1 (a) A police car siren emits sound waves that vary in pitch.

Tick **two** boxes that apply to the sound waves emitted by the siren.

- ☐ electromagnetic
- ☐ longitudinal
- ☐ transverse
- ☐ visible
- ☐ frequency 0.1–10 Hz
- ☐ frequency 100–10 000 Hz
- ☐ frequency 100 000–1 000 000 Hz

[2]

(b) Fig. 7.1 is a top view of one wavefront of a water wave before it strikes a hard boundary.

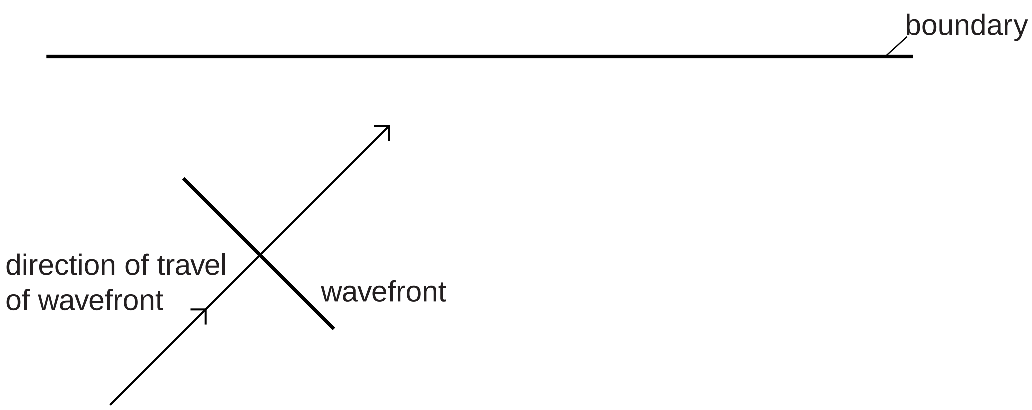

Fig. 7.1

(i) Name the process that occurs as the wavefront strikes the boundary.

.... [1]

(ii) Explain, in terms of wave theory, what occurs as the wavefront strikes the boundary.

....

....

....

....

.... [2]

(iii) State whether there is an increase, a decrease or no change in the wavelength of the wave after it strikes the boundary.

.... [1]

(iv) The speed of the wave is 3.0 m / s and its wavelength 7.0 cm.

Calculate the frequency of the wave.

frequency = ... [2]

[Total: 8]

2 **(a)** Underline the most appropriate value below for the speed of sound in water. [1]

1.5 m/s 15 m/s 150 m/s 1500 m/s 15000 m/s

(b) Sound travels in water as a series of compressions and rarefactions.

Describe what is meant by a *compression* and by a *rarefaction*.

compression ....

....

rarefaction ....

.... [2]

(c) An echo-sounder sends out a pulse of sound to determine the depth of the sea bed. It measures the time between sending out the pulse and receiving its echo.

Fig. 7.1 shows a boat using an echo-sounder.

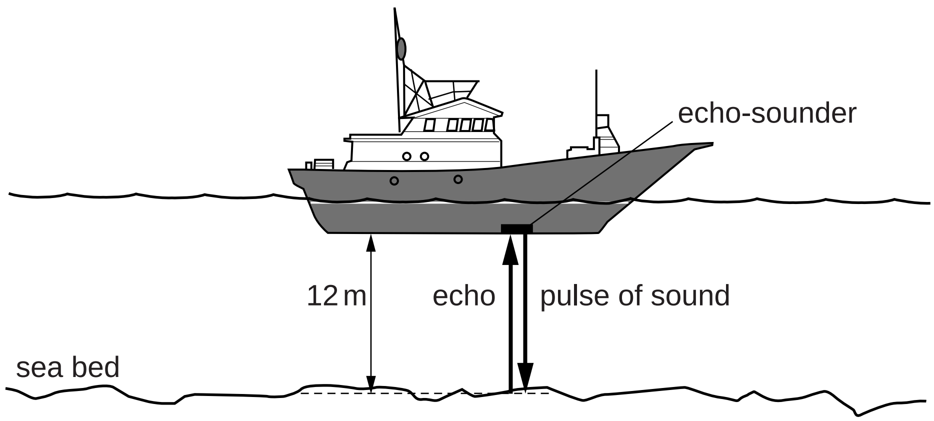

Fig. 7.1

The sea bed is 12 m below the echo-sounder.

(i) Use your value for the speed of sound in water from **(a)** to calculate the time between the sending out of the pulse and receiving its echo.

time = ... [3]

(ii) The boat passes over a region of the sea bed of the same depth, where the reflection of sound waves is weaker.

State whether there is an increase, a decrease or no change in the amplitude and pitch of the reflected wave.

amplitude ....

pitch ....
[2]

[Total: 8]

3 **(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.

speed = ... [3]

[Total: 8]

4 **(a)** State an approximate value for

(i) the speed of sound in air, ...

(ii) the speed of light in air. .... [2]

(b) Use your value from **(a)(i)** to calculate the frequency of a sound wave that has a wavelength of 1.2 m.

frequency = ... [2]

(c) A meteorologist observes an approaching thunderstorm and records a time difference of 4.8 s between seeing a lightning flash and hearing the thunder that follows.

(i) Calculate the distance of the thunderstorm from the meteorologist.

distance = ...

(ii) State an assumption you made when calculating this distance.

....

....

....
[2]

[Total: 6]

5 Fig. 8.1 shows a loudspeaker cone oscillating to produce sound waves.

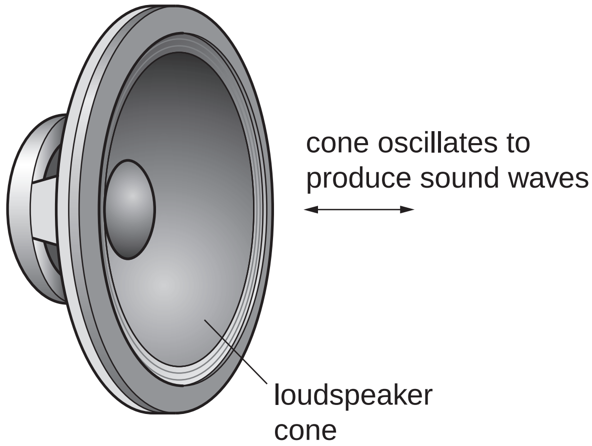

Fig. 8.1

(a) As the sound wave passes a point, it produces regions of higher and lower pressure. State the names of these regions.

higher pressure ....

lower pressure .... [2]

(b) Describe how the movement of the loudspeaker cone produces these regions of different pressure.

higher pressure ....

....

lower pressure ....

.... [2]

(c) State the effect on the loudness and pitch of the sound from the loudspeaker when

(i) the amplitude increases but the frequency of the sound stays the same,

loudness ....

pitch ....

(ii) the amplitude stays the same but the frequency increases.

loudness ....

pitch ....
[2]

[Total: 6]

6 During a thunderstorm, thunder and lightning are produced at the same time.

(a) A person is some distance away from the storm.

Explain why the person sees the lightning before hearing the thunder.

....

....

.... [1]

(b) A scientist in a laboratory made the following measurements during a thunderstorm.

time from start of storm / minutes	0.0	2.0	4.0	6.0	8.0	10.0
time between seeing lightning and hearing thunder / s	3.6	2.4	1.6	2.4	3.5	4.4

Fig. 7.1

(i) How many minutes after the storm started did it reach its closest point to the laboratory?

.... [1]

(ii) How can you tell that the storm was never immediately over the laboratory?

.... [1]

(iii) When the storm started, it was immediately above a village 1200 m from the laboratory.

Using this information and information from Fig. 7.1, calculate the speed of sound.

speed of sound = ... [2]

(iv) State the assumption you made when you calculated your answer to **(b)(iii)**.

.... [1]

(c) Some waves are longitudinal; some waves are transverse.

Some waves are electromagnetic; some waves are mechanical.

Put ticks (✓) in the table below to indicate which of these descriptions apply to the light waves of the lightning and the sound waves of the thunder.

	light waves	sound waves
longitudinal		
transverse		
electromagnetic		
mechanical		

[3]

[Total: 9]

7 A disused railway line has a length of 300 m. A man puts his ear against one end of the rail and another man hits the other end with a metal hammer, as shown in Fig. 7.1.

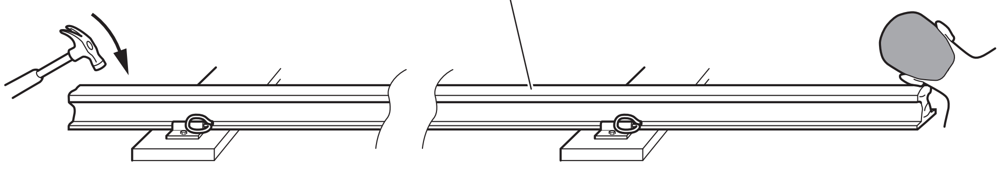

Fig. 7.1

(a) **(i)** State an approximate value for the speed of sound in air.

.... [1]

(ii) Sound travels at 5000 m / s in steel.

Calculate the time it takes for the sound to travel along the rail.

time taken = ... [2]

(b) The man with his ear to the railway line actually hears two sounds from the hammer, separated by a short interval.

Explain why he hears two sounds.

....

....

....

.... [2]

[Total: 5]