1 **(a)** Fig. 5.1 shows a metal strip, held in a clamp.

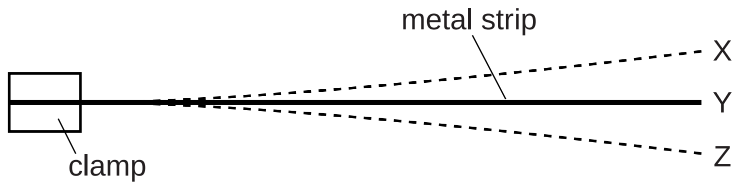

Fig. 5.1

The end of the strip is pulled down and released, so that the strip vibrates. X and Z are the extreme positions of the end of the strip during this vibration. Y is the mid-position.

Explain what is meant by

(i) the *frequency* of vibration of the strip,

....

....

(ii) the *amplitude* of vibration of the end of the strip.

....

....

[2]

(b) Fig. 5.2 shows two tall buildings, A and B, that are 99 m apart.

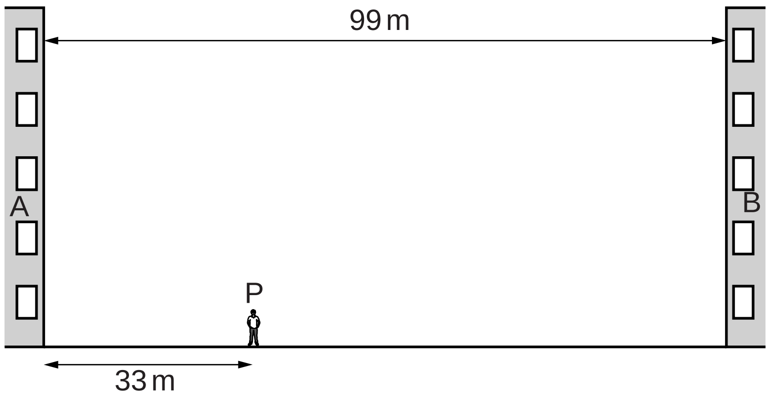

Fig. 5.2 (not to scale)

A student stands at P so that his distance from building A is 33 m. After clapping his hands once, he hears several echoes. The speed of sound in air is 330 m / s.

Calculate the time interval between clapping his hands and hearing

(i) the first echo,

time = ...[2]

(ii) the **third** echo.

time = ...[1]

(c) Write down an approximate value for the speed of sound

(i) in water, speed = ...

(ii) in steel. speed = ...

[2]

(d) Fig. 5.3 shows a dolphin in water emitting a sound wave of frequency 95 kHz.

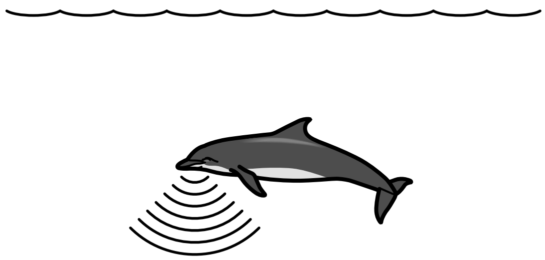

Fig. 5.3 (not to scale)

Using your value from **(c)(i)**, calculate the wavelength of this sound wave.

wavelength = ...[2]

[Total: 9]

2 Sound from a loudspeaker is travelling in air towards a solid wall.

Fig. 7.1 shows compressions of the incident sound wave and the direction of travel of the wave.

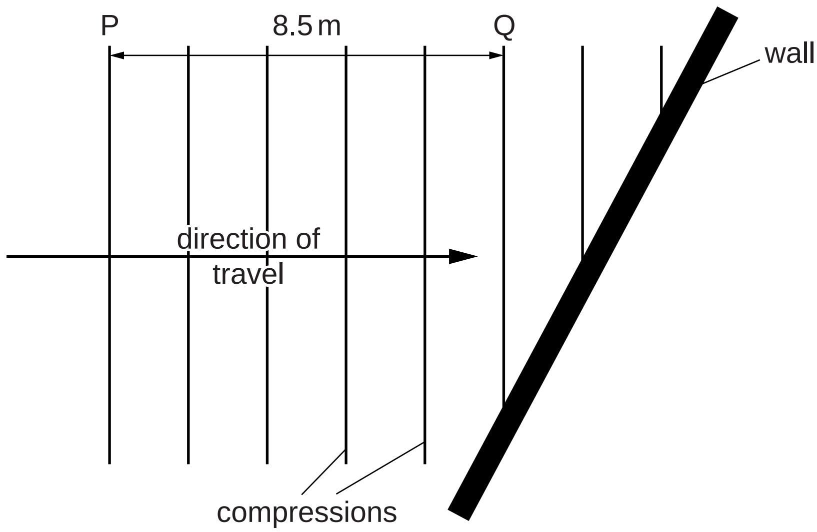

Fig. 7.1

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

....

....[1]

(b) The distance from point P to point Q is 8.5 m. It takes 25 ms for the compression at P to reach Q.

For this sound wave, determine

(i) the wavelength,

wavelength = ...[1]

(ii) the frequency.

frequency = ...[2]

(c) As it strikes the wall, the sound reflects.

Complete Fig. 7.1 to show the positions of three compressions of the reflected sound wave. [2]

(d) The loudspeaker is immersed in water, where it continues to produce sound of the same frequency.

State and explain how the wavelength of the sound wave in water compares with the wavelength determined in **(b)(i)**.

....

....

....[2]

[Total: 8]

3 **(a)** State how a longitudinal wave differs from a transverse wave.

....

....

.... [2]

(b) A sound wave of frequency 7.5 kHz travels through a steel beam at a speed of 6100 m/s.

(i) Calculate the wavelength of this sound wave in the steel beam.

wavelength = ... [2]

(ii) The sound wave passes from the end of the beam into air.

State

1. the effect on the speed of the sound,

.... [1]

2. the effect on the wavelength of the sound.

.... [1]

[Total: 6]

4 **(a)** Two types of seismic waves are produced by earthquakes. They are called P-waves and S-waves. P-waves are longitudinal and S-waves are transverse.

(i) Explain what is meant by the terms *longitudinal* and *transverse*.

longitudinal ....

....

transverse ....

....
[2]

(ii) State another example of

1. a longitudinal wave, ...

2. a transverse wave. ....
[2]

(iii) A seismic wave has a speed of 7.2 km / s and a frequency of 30 Hz.

Calculate its wavelength.

wavelength = ...[2]

(b) Fig. 5.1 shows an electric bell ringing in a sealed glass chamber containing air.

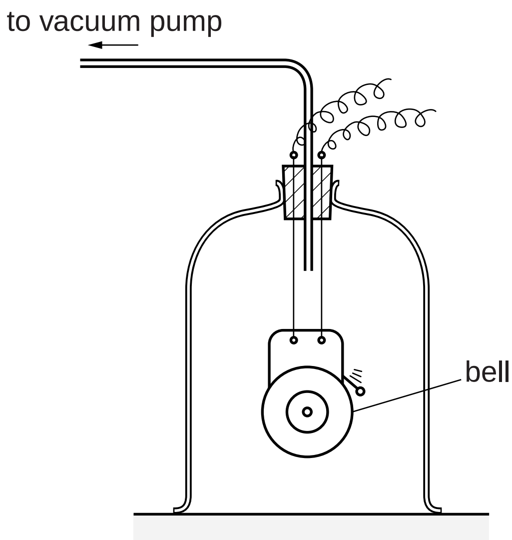

Fig. 5.1

A student hears the bell ringing. The air is then removed from the chamber.

State and explain any change in the sound heard by the student.

....

....

....

....[2]

[Total: 8]

5 **(a)** Fig. 7.1 shows the surface of water in a tank.

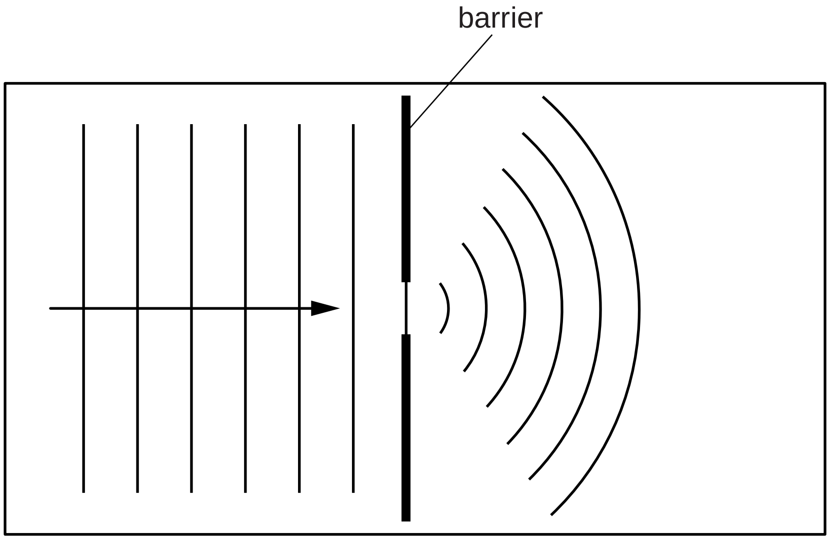

Fig. 7.1

Straight wavefronts are produced at the left-hand end of the tank and travel towards a gap in a barrier. Curved wavefronts travel away from the gap.

(i) Name the process that causes the wavefronts to spread out at the gap.

.... [1]

(ii) Suggest a cause of the reduced spacing of the wavefronts to the right of the barrier.

.... [1]

(iii) State how the pattern of wavefronts to the right of the barrier changes when the gap is made narrower.

.... [1]

(b) Fig. 7.2 shows a wave travelling, in the direction of the arrow, along a rope.

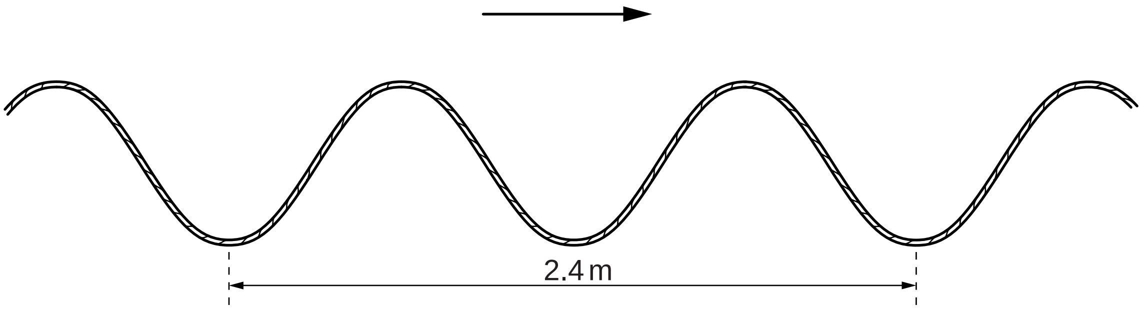

Fig. 7.2

(i) Explain why the wave shown in Fig. 7.2 is described as a *transverse* wave.

....

.... [1]

(ii) The speed of the wave along the rope is 3.2 m/s.

Calculate the frequency of the wave.

frequency = ... [3]

[Total: 7]

6 (a) Draw a straight line from each wave to the most appropriate speed on the right.

wave	speed
	15 m/s (1.5×10 m/s)
	300 m/s (3×10^2 m/s)
light in air	1500 m/s (1.5×10^3 m/s)
sound in air	1 500 000 m/s (1.5×10^6 m/s)
sound in water	300 000 000 m/s (3×10^8 m/s)
	1 500 000 000 m/s (1.5×10^9 m/s)

[3]

(b) Fig. 6.1 shows a railway-line testing-team checking a continuous rail of length 120 m. The diagram is not to scale.

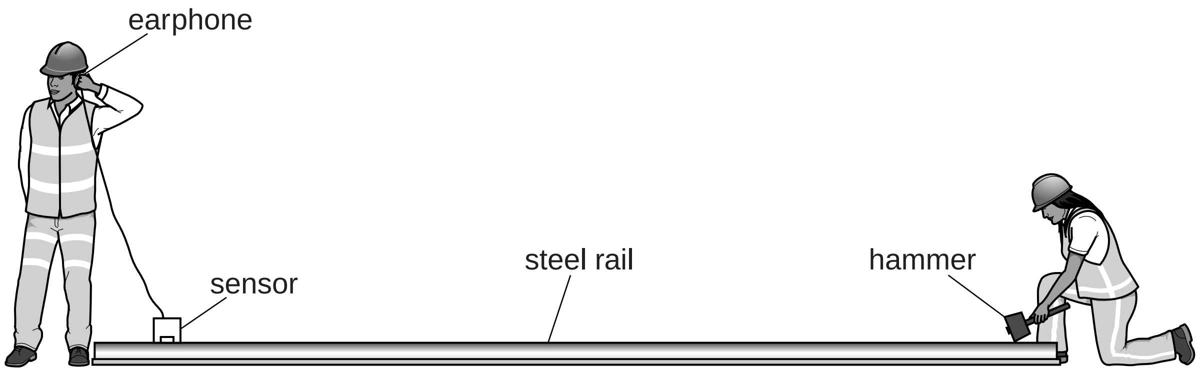

Fig. 6.1 (not to scale)

One tester strikes one end of the rail with a hammer. The other tester hears the sound transmitted through the air and transmitted through the rail. He hears the two sounds at different times.

The speed of sound in steel is 5000 m / s.

Calculate the time difference, using your value from **(a)** for the speed of sound in air.

time difference = ... [4]

[Total: 7]

7 **(a)** The speed of light in air is known to be 3.0×10^8 m/s.

Outline how you would use a refraction experiment to deduce the speed of light in glass. You may draw a diagram if it helps to clarify your answer.

....

....

....

....

....

....[4]

(b) A tsunami is a giant water wave. It may be caused by an earthquake below the ocean.

Waves from a certain tsunami have a wavelength of 1.9×10^5 m and a speed of 240 m/s.

(i) Calculate the frequency of the tsunami waves.

frequency = ...[2]

(ii) The shock wave from the earthquake travels at 2.5×10^3 m/s.

The centre of the earthquake is 6.0×10^5 m from the coast of a country.

Calculate how much warning of the arrival of the tsunami at the coast is given by the earth tremor felt at the coast.

warning time = ...[4]

[Total: 10]

8 **(a)** Fig. 6.1 shows the position of layers of air, at one moment, as a sound wave of constant frequency passes through the air. Compressions are labelled C. Rarefactions are labelled R.

Fig. 6.1

(i) State how Fig. 6.1 would change if

1. the sound had a higher frequency,

....[1]

2. the sound were louder.

....

....

....[2]

(ii) On Fig. 6.1, draw a line marked with arrows at each end to show the wavelength of the sound. [1]

(b) In an experiment to measure the speed of sound in steel, a steel pipe of length 200 m is struck at one end with a hammer. A microphone at the other end of the pipe is connected to an accurate timer. The timer records a delay of 0.544 s between the arrival of the sound transmitted by the steel pipe and the sound transmitted by the air in the pipe.

The speed of sound in air is 343 m / s. Calculate the speed of sound in steel.

speed of sound in steel = ...[3]

[Total: 7]

9 In a thunderstorm, both light and sound waves are generated at the same time.

(a) How fast does the light travel towards an observer?

speed = ... [1]

(b) Explain why the sound waves always reach the observer after the light waves.

....[1]

(c) The speed of sound waves in air may be determined by experiment using a source that generates light waves and sound waves at the same time.

(i) Draw a labelled diagram of the arrangement of suitable apparatus for the experiment.

(ii) State the readings you would take.

....

....

....

(iii) Explain how you would calculate the speed of sound in air from your readings.

....

....

[4]

[Total : 6]