3.4 Sound

01. 0625_s22_qp_42 Q: 5

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]

02. 0625_s22_qp_43 Q: 6

(a) (i) Fig. 6.1 shows crests of a plane water wave approaching a barrier with a gap.

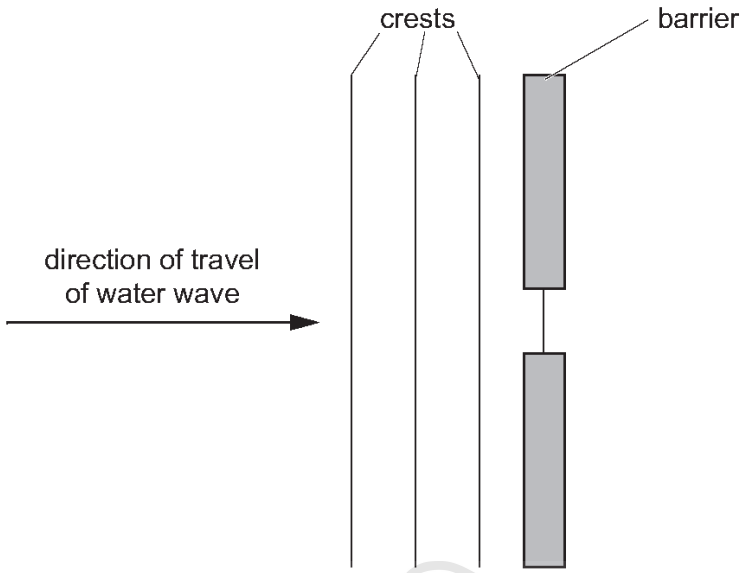


Fig. 6.1

On Fig. 6.1, draw **three** crests of the water wave to the right of the barrier. [2]

(ii) Fig. 6.2 shows crests of a plane water wave in deep water approaching a region of shallow water.

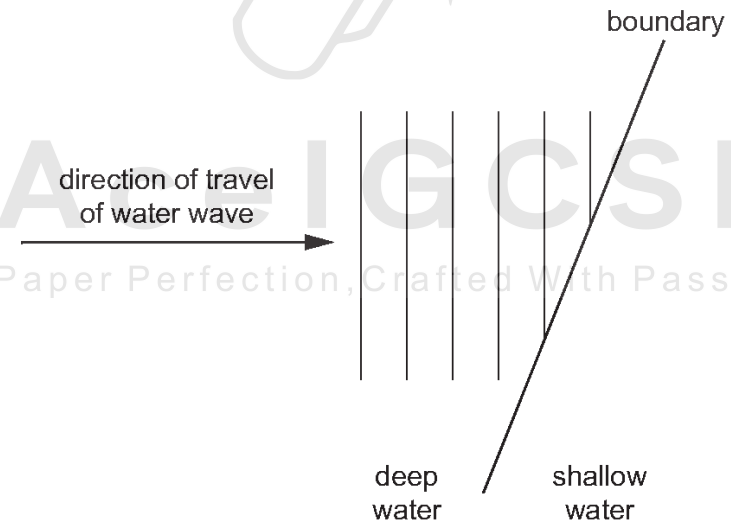


Fig. 6.2

The water wave moves more slowly in shallow water.

On Fig. 6.2, draw:

1. **three** crests of the water wave in the shallow water [2]

2. the direction of travel of the wave in the shallow water. [1]

(b) State **two** ways in which transverse waves differ from longitudinal waves.

1. .....

.....

2. .....

.....

[2]

(c) **(i)** State a typical value of the speed of sound in water.

..... [1]

(ii) Explain why sound travels faster in water than in air.

..... [1]

03. 0625_m21_qp_42 Q: 5

(a) State the name of the reflection of a sound wave or ultrasound wave.

..... [1]

(b) Fig. 5.1 shows an ultrasound wave being used to scan an internal organ of a human body.

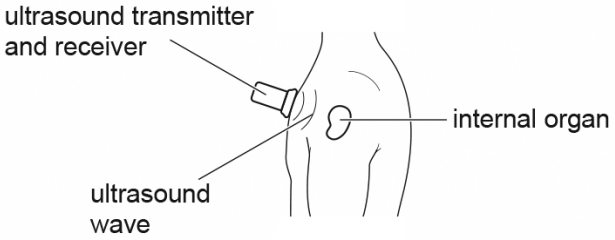


Fig. 5.1

The ultrasound wave has a frequency of 2.0 MHz and passes through human tissue at a speed of 1500 m/s.
Calculate the wavelength of the ultrasound wave in human tissue.

wavelength = ... [3]

(c) Fig. 5.2 shows crests of a wave from a point source S approaching a straight barrier.

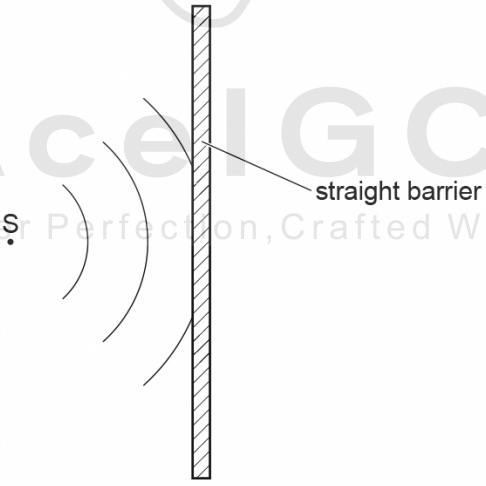


Fig. 5.2

(i) On Fig. 5.2, indicate and label **one** wavelength.

(ii) On Fig. 5.2, draw **three** crests of the wave reflected from the barrier.

[3]

[Total: 7]

04. 0625_s21_qp_41 Q: 6

Fig. 6.1 is a full-scale diagram that represents a sound wave travelling in air.

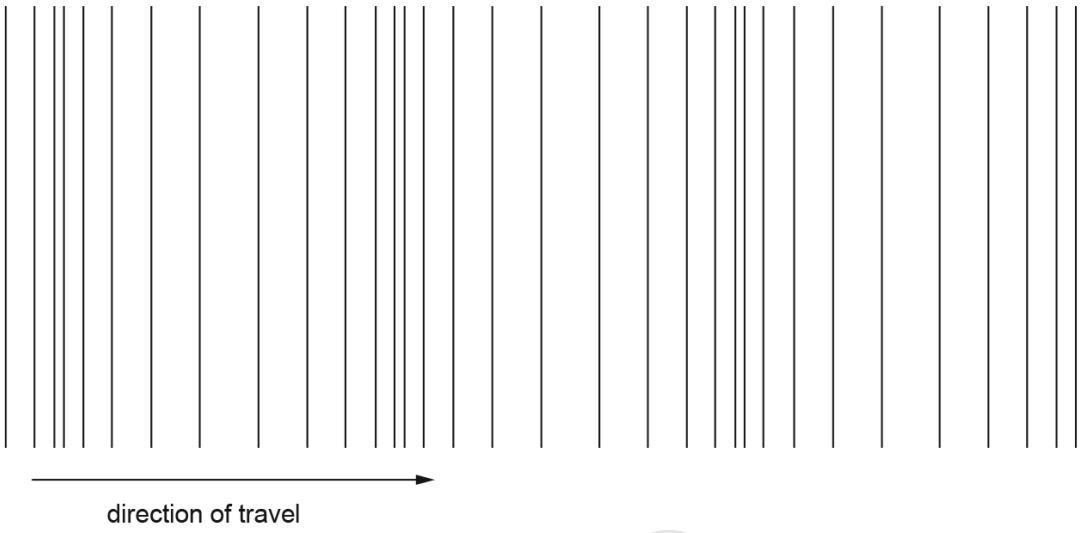


Fig. 6.1

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

(b) The speed of sound in air is 330 m / s.

Measure the diagram and determine the frequency of the sound.

frequency = ... [3]

(c) The wave reaches a barrier. Fig. 6.2 shows the wave passing through a gap in the barrier.

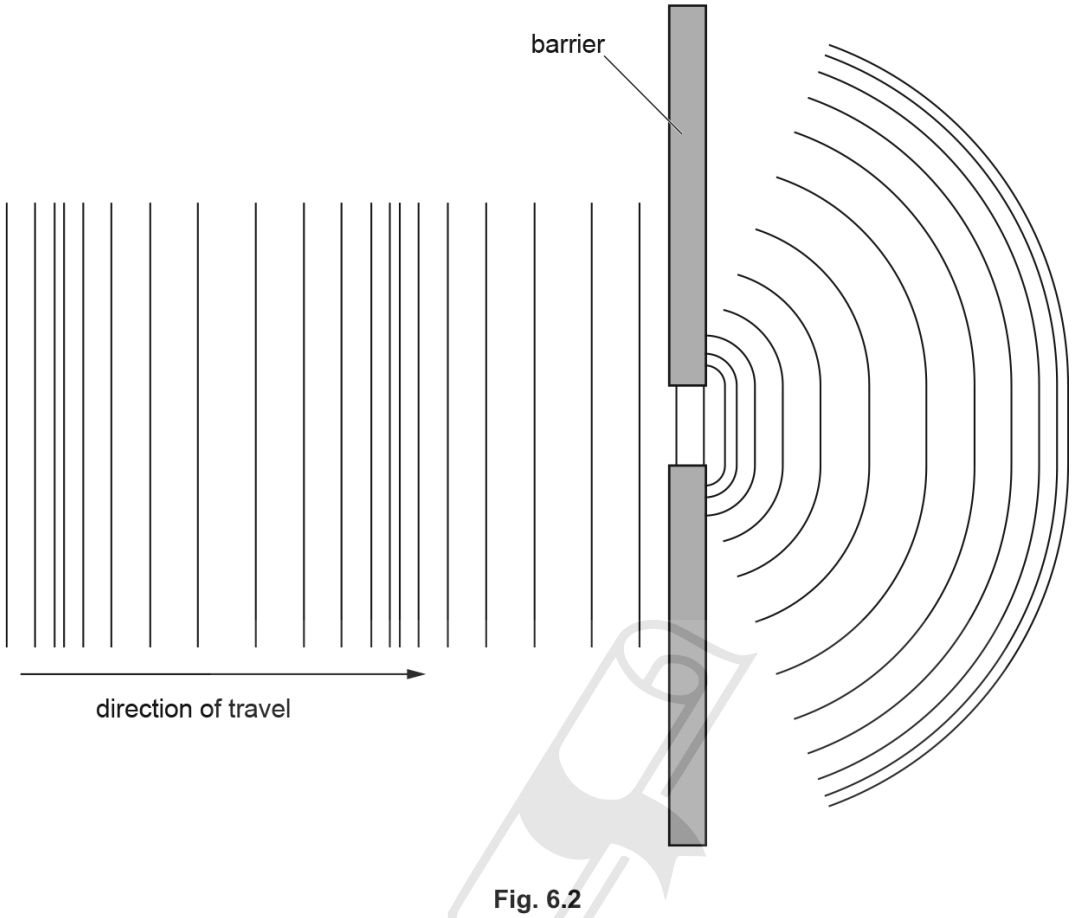


Fig. 6.2

The frequency of the wave is increased to a value many times greater than the value obtained in **(b)**.

Describe and explain **two** ways in which a diagram representing the wave with the greater frequency differs from Fig. 6.2.

1. .....

.....

2. .....

.....

[3]

[Total: 7]

05. 0625_s21_qp_43 Q: 5

(a) Fig. 5.1 shows a wave on the sea approaching a harbour.

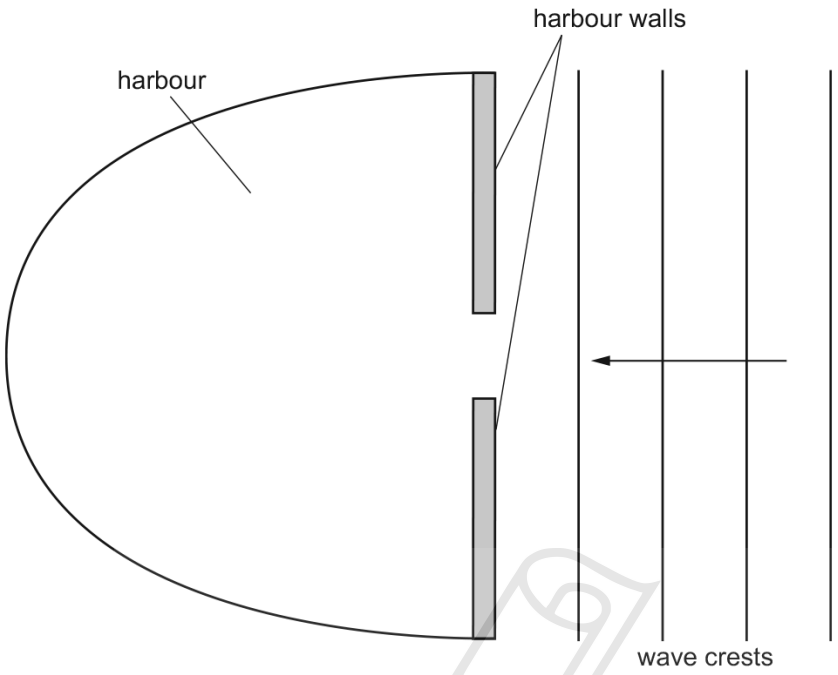


Fig. 5.1

(i) On Fig. 5.1, draw **three** wave crests in the harbour. [2]

(ii) Another harbour has a much wider gap between its walls.

Describe and explain how the pattern of wave crests in this harbour is different from the pattern you have drawn in **(i)**.

description .....

.....

explanation .....

..... [2]

(b) A sound wave of frequency 850 Hz travels through sea water. The speed of sound in sea water is 1500 m / s.

Calculate the wavelength of this sound wave in sea water.

wavelength = ... [2]

[Total: 6]

---

06. 0625_w21_qp_42 Q: 6

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:

(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.

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.

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.

statement .....

explanation .....

.....

..... [2]

07. 0625_w21_qp_43 Q: 6

(a) Describe an experiment to determine the speed of sound in air. State the apparatus you need, details of how to take measurements and how to calculate the speed of sound in air.

You may use the space below to draw a **labelled** diagram as part of your answer.

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) Sound waves from a television are diffracted through doorways. Light waves from a television are **not** diffracted through doorways.

Suggest why light waves and sound waves behave differently in this situation.

.....

.....

..... [2]

08. 0625_s20_qp_41 Q: 6

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

(a) Calculate the range of wavelengths for sounds that are audible by a healthy human ear.

wavelengths range from ..... to ..... [2]

(b) Sound waves are longitudinal waves.

Describe how a longitudinal wave differs from a transverse wave.

.....

.....

.....

..... [3]

(c) Fig. 6.1 shows a band in front of a building.

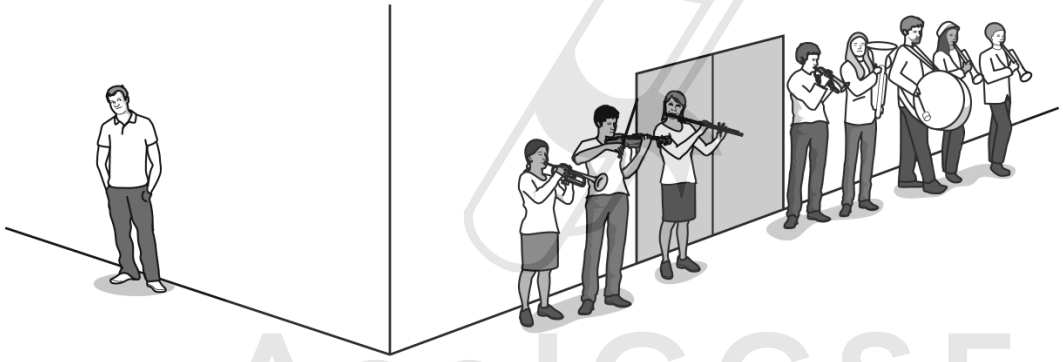


Fig. 6.1

The drum produces a low frequency sound. Other musical instruments produce a high frequency sound. These sounds are equally loud.

A young man at the side of the building hears the drum but not the high frequency sounds from the other musical instruments.

Explain why this happens.

.....

.....

..... [3]

[Total: 8]

09. 0625_s20_qp_42 Q: 5

Fig. 5.1 shows crests of a wave approaching a barrier where the wave is reflected.

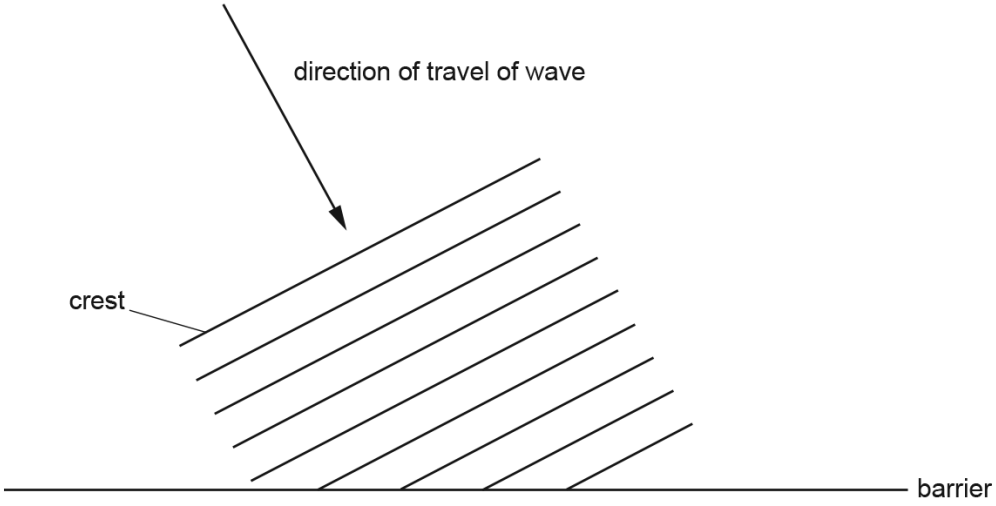


Fig. 5.1

(a) On Fig. 5.1, draw **three** crests of the reflected wave. [3]

(b) The wave has a wavelength of 36 cm and a speed of 1.2 m/s.

Calculate the frequency of the wave.

frequency = ... [3]

(c) Complete the following sentences.

An echo is the name for a reflected ..... wave.

The waves that form an echo are a type of longitudinal wave. Longitudinal waves are made up of ..... and rarefactions.

[2]

[Total: 8]

10. 0625_s20_qp_43 Q: 6

(a) Fig. 6.1 shows crests of a sound wave after reflection from a solid surface.

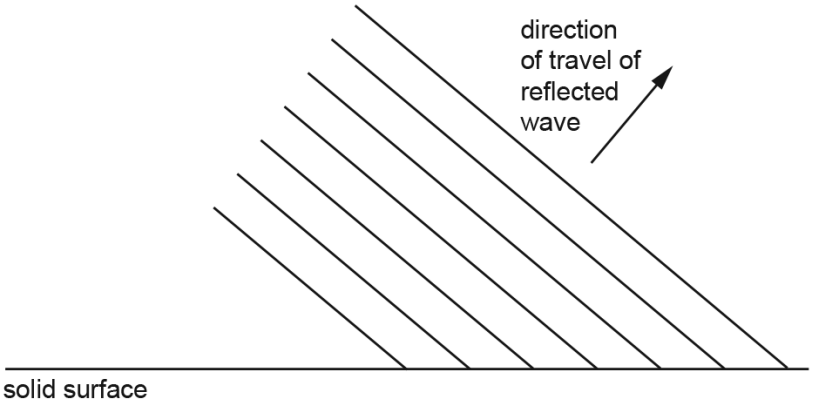


Fig. 6.1

On Fig. 6.1, draw **three** crests of the incident wave. [3]

(b) Tick **four** statements in the list below that are **false** for a sound wave that is audible to a healthy human ear.

The wave is longitudinal. ☐

The wave is transverse. ☐

The frequency of the wave is 1 Hz. ☐

The frequency of the wave is 1 kHz. ☐

The frequency of the wave is 1 MHz. ☐

The wave travels in a vacuum. ☐

The wave could travel in aluminium. ☐

[3]

(c) State a typical value for the speed of a sound wave in water.

..... [1]

[Total: 7]

11. 0625_w20_qp_43 Q: 6

(a) Sound waves consist of compressions and rarefactions.

Explain the terms *compression* and *rarefaction*. Give your explanation in terms of the spacing of molecules and the pressure for sound waves in air.

compression .....

.....

rarefaction .....

.....

[3]

(b) A musical instrument emits a sound with a frequency of 4.4 kHz. The speed of sound in air is 340 m/s.

(i) Calculate the wavelength of the sound.

wavelength = ... [3]

(ii) The frequency of the sound emitted by the instrument is changed to 5.1 kHz and the amplitude of the sound is increased.

Without calculation, state what happens to

1. the speed of the sound .....

2. the wavelength of the sound .....

[2]

12. 0625_w20_qp_43 Q: 7

(a) State **two** uses for infrared radiation.

1. .....

.....

2. .....

.....
[2]

(b) X-rays are used in hospitals to help treat patients.

Suggest and explain **three** precautions for the safe use of X-rays.

1. .....

.....

2. .....

.....

3. .....

.....
[3]

(c) **(i)** State the speed in a vacuum of

1. microwaves ..... [1]

2. X-rays ..... [1]

(ii) State a possible frequency for an ultrasound wave.

..... [1]

13. 0625_s19_qp_42 Q: 6

(a) Fig. 6.1 shows a water wave in a ripple tank.

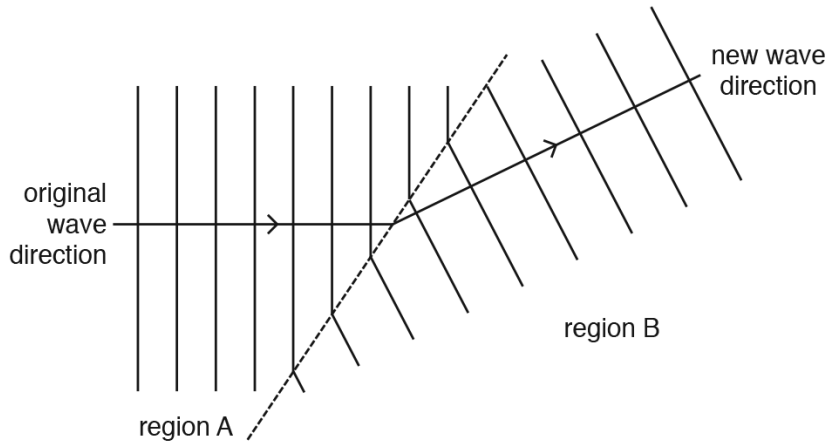


Fig. 6.1

(i) State the name of the process that occurs as the wave moves from region A to region B.

..... [1]

(ii) Suggest a cause for the change in direction of the wave.

..... [1]

(b) Fig. 6.2 shows a transverse wave.

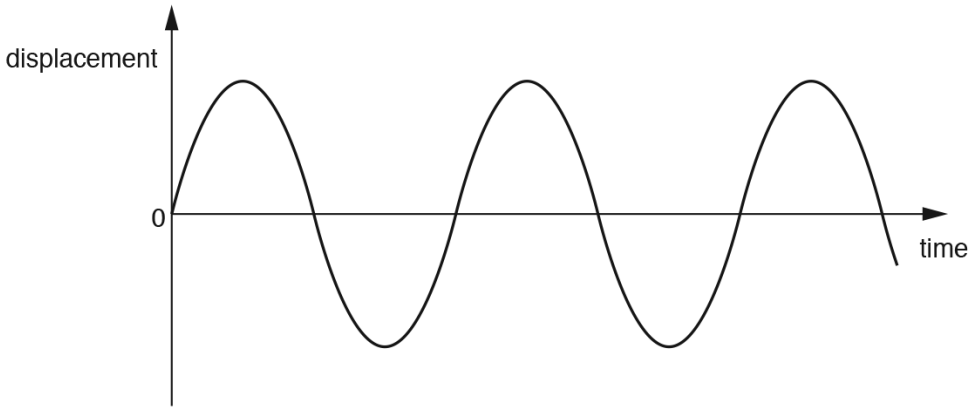


Fig. 6.2

On Fig. 6.2, draw a wave which has half the amplitude and a greater frequency than the wave shown. [2]

(c) A train travels along steel rails. A person waiting at a station hears the sound of the train through the rails before he hears the sound through the air.

(i) Explain why this happens.

.....

..... [1]

(ii) The speed of sound in the rails is 5800 m/s.

Calculate the wavelength of sound of frequency 1100 Hz travelling at this speed.

wavelength = ... [2]

[Total: 7]

14. 0625_s19_qp_43 Q: 3

Fig. 3.1 shows a small submarine submerged below the surface of the sea.

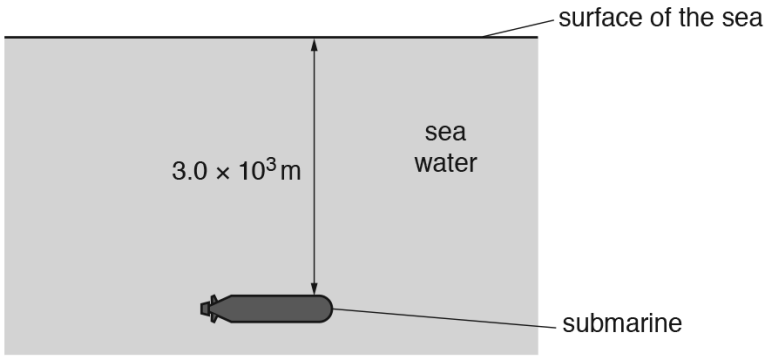


Fig. 3.1

(a) The density of sea water is 1030 kg/m^3.

Calculate the pressure due to the sea water on the top of the submarine when it is 3.0×10^3 m below the surface.

pressure = ... [2]

(b) The submarine emits a pulse of sound to detect other objects in the sea. The speed of sound in sea water is 1500 m/s. An echo is received with a time delay of 0.50 s after the original sound is emitted.

(i) Calculate the distance between the submarine and the other object.

distance = ... [3]

(ii) Another pulse of sound is emitted through the air when the submarine is on the surface.

An echo is received from a second object that is in the air. This echo is received 0.50 s after the pulse of sound is emitted.

Compare the distance of the second object from the submarine with the distance calculated in **(b)(i)**. Tick **one** box. Give a reason for your answer.

distance is smaller ☐

distance is the same ☐

distance is larger ☐

Reason ..... [1]

[Total: 6]

15. 0625_w19_qp_41 Q: 4

Fig. 4.1 shows a loudspeaker that is producing a sound wave in air of frequency 15000 Hz.

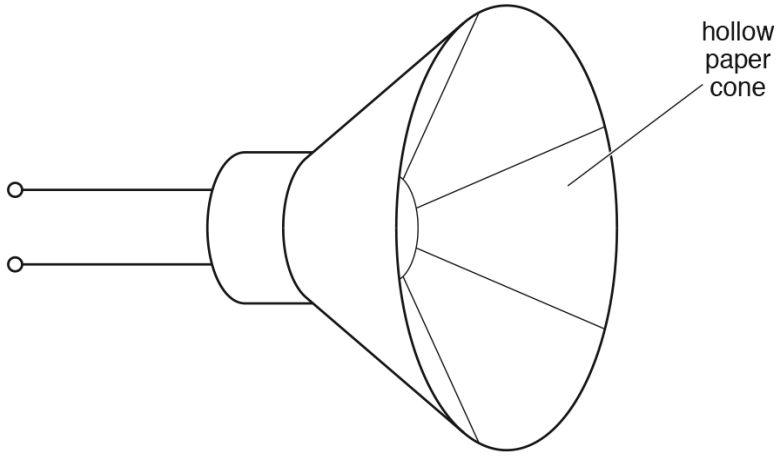


Fig. 4.1

(a) Describe how the cone of the loudspeaker produces this sound.

.....

.....

.....

..... [3]

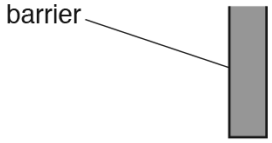
(b) The speed of sound in air is 330 m/s.

Calculate the wavelength of this sound.

wavelength = ... [2]

(c) The loudspeaker is placed a considerable distance to the left of a barrier with a gap. The width of the gap is double the wavelength of the sound. Sound from the loudspeaker reaches the barrier and passes through the gap.

Fig. 4.2 shows the gap in the barrier.



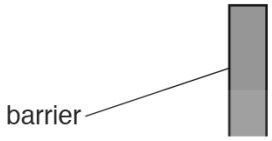


Fig. 4.2 (not to scale)

On Fig. 4.2, sketch a diagram that represents the sound wave as a series of wavefronts

- travelling towards the barrier
- in the gap
- and travelling away from the barrier.

[3]

[Total: 8]

16. 0625_w19_qp_42 Q: 5

(a) One difference between a longitudinal wave and a transverse wave is that a longitudinal wave consists of compressions and rarefactions.

(i) Explain the terms compression and rarefaction using ideas about particles.

compression .....

.....

.....

rarefaction .....

.....

.....

[2]

(ii) Describe **one** other way in which longitudinal wave motion differs from transverse wave motion.

Longitudinal wave motion .....

.....

.....

Transverse wave motion .....

.....

.....

[2]

(b) **(i)** A sound wave of frequency 0.120 kHz travels through a rock at a speed of 3500 m/s.

Calculate the wavelength of the wave.

wavelength = ... [3]

(ii) The wave travels from the rock into the air.

State and explain whether the wave will be audible to a healthy human ear.

statement .....

explanation .....

.....

[2]

[Total: 9]

17. 0625_w19_qp_43 Q: 6

Fig. 6.1 represents wavefronts of a sound wave travelling in air from left to right.

Fig. 6.1

(a) State the name given to the:

(i) region around A in the diagram ..... [1]

(ii) region around B in the diagram. ..... [1]

(b) On Fig. 6.1, draw a double-headed arrow to show **one** wavelength. [1]

(c) The loudness of the sound increases at the same pitch.

State and explain any change there would be in the pattern of wavefronts shown in Fig. 6.1.

.....

.....

.....

..... [3]

(d) The wave passes into water.

State and explain any change in the pattern of wavefronts shown in Fig. 6.1.

.....

.....

.....

..... [3]

[Total: 9]

18. 0625_s18_qp_42 Q: 6

(a) Circle **two** of the following that apply to an ultrasound wave travelling in air.

frequency 3.5 Hz frequency 350 Hz frequency 35 000 Hz longitudinal

transverse speed 1.5 m/s speed 1.5×10^3 m/s speed 1.5×10^6 m/s

[2]

(b) Calculate the wavelength in a vacuum of X-rays of frequency 1.3×10^{17} Hz.

wavelength = ...[3]

(c) A dentist takes an X-ray photograph of a patient's teeth. Explain why it is safe for the patient to be close to the source of X-rays, but the dentist must stand away from the source.

.....

.....

.....

.....[2]

(d) State, with a reason, why microwave ovens are designed only to work with the door closed.

.....

.....

.....[2]

[Total: 9]

19. 0625_s18_qp_43 Q: 6

Sound is a longitudinal wave.

(a) Sketch a representation of a longitudinal wave. On your sketch

- indicate and label a distance to show the wavelength,
- mark and label the centre of one compression,
- mark and label the centre of one rarefaction.

[3]

(b) A longitudinal wave passes from one medium into another medium. The speed of the wave is slower in the second medium.

State what happens to

(i) the frequency of the wave,

.....[1]

(ii) the wavelength of the wave.

.....[1]

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

.....[1]

[Total: 6]

20. 0625_w18_qp_41 Q: 8

A vibrating source on a ship produces a sound wave that travels through the ocean. The wave produced is a longitudinal wave.

(a) Explain what is meant by the term *longitudinal wave*.

.....

.....

.....

.....[3]

(b) The frequency of the sound wave is 800 Hz.

(i) The speed of sound in air is 330 m/s.

State a typical value for the speed of sound in a liquid.

..... [1]

(ii) Using your value from **(b)(i)**, calculate the wavelength of the sound wave in the ocean.

wavelength = ...[2]

[Total: 6]

21. 0625_w18_qp_42 Q: 6

Fig. 6.1 represents a sound wave of wavelength 0.45 m travelling from left to right.

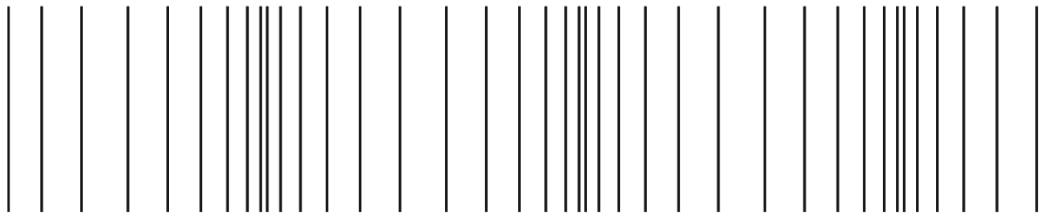


Fig. 6.1 (not to scale)

(a) On Fig. 6.1:

(i) at the centre of a compression, mark a cross and label it C [1]

(ii) at the centre of a rarefaction, mark a cross and label it R [1]

(iii) draw a double-headed arrow to represent a distance of 0.90 m. [1]

(b) The frequency of the wave is 750 Hz.

Calculate the speed of the wave.

speed = ...[2]

(c) Suggest a medium through which the sound wave is travelling and state your reasoning.

medium .....

reason .....

.....
[1]

(d) Another type of wave that consists of compressions and rarefactions is ultrasound.

(i) State **one** other similarity between sound of frequency 750 Hz and ultrasound.

.....

.....[1]

(ii) State **one** way in which sound of frequency 750 Hz is different from ultrasound.

.....

.....[1]

[Total: 8]

22. 0625_s17_qp_41 Q: 7

A loudspeaker produces a sound wave of constant frequency.

(a) State what is meant by *frequency*.

.....

.....[1]

(b) The sound wave travels in air towards a barrier with a small gap at its centre. Fig. 7.1 represents the compressions of the wave travelling towards the barrier.

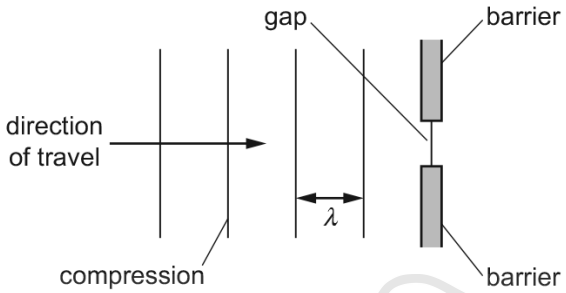


Fig. 7.1

(i) State what is meant by a *compression*.

.....[1]

(ii) The width of the gap is smaller than the wavelength λ of the wave.

On Fig. 7.1, draw the pattern of the compressions after the sound wave has passed through the gap. [2]

(iii) The barrier is adjusted so that the gap becomes wider.

Describe how this affects the pattern of the compressions after the sound wave has passed through the gap.

.....

.....

.....[1]

(c) The frequency of the sound wave is 6800 Hz. The speed of sound in air is 340 m / s.

(i) Calculate the wavelength of the sound wave in air.

wavelength = ...[2]

(ii) State a typical value for the speed of sound in a liquid.

.....[1]

[Total: 8]

23. 0625_s17_qp_43 Q: 7

A loudspeaker is built into the side of a swimming pool. The loudspeaker produces sound waves in the water of wavelength 0.25 m.

(a) (i) The frequency of the sound waves is 6.0 kHz.

Calculate the speed of the sound waves in water.

speed of sound waves in water = ...[2]

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

speed of sound in air = ...[1]

(iii) State and explain, for the sound produced by the loudspeaker, how the wavelength of the sound in air compares with the wavelength of the sound in water.

.....

.....[1]

(b) Sound is a longitudinal wave.

Explain what is meant by a *longitudinal* wave.

.....

.....

.....[2]

(c) The sound emerges from the loudspeaker through a gap. The sound diffracts as it passes through the gap.

(i) State how the width of the gap affects the diffraction.

.....

.....[1]

(ii) State how the wavelength of the sound affects the diffraction.

.....

.....[1]

[Total: 8]

24. 0625_w17_qp_41 Q: 6

(a) The left-hand column of the table shows some possible speeds of a sound wave.

In the right-hand column, write down the medium in which a sound wave has this speed.

Choose from solid, liquid or gas.

speed of sound wave / m/s	medium
1500	
5000	
300	

[2]

(b) Fig. 6.1 represents a series of compressions and rarefactions of a sound wave.

Fig. 6.1

(i) On Fig. 6.1, mark, with the letters X and Y, the mid-points of **two** rarefactions. [1]

(ii) State, in terms of pressure, what is meant by a *rarefaction*.

.....

.....[1]

(c) Astronauts set up a mirror on the Moon's surface. A laser beam is transmitted from the Earth's surface to the mirror and is then reflected back to Earth.

On a certain day, the time between transmitting the beam from a point on the Earth's surface and receiving the reflected signal at the same point is 2.56 s.

The speed of the laser beam is 3.00×10^8 m/s.

Calculate the distance between the Earth's surface and the Moon's surface.

distance = ...[3]

[Total: 7]