3. Waves

3.1 General properties of waves

Paper 3 and 4

Question Paper

Paper 3

Questions are applicable for both core and extended candidates

1 **(a)** A student demonstrates three different processes that change the direction of water waves in a ripple tank.
Fig. 7.1, Fig. 7.2 and Fig. 7.3 illustrate the three processes.

(i)

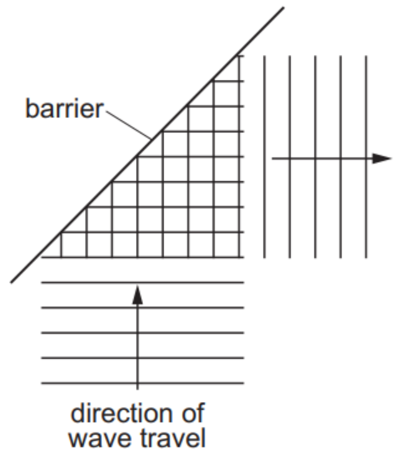

Fig. 7.1

State the name of the process shown in Fig. 7.1.

.... [1]

(ii)

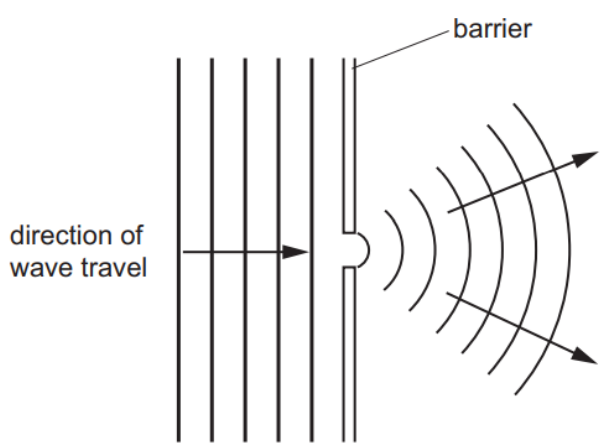

Fig. 7.2

State the name of the process shown in Fig. 7.2.

.... [1]

(iii)

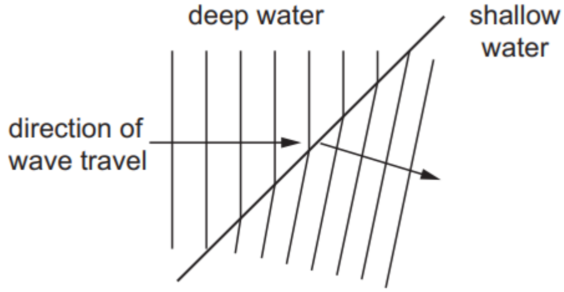

Fig. 7.3

State the name of the process shown in Fig. 7.3.

.... [1]

(iv) Give a reason why the waves in Fig. 7.3 change direction as they move from deep water to shallow water.

.... [1]

(b) Describe the direction of vibration of particles in a transverse wave.

....

.... [2]

(c) Fig. 7.4 lists examples of waves. **Two** of the examples are transverse waves.

☐ radio waves

☐ seismic P-waves

☐ light waves

☐ sound waves

Fig. 7.4

Indicate which of the examples are transverse waves.
Put a tick (✓) in the box next to each example of a transverse wave. [2]

(d) The velocity of a wave is 1500 m/s. The frequency of the wave is 250 Hz.

Calculate the wavelength of the wave.

wavelength = ... m [3]

[Total: 11]

2 **(a)** The direction of vibration in a type of wave is parallel to the direction in which the wave is moving.
State the name of this type of wave.

type of wave .... [1]

(b) Fig. 7.1 represents a ripple tank showing diffraction. The ripple tank is viewed from above. The wavefronts move from left to right until they reach a barrier. They are diffracted at a gap in the barrier.

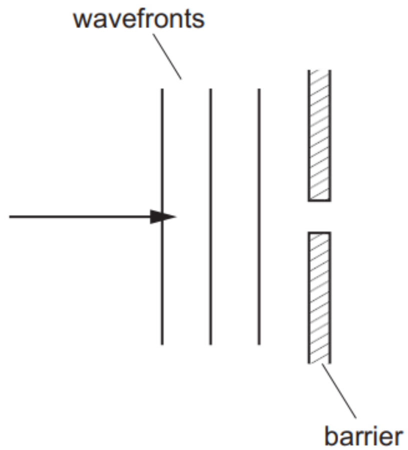

Fig. 7.1

On Fig. 7.1:

(i) draw **three** wavefronts to the right of the barrier [2]

(ii) indicate and label **one** wavelength. [1]

(c) The wavelength of the wave is 4.6 cm.
The speed of the wave is 38 cm/s.
Determine the frequency of the wave.

frequency = ...Hz [3]

[Total: 7]

3 A student studies different types of wave.

(a) She studies waves on the surface of water in a ripple tank. The frequency of the waves is 4.0 Hz. The wavelength of the waves is 5.0 cm.

Calculate the speed of the waves.

speed = ... cm/s [3]

(b) The student puts a block into the ripple tank, as shown in Fig. 6.1. The block sinks. The waves travel towards the block and then over the block.

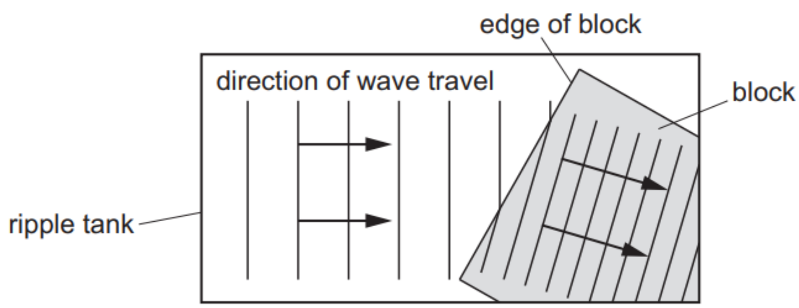

Fig. 6.1

State and explain what happens to the waves as they travel over the edge of the block.

....

....

.... [3]

4 Fig. 4.1 represents a wave on the surface of water.

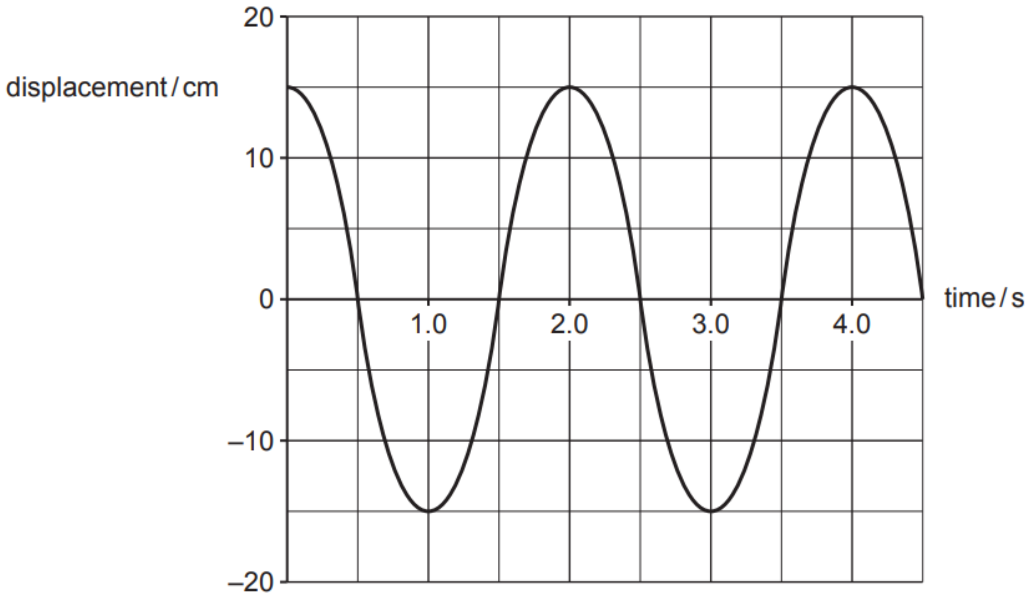

Fig. 4.1

(a) **(i)** Determine the amplitude of the wave in Fig. 4.1.

amplitude = ... cm [1]

(ii) Determine the frequency of the wave in Fig. 4.1.

frequency = ... Hz [2]

(b) Fig. 4.2 shows wavefronts passing through a small gap in a barrier.
The arrows on the diagram show the directions of propagation of the wavefronts.

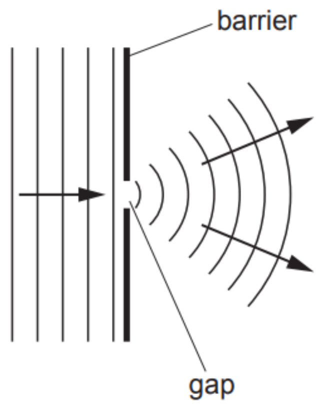

Fig. 4.2

State the name of the wave property shown in Fig. 4.2.

.... [1]

(c) Fig. 4.3 shows wavefronts changing direction as they pass from shallow water to deep water.
The arrows on the diagram show the directions of propagation of the wavefronts.

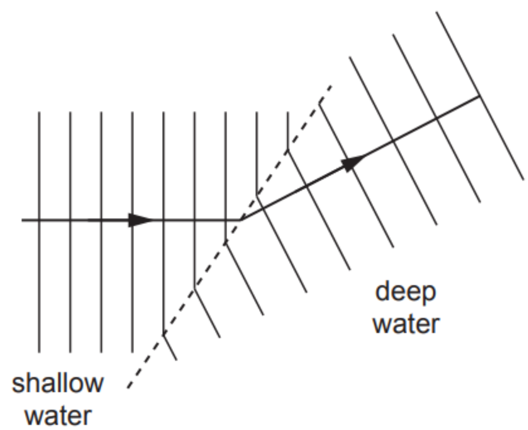

Fig. 4.3

(i) State the name of the wave property shown in Fig. 4.3.

.... [1]

(ii) State **one** property of the water wave, other than direction, that changes as it moves from shallow water to deep water.

.... [1]

[Total: 6]

5 A student observes waves on the surface of water in a tank. The waves all have the same wavelength.

(a) The student measures the wavelength of the waves by measuring the distance between one peak and the next peak.

Describe a more accurate method for determining the wavelength.

....

.... [2]

(b) The wavelength of the waves is 4.0 cm and their frequency is 6.0 Hz.

Calculate the wave speed.

wave speed = ... cm/s [3]

(c) Fig. 6.1 shows water waves in the tank travelling from deep water to shallow water.

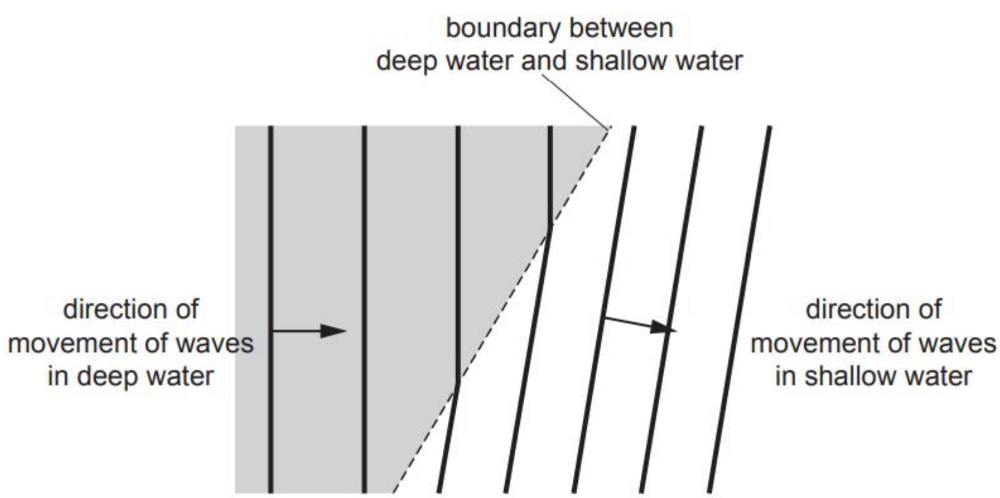

Fig. 6.1

State and explain what happens to the waves as they move from deep water to shallow water.

name of effect ....

explanation ....

....

[2]

[Total: 7]

6 A student investigates wave properties. He uses waves on the surface of a tank of water to show the properties.

(a) The waves move from deep water to shallow water. Fig. 6.1 shows the wavefronts.

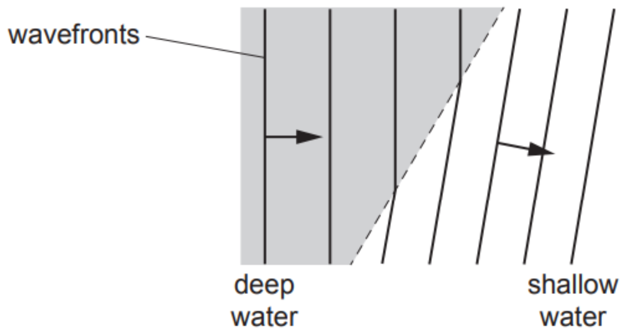

Fig. 6.1

(i) State the name of the effect shown in Fig. 6.1.

.... [1]

(ii) When the wave passes from deep water to shallow water, two of its properties change.

Describe how **one** of these properties changes.

property ....

change in property ....

[2]

(b) The student notes that it takes 10 s to produce 25 complete waves in the water tank.

Calculate the frequency of the waves.

frequency of waves = ... Hz [3]

(c) Waves on the surface of water are transverse waves.

(i) State **one** other example of a transverse wave.

.... [1]

(ii) Describe the vibration of particles in a transverse wave.

....

.... [2]

[Total: 9]

7 **(a)** The diagram in Fig. 5.1 shows the profile (side view) of a water wave.

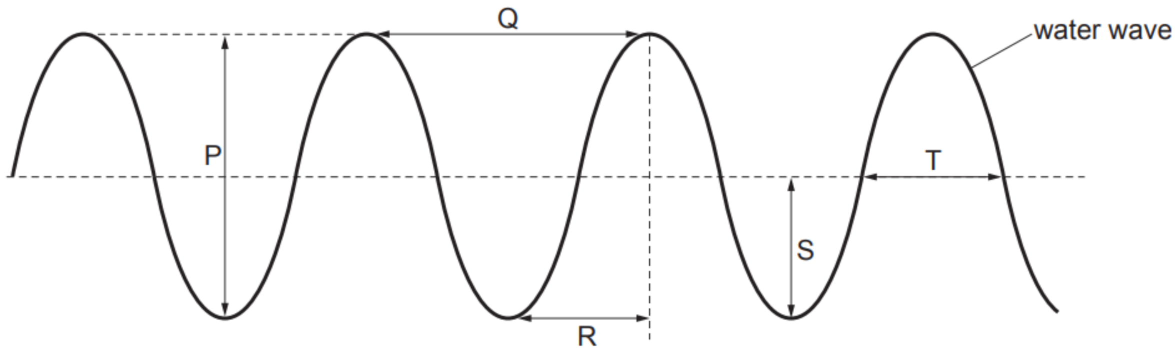

Fig. 5.1

State the letter which represents:

(i) the amplitude of the wave .... [1]

(ii) the wavelength of the wave. .... [1]

(b) The water molecules move at right angles to the direction of travel of the water wave.

State the name for this type of wave.

.... [1]

(c) State the meaning of the frequency of a wave.

.... [1]

8 **(a)** Fig. 7.1 shows the displacement of particles in a water wave.

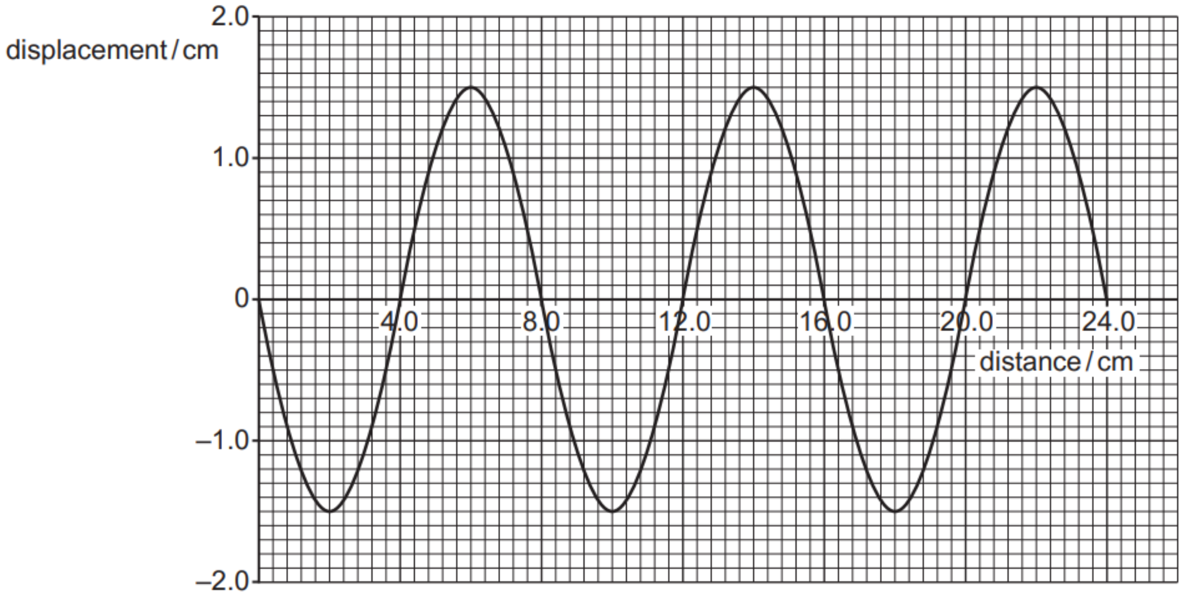

Fig. 7.1

Using the information in Fig. 7.1, determine:

(i) the wavelength of the wave

wavelength = ... cm [1]

(ii) the amplitude of the wave.

amplitude = ... cm [1]

9 **(b)** Fig. 6.2 represents a wave on a rope at one instant.

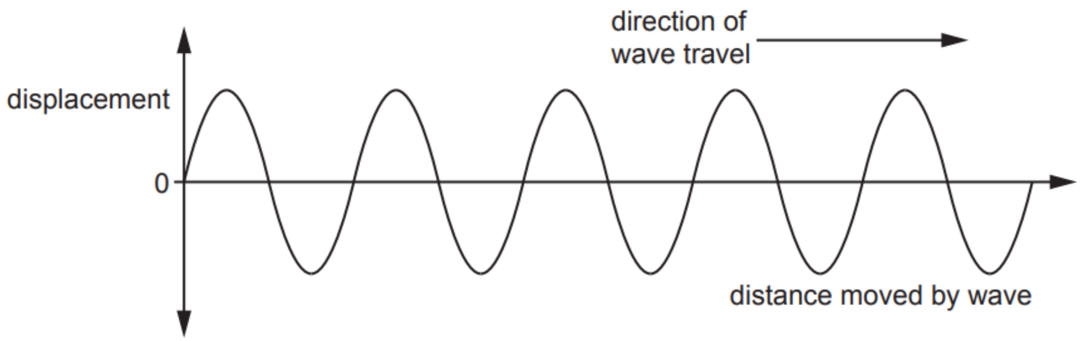

Fig. 6.2

On Fig. 6.2, draw a line representing **one** wavelength. Label the line L. [1]

(d) Describe the difference between the vibrations of longitudinal waves and transverse waves.

....

....

.... [2]

10 **(a)** Fig. 6.1 shows part of a water wave.

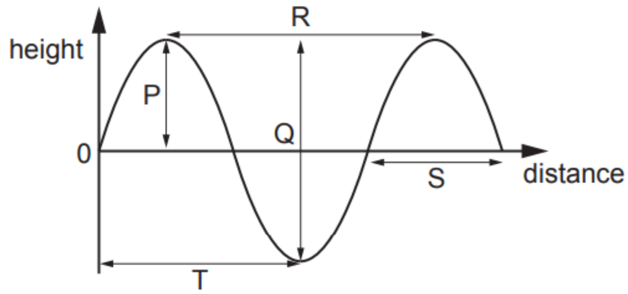

Fig. 6.1

(i) State the letter P, Q, R, S or T on Fig. 6.1 that represents the wavelength of the water wave.

.... [1]

(ii) State the letter P, Q, R, S or T on Fig. 6.1 that represents the amplitude of the water wave.

.... [1]

(iii) State what is meant by the term *frequency* of a wave.

....

.... [1]

11 A teacher uses a long spring to demonstrate wave motion. She makes a wave move along the coils of the spring.
Fig. 7.1 shows the wave on the spring.

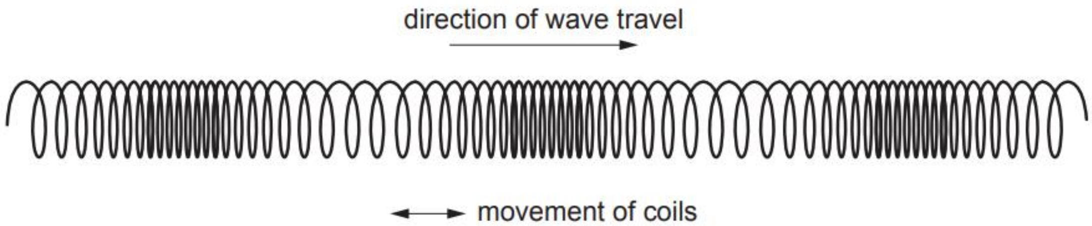

Fig. 7.1

(a) Explain why the type of wave in Fig. 7.1 is a longitudinal wave.

....

.... [2]

(b) Measure the wavelength of the wave shown in Fig. 7.1.

wavelength = ... cm [1]

(c) State what is meant by the frequency of a wave.

....

.... [2]

(d) The wave in Fig. 7.1 travels 25 cm in 0.20 s.

Calculate the speed of the wave.

speed = ... cm/s [3]

[Total: 8]

Paper 4

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

12 A student plays the violin near the doorway to a large room. Fig. 6.1 shows a young teacher standing where he can hear the sound but cannot see the student.

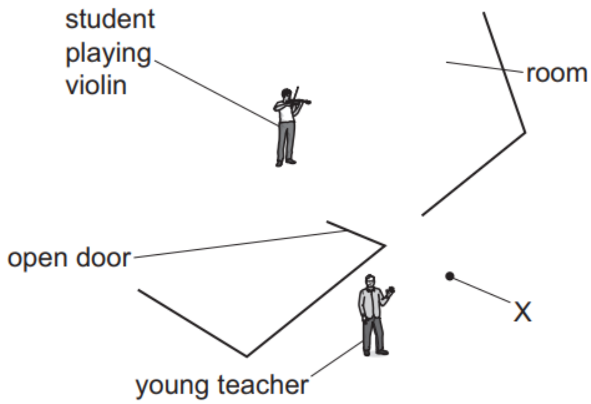

Fig. 6.1

(a) (i) State the wave effect that allows the young teacher to hear sounds from the violin at the position he is standing in Fig. 6.1.

.... [1]

(ii) Calculate the frequency of sound with a wavelength of 0.75 m.
The speed of sound in air is 340 m/s.

frequency = ... [2]

(iii) A violin produces sounds in the frequency range 200 Hz–3800 Hz. The width of the open doorway is 0.75 m. **(extended only)**

Explain why the young teacher hears the frequency calculated in **(a)(ii)** clearly but finds a frequency of 3500 Hz much harder to hear.

....

....

.... [2]

(b) A plane mirror is placed at point X so that the teacher can see the student. **(extended only)**
On Fig. 6.1:

- draw a light ray from the violin to point X and from point X to the teacher
- draw and label the mirror
- add an arrow to the ray to show how the teacher sees the student.

Use a ruler and sharp pencil for this drawing. [3]

[Total: 8]

13 **(a)** Describe how a longitudinal wave differs from a transverse wave.

....

....

.... [2]

(b) Fig. 5.1 represents a seismic wave produced by an earthquake.

Fig. 5.1

(i) State whether this seismic wave is a P-wave (primary) or an S-wave (secondary). Justify your choice.

....

.... [1]

(ii) The wave represented in Fig. 5.1 has a wavelength of 1.2×10^4 m.

Calculate the actual distance between point J and point K.

distance = ... [2]

(iii) The wave in **(ii)** travels through the ground at a speed of 4600 m/s.

As the wave passes a certain point, the ground completes 5 oscillations.

Calculate the time that it takes for the wave to pass. Show your working.

time = ... [3]

14 Two types of seismic waves are P-waves and S-waves.

(a) State the types of wave that P-waves and S-waves can be modelled as.

P-waves ....

S-waves ....
[2]

(b) The velocity of a P-wave in the Earth's solid crust is 7.2 km / s and its frequency is 4.5 Hz.

Calculate the wavelength of this P-wave.

wavelength = ... [3]

[Total: 5]

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

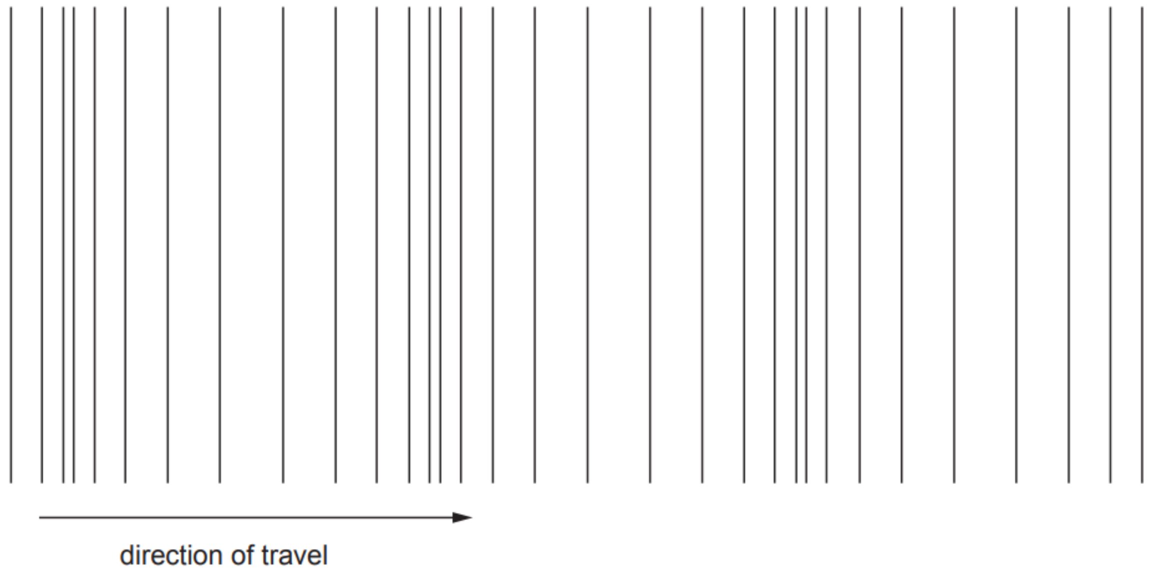

Fig. 6.1

(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.
(extended only)

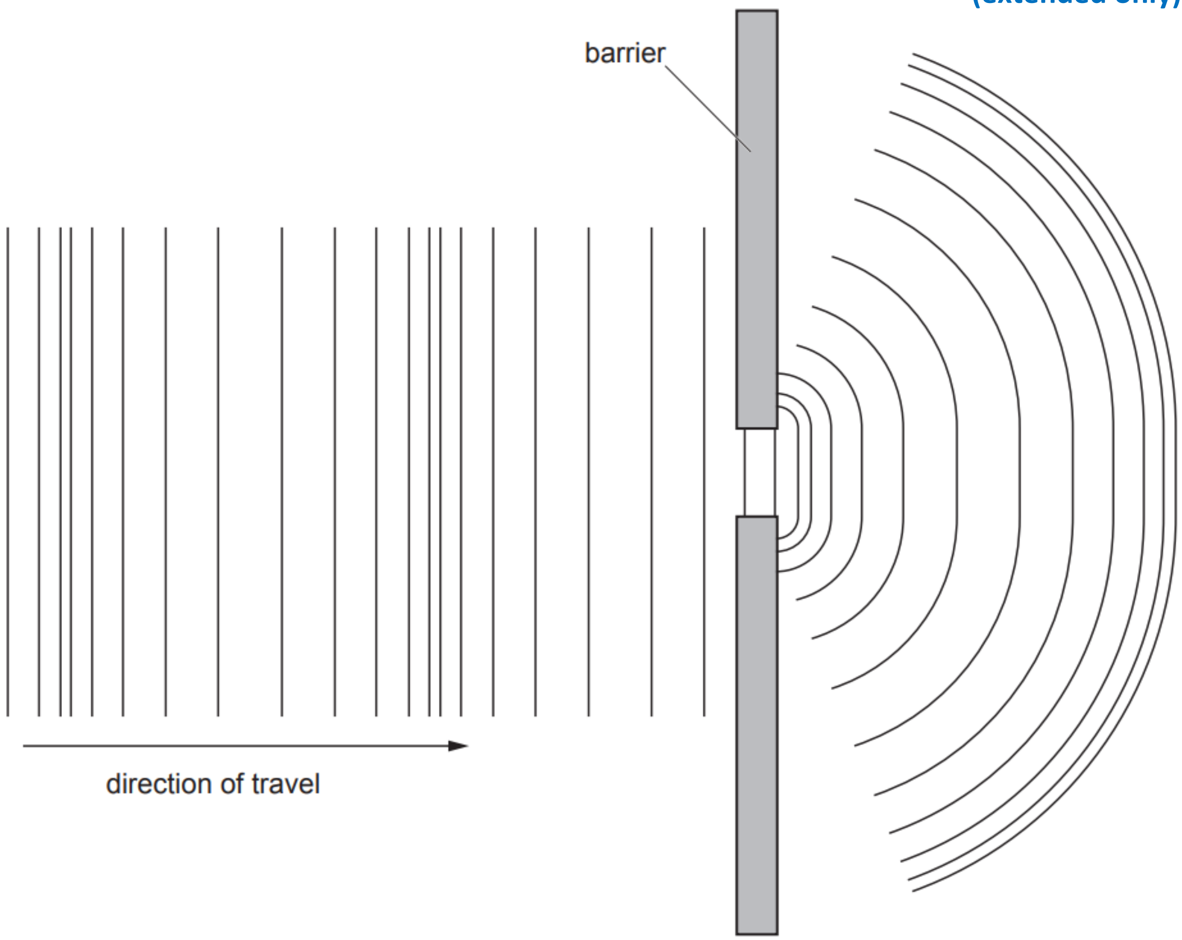

Fig. 6.2

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]

16 Fig. 6.1 shows a shallow tank viewed from above. The depth of the water is different in the two parts of the tank. Fig. 6.1 shows the crests and the troughs of a wave that pass from left to right.

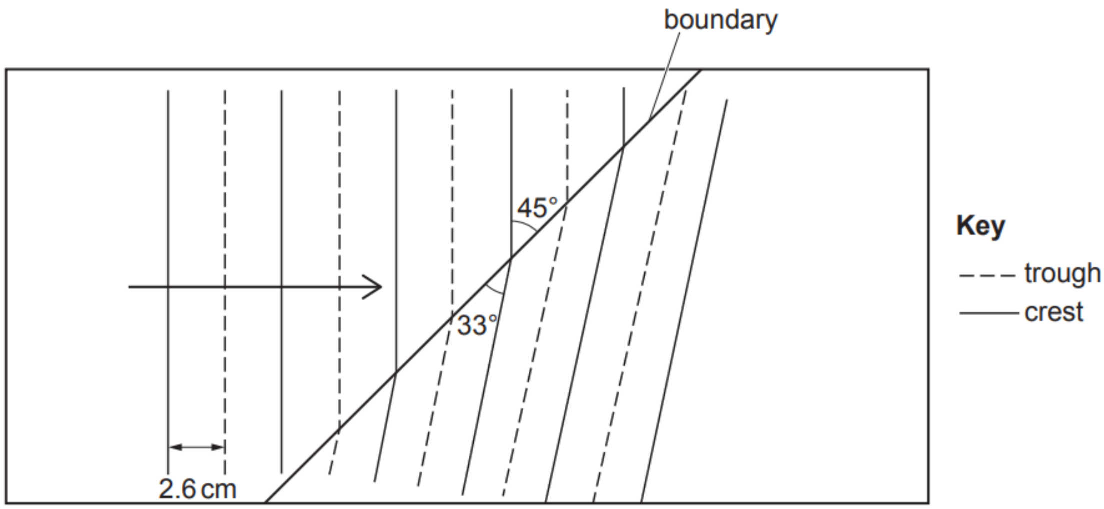

Fig. 6.1 (not to scale)

As the wave passes from one side to the other, the direction of the wavefronts changes.

(a) Explain why the direction of the wavefronts changes in the way shown in Fig. 6.1.

....

....

....

....

.... [3]

(b) The speed of the wave in the left-hand part of the tank is 0.39 m/s.

(i) Using information from Fig. 6.1, determine the frequency of the wave.

frequency = ... [3]

(ii) Determine the speed of the wave in the right-hand side of the tank. **(extended only)**

speed = ... [3]

[Total: 9]

17 Fig. 6.1 shows a transverse wave produced in a string.

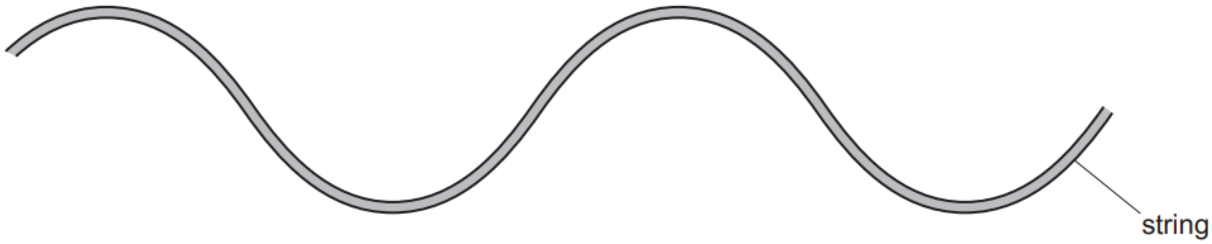

Fig. 6.1 (full size)

(a) On Fig. 6.1:

(i) draw labelled lines to show

1. the amplitude of the wave

2. the wavelength of the wave

[2]

(ii) label a trough with the letter T. [1]

(b) A person vibrates one end of the string vertically to produce the wave. He makes 15 complete oscillations in 60 s.

Show that the speed of the wave is 2.0 cm / s.

[3]

(c) State the difference between transverse waves and longitudinal waves. Use your ideas about the direction of oscillations.

transverse waves ....

....

longitudinal waves ....

....

[2]

[Total: 8]

18 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. **(extended only)**

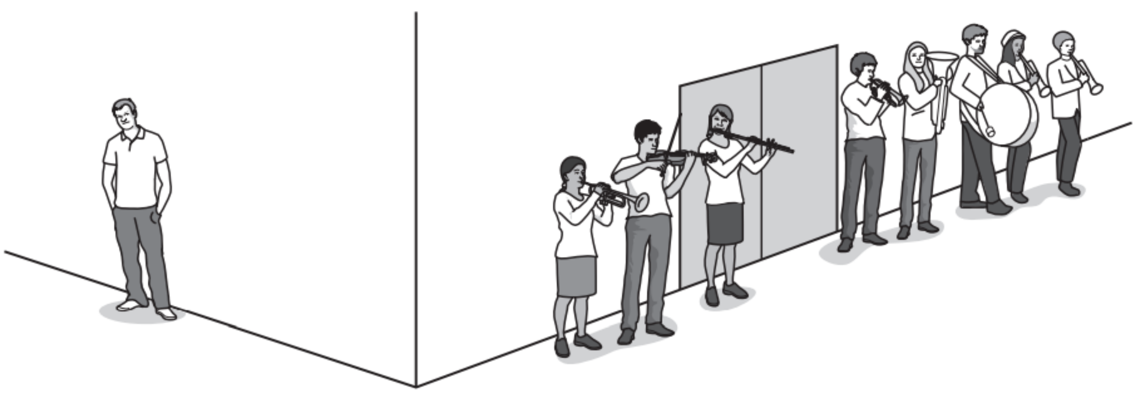

Fig. 6.1

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]

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

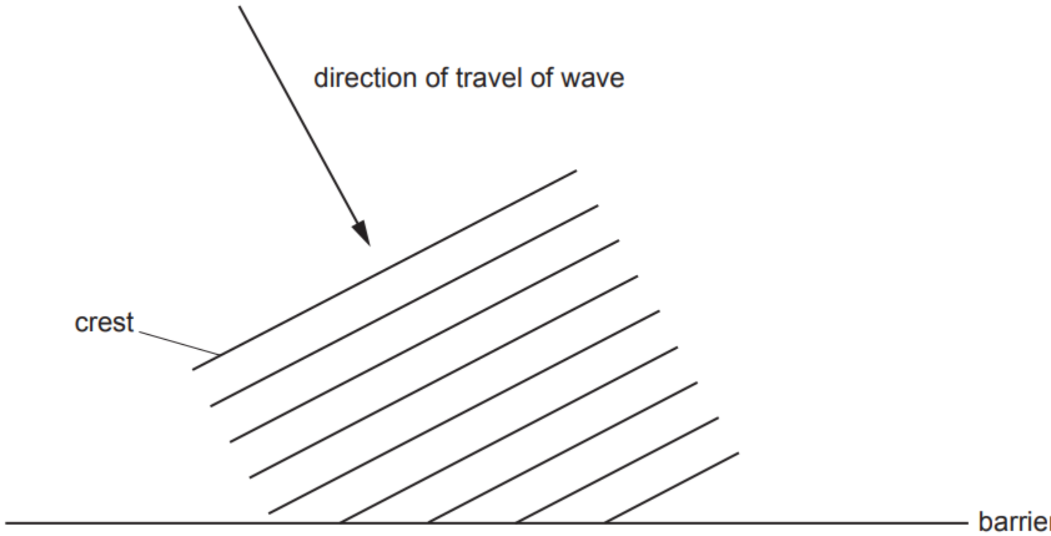

Fig. 5.1

(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]

20 **(a)** Fig. 6.1 shows wavefronts approaching a gap in a barrier.

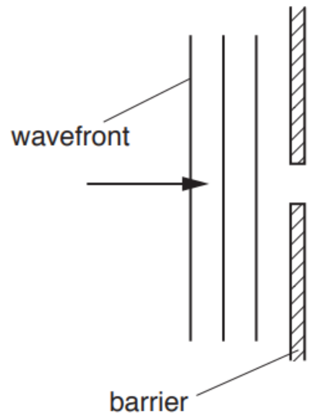

Fig. 6.1

(i) On Fig. 6.1, draw **three** wavefronts to the right of the barrier. [2]

(ii) Fig. 6.2 shows the gap in the barrier increased to five times the gap in Fig. 6.1.
(extended only)

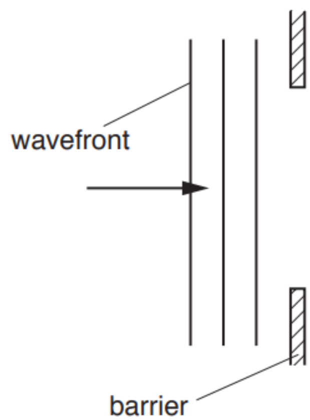

Fig. 6.2

On Fig. 6.2, draw **three** wavefronts to the right of the barrier. [2]