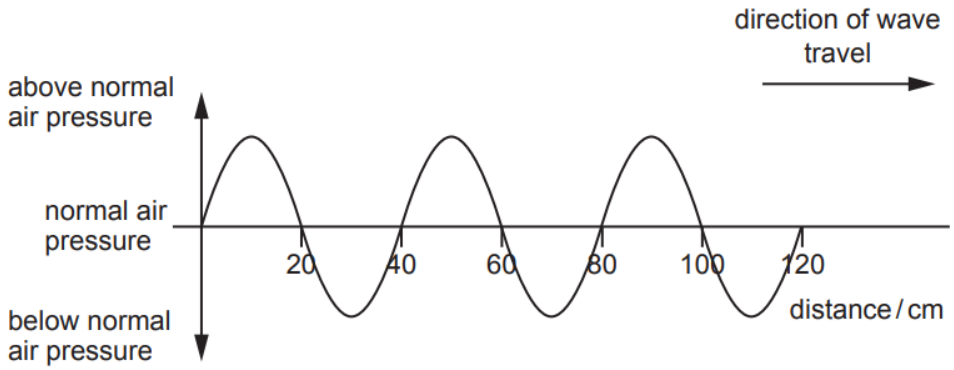


Fig. 8.1

(a) **(i)** Determine the wavelength of the sound wave.

wavelength of the sound wave = ... cm [1]

(ii) On Fig. 8.1, draw a wave representing a louder sound of the same wavelength. [1]

(b) State the range of audible frequencies for a healthy human ear. Include the unit.

..... [2]

[Total: 4]

7 Sound travels as a wave.

(a) Complete each sentence.

Sound is produced when an object ..... .

An echo is produced when sound is ..... from a hard surface.

Compared with a quiet sound, a loud sound always has a greater ..... .

Compared with a high pitched sound, a low pitched sound always has a smaller ..... .

Waves transfer energy without transferring ..... .

[5]

(b) State the meaning of the term ultrasound.

..... [1]

[Total: 6]

8 **(a)** Fig. 8.1 shows a student listening to the sound produced by a tuning fork.

Fig. 8.1

(i) State how the tuning fork produces the sound.

..... [1]

(ii) Complete the following sentence. Choose a word from the box.

electromagnetic	longitudinal	transverse

A sound wave is ..... [1]

(iii) A loudspeaker produces a sound with a frequency of 25 kHz.

A student with healthy ears cannot hear this sound. Explain why.

.....

..... [2]

(b) Fig. 8.2 represents a sound wave travelling in air.

Fig. 8.2 (drawn full size)

(i) The air particles are moving. On Fig. 8.2, draw **two** arrows in opposite directions to show the movement of the air particles. [1]

(ii) Use Fig. 8.2 to determine the wavelength of the sound wave.

wavelength = ... cm [1]

(c) Describe a method of using water waves to demonstrate refraction.

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

9 A boat race starts on the sea, but close to land. Fig. 9.1 shows the boats at the start of the race.

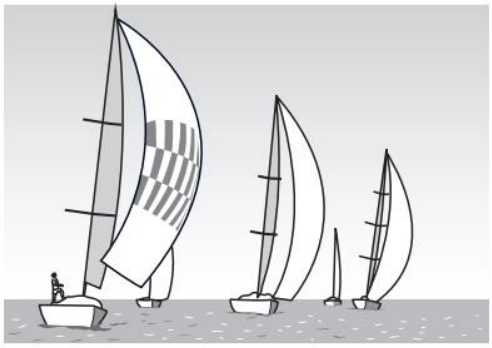


Fig. 9.1

On the land, a cannon produces a loud bang to start the race. There is a flash of light at the same time as the bang.

(a) (i) At the start of the race, the sailors watch for the flash of light from the cannon.

Suggest why the sailors watch for the flash of light rather than listen for the bang.

.....

..... [1]

(ii) One of the sailors is 500 m from the cannon. She measures a time difference of 1.6 seconds between seeing the flash of light and hearing the bang.

Calculate the speed of sound.

speed of sound = ... m/s [3]

(iii) The value of the speed of sound obtained in **(a)(ii)** is lower than expected.

Suggest a reason for this difference.

.....

..... [1]

(b) The race is held close to a part of the coast with high cliffs. A sailor hears a second bang shortly after the first bang.

State the term for the second bang and explain how it is produced.

term .....

explanation .....

[2]

[Total: 7]

10 **(a)** Fig. 8.1 shows a tuning fork and a wooden block.

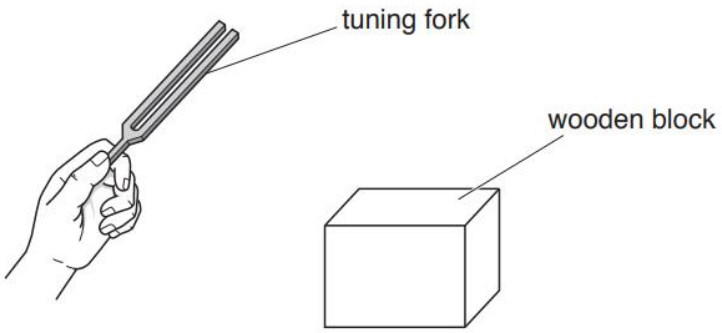


Fig. 8.1

(i) The tuning fork is hit against the wooden block and then makes a sound.

Describe how the tuning fork produces the sound.

.....

.....[1]

(ii) The tuning fork produces a sound with a frequency of 659 Hz.

State whether a healthy human ear can hear this frequency of sound. Explain your answer.

.....

.....[2]

(b) Fig. 8.2 represents the sound wave produced by a tuning fork.

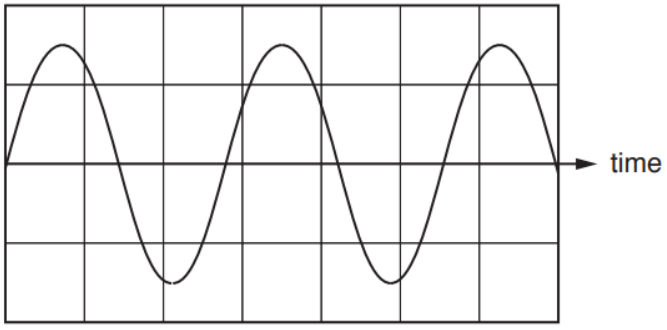


Fig. 8.2

A second tuning fork produces a different sound.

Compared with the sound represented in Fig. 8.2, this sound is quieter and has half the frequency.

On Fig. 8.2, draw the wave to show the sound produced by the second tuning fork. [2]

[Total: 5]

11 **(a)** A healthy human ear can hear a range of frequencies.

Three frequency ranges are shown.

Draw a ring around the range for a healthy human ear.

0 Hz – 20 Hz 10 Hz – 10 000 Hz 20 Hz – 20 000 Hz

[1]

(b) Explain the meaning of the term *ultrasound*.

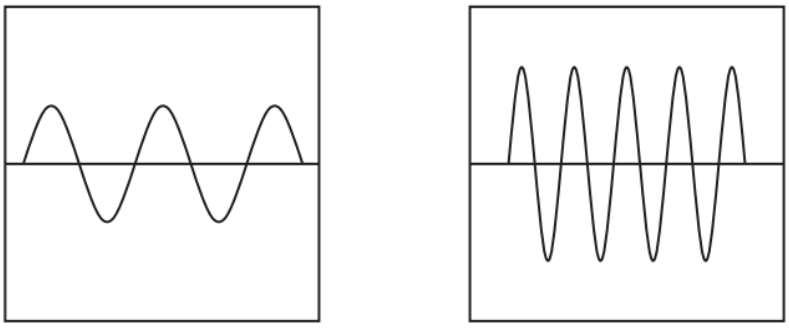
.....

..... [2]

(c) A student listens to two different sounds, P and Q.

The two different sounds are represented on a computer screen on the same scale.

Fig. 8.1 shows the screens.



sound P sound Q

Fig. 8.1

State and explain how sound P is different from sound Q.

.....

.....

.....

..... [3]

[Total: 6]

12 This question is about measuring the speed of sound in air.

A student stands in front of a large wall. She hits a drum and hears an echo. Fig. 8.1 shows the position of the student and the wall.

Fig. 8.1

(a) (i) State the name of a piece of equipment for measuring the distance from the student to the wall.

.....[1]

(ii) Explain how sound forms an echo.

.....

.....[1]

(b) The student hits her drum repeatedly once per second. She walks away from the wall and listens for the echo. When the student is 170 m from the wall she hears the echo from one beat of the drum at the same time as the next beat of the drum.

Use this information to determine the speed of sound. State the unit.

speed = ... [4]

[Total: 6]

13 **(a)** Complete the sentences about sound. Use words from the box above each sentence.

(i)

glows	reflects	refracts	vibrates

Sound is produced when a source ..... . [1]

(ii)

electromagnetic	longitudinal	transverse

Sound waves are ..... waves. [1]

(iii)

metal	vacuum	liquid

Sound waves cannot travel through a ..... . [1]

(b) Humans, elephants, mice and dolphins have different hearing ranges. Fig. 8.1 shows the hearing range for each type of animal.

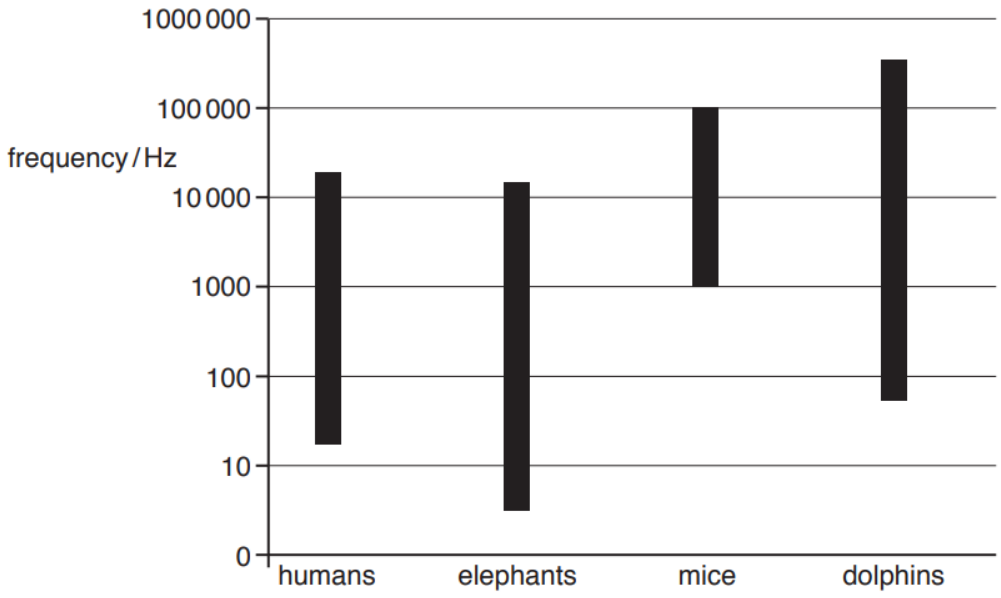


Fig. 8.1

(i) State the lowest frequency of sound that can be heard by mice.

..... Hz [1]

(ii) State the highest frequency of sound that can be heard by elephants.

..... Hz [1]

(iii) Explain how the chart shows that elephants can hear some sounds that humans **cannot** hear.

.....

.....

.....[2]

(iv) State the term given to the high frequencies that dolphins can hear but humans **cannot** hear.

.....[1]

[Total: 8]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

14 A loudspeaker produces a sound wave in air. The distance between the centre of a compression and the centre of a neighbouring rarefaction is 0.10 m.

(a) Calculate the wavelength of the sound wave.

wavelength = ... [1]

(b) State a typical value for the speed of sound in air.

..... [1]

(c) **(i)** Calculate the frequency of the sound from the loudspeaker.

frequency = ... [2]

(ii) Explain whether the sound from the loudspeaker is audible to a human with normal hearing.

.....

..... [1]

(d) Another loudspeaker produces a sound of wavelength 0.40 m. Sound from the loudspeaker reaches a sound absorbing surface with a gap of width 0.80 m at the centre.

Fig. 5.1 shows the arrangement. **(extended only)**

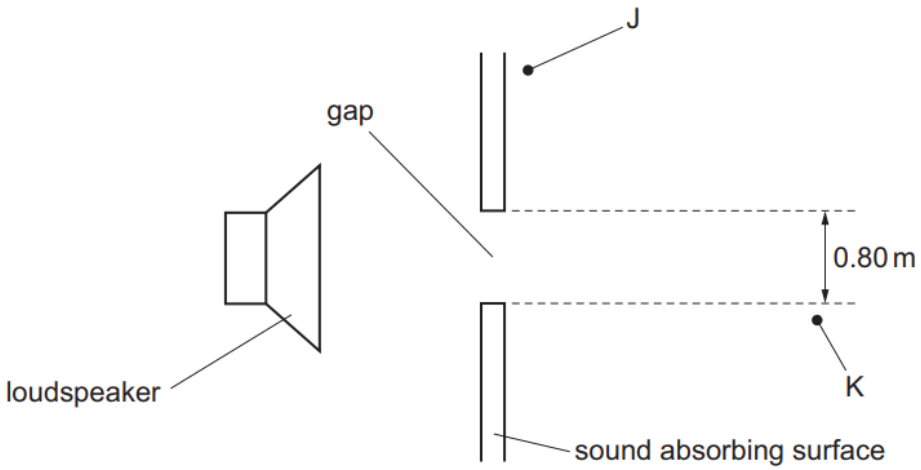


Fig. 5.1

Explain whether it is possible to detect sound from the loudspeaker at either point J or at point K.

point J .....

.....

.....

point K .....

.....

.....

[4]

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

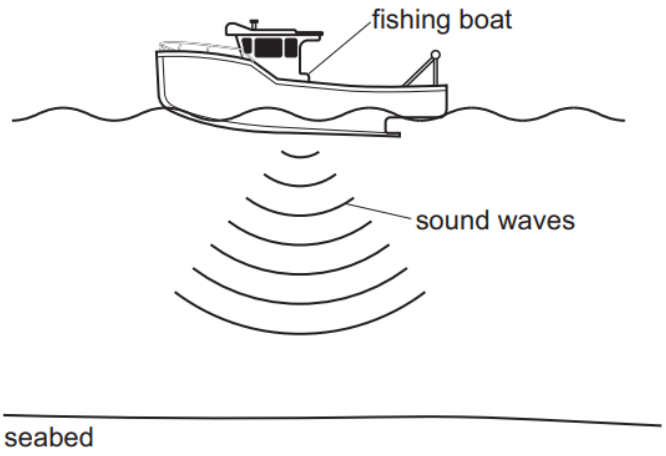


Fig. 8.1 (not to scale)

(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. **(extended only)**
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]

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

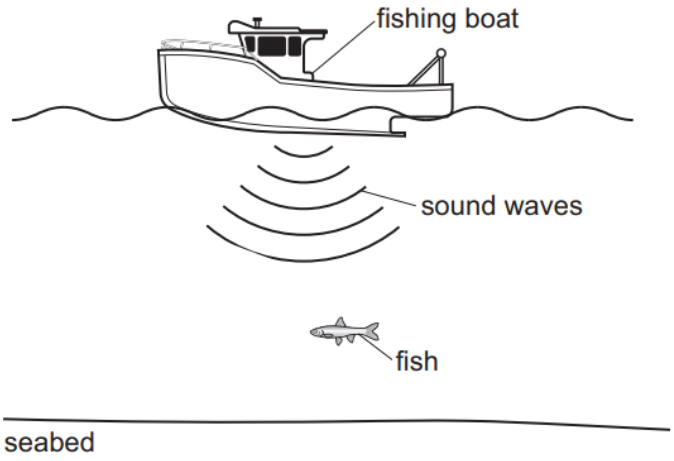


Fig. 8.2 (not to scale)

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]

16 **(a)** A sound wave travels through air. Fig. 6.1 shows a pressure–time graph for the air at one place.

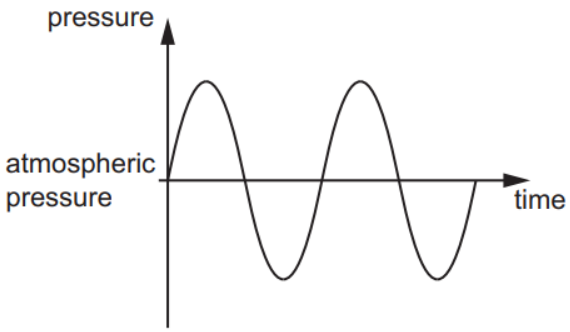


Fig. 6.1

(i) On Fig. 6.1: **(extended only)**

- label **one** point C to indicate a compression
- label **one** point R to indicate a rarefaction.

[2]

(ii) Explain why this graph **cannot** be used to find the wavelength of the sound wave.

.....

..... [1]

(iii) The sound becomes louder and of lower pitch.

State what happens to:

the amplitude of the sound

.....

the frequency of the sound.

.....

[1]

(b) A sound of frequency 13 kHz is transmitted through water.
The speed of sound in water is 1500 m/s.

Calculate the wavelength of this sound in water.

wavelength = ... [3]

(c) State the approximate speed of sound in air.

speed = ... [1]

[Total: 8]

17 Fig. 6.1 shows particles of a material in which a sound wave is travelling.

Fig. 6.1 (not to scale)

(a) On Fig. 6.1, mark: **(extended only)**

(i) the centre of a compression with the letter C [1]

(ii) the centre of a rarefaction with the letter R [1]

(iii) one wavelength with a double-ended arrow. [1]

(b) Circle **one** value from the list which is the speed of sound in water. **(extended only)**

15 m/s **150 m/s** **1500 m/s** **15 000 m/s** **150 000 m/s** **1 500 000 m/s** [1]

(c) The wavelength of a sound wave in water is 12 cm. **(extended only)**

Calculate the frequency of this sound wave using your value from **(b)**.

frequency = ... [3]

(d) State and explain whether the sound in **(c)** is ultrasound. **(extended only)**

statement .....

explanation .....

.....

.....

[2]

[Total: 9]

18 Fig. 6.1 is a full-scale diagram that represents a sound wave travelling in air. **(extended only)**

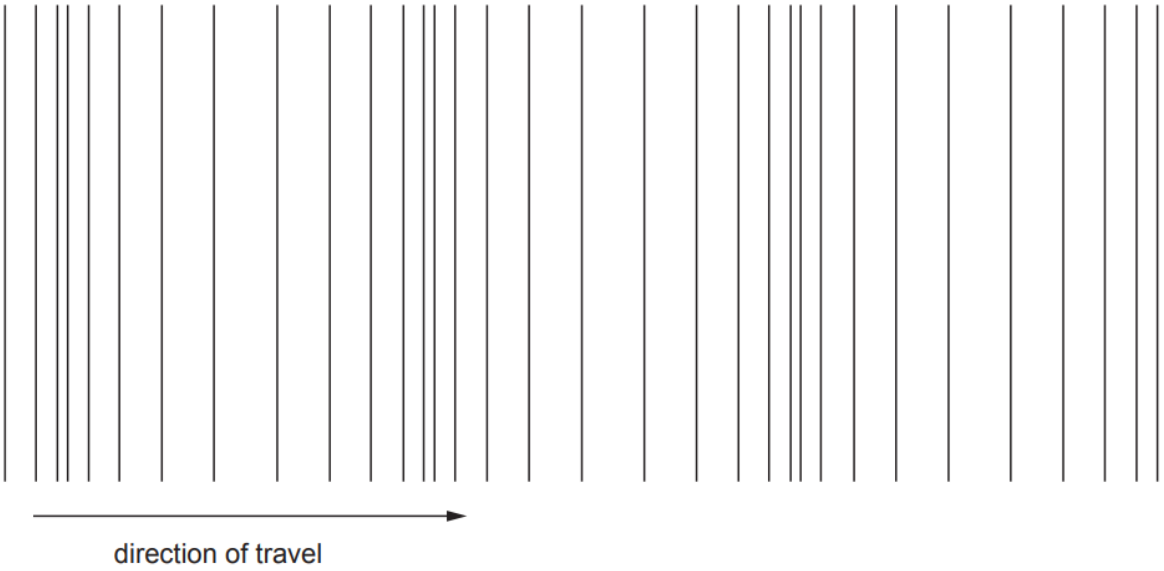


Fig. 6.1

(a) On Fig. 6.1, mark **two** points, each at the centre of a different compression. Label both of the points C. [1]

19 Sound waves are longitudinal and electromagnetic waves are transverse.

(a) A sound wave used for a medical examination has a frequency of 1.5 MHz.

(i) State and explain what type of sound wave this is.

.....

..... [2]

(ii) The wave travels through soft human tissue at a speed of 1.3 km / s.

Calculate the wavelength of the wave in soft human tissue.

wavelength = ... [3]

(b) Describe **one** use of X-rays in medicine.

.....

..... [2]

[Total: 7]