**1** Fig. 9.1 represents the regions of the electromagnetic spectrum.

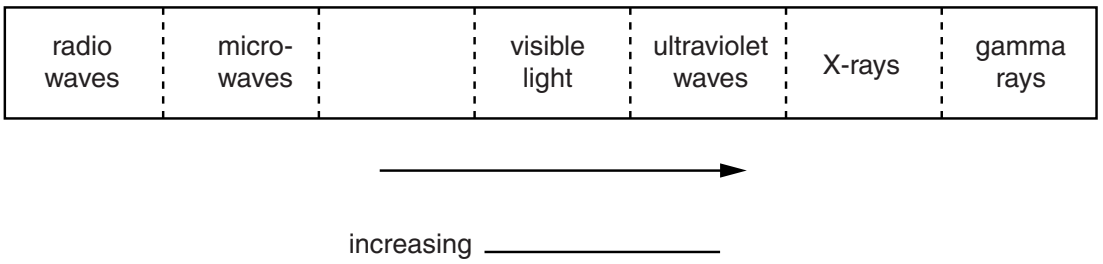


**Fig. 9.1**

**(a)** Complete Fig. 9.1:

**(i)** Add the label of the missing region. [1]

**(ii)** Complete the label under the arrow. [1]

**(b)** **(i)** State **two** uses of X-rays.

1. .....

2. .....

[2]

**(ii)** Describe **two** safety precautions taken by people using X-rays.

1. .....

2. .....

[2]

**(iii)** X-rays and light waves can both travel through a vacuum.

Identify the correct statement. Tick **one** box.

☐ X-rays travel at a slower speed than light waves.

☐ X-rays travel at the same speed as light waves.

☐ X-rays travel at a faster speed than light waves.

[1]

[Total: 7]

**2** Waves from different regions of the electromagnetic spectrum have different uses.

**(a)** Draw **one** line from each type of electromagnetic wave to its use.

| | |
|---|---|
| | household lights |
| microwaves | television remote control |
| | loudspeaker |
| infra-red waves | satellite communications |
| | security check of suitcases |

[2]

**(b)** Many years ago, some shoe shops used X-ray machines to make images of feet, as shown in Fig. 9.1.

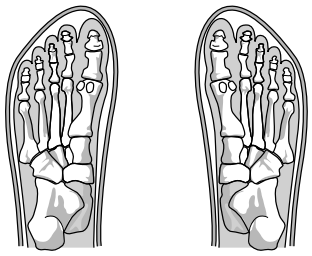

**Fig. 9.1**

Explain the risk to health of using these X-ray machines.

.....

.....

.....

.....[2]

[Total: 4]

**3** **(a)** Some students want to determine the speed of sound in air.

Describe a method they could use. Include the measurements they must make.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

**(b)** The graph in Fig. 8.1 represents a sound wave.

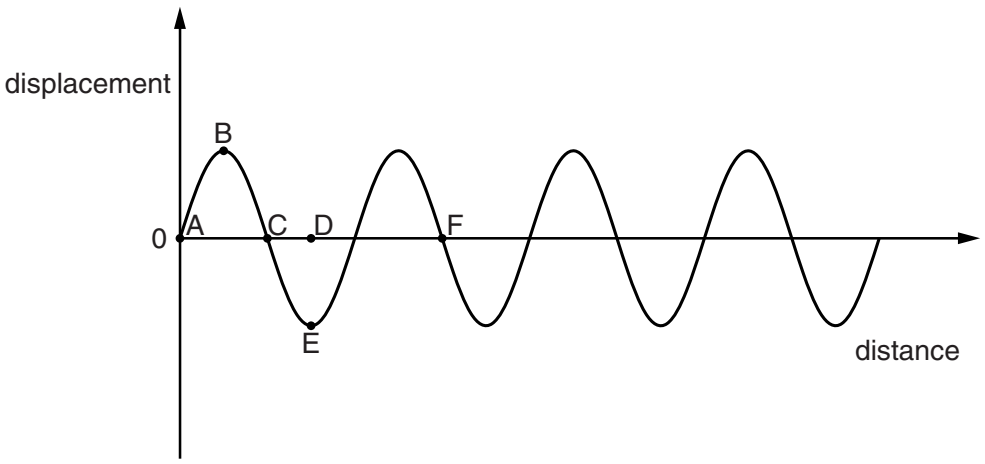


**Fig. 8.1**

**(i)** Which distance represents the amplitude of the wave? Circle your answer. [1]

AC AF BE DE CF

**(ii)** Which distance represents the wavelength of the wave? Circle your answer. [1]

AC AF BE DE CF

**(iii)** Another sound wave, of the same wavelength, is louder.

On Fig. 8.1, draw this wave. [2]

[Total: 8]

**4** **(a)** State the type of electromagnetic radiation

**(i)** used in luggage security checks at airports,

.....

**(ii)** used by remote controls for TV sets.

.....

[2]

**(b)** **(i)** The electromagnetic waves used in a microwave oven have a frequency of $2.45 \times 10^9$ Hz. The speed of the waves is $3.00 \times 10^8$ m/s.

Calculate the wavelength of the waves.

wavelength = ..... [2]

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

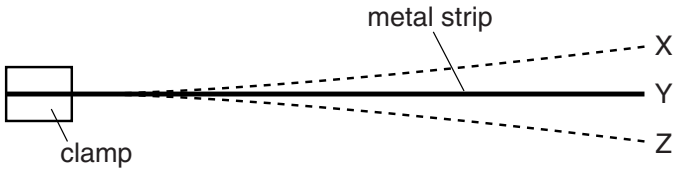


**Fig. 5.1**

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]

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

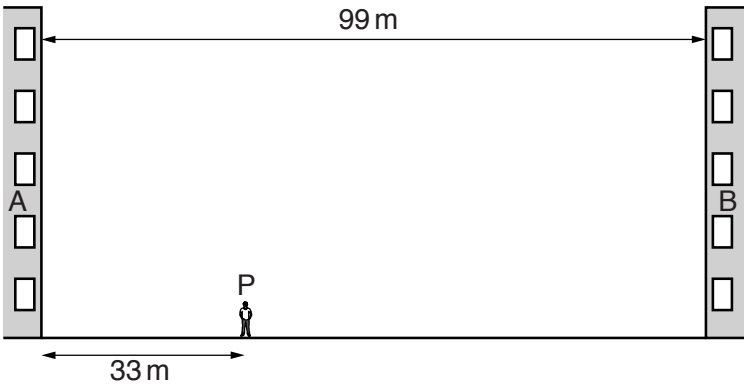


**Fig. 5.2** (not to scale)

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]

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

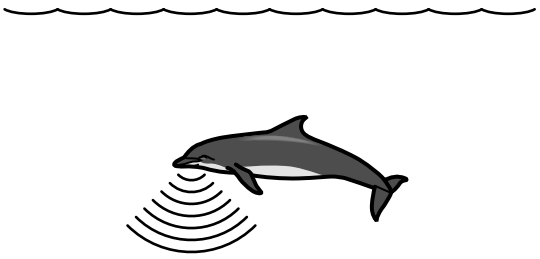

**Fig. 5.3** (not to scale)

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

wavelength = .....[2]

[Total: 9]

**6** **(a)** A sound wave in air consists of alternate compressions and rarefactions along its path.

**(i)** Explain how a compression differs from a rarefaction.

.....

.....[1]

**(ii)** Explain, in terms of compressions, what is meant by

**1.** the wavelength of the sound,

.....

.....[1]

**2.** the frequency of the sound.

.....

.....[1]

**(b)** At night, bats emit pulses of sound to detect obstacles and prey. The speed of sound in air is 340 m/s.

**(i)** A bat emits a pulse of sound of wavelength 0.0085 m.

Calculate the frequency of the sound.

frequency = .....[2]

**(ii)** State why this sound cannot be heard by human beings.

.....

.....[1]

**(iii)** The pulse of sound hits a stationary object and is reflected back to the bat. The pulse is received by the bat 0.12 s after it was emitted.

Calculate the distance travelled by the pulse of sound during this time.

distance = .....[2]

[Total: 8]

**7** A sound wave, travelling in air, approaches a solid barrier with a gap in the middle. Fig. 6.1 represents the compressions and rarefactions of the sound wave. The compressions are labelled A, B and C.

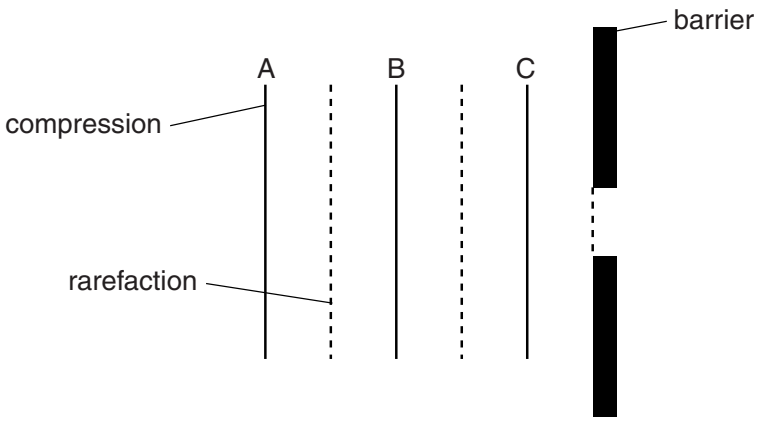


**Fig. 6.1**

**(a)** State how a *compression* differs from a *rarefaction*.

.....

.....[1]

**(b)** The speed of sound in air is 340 m / s. The frequency of the sound is 850 Hz.

For this wave, determine

**(i)** the wavelength,

wavelength = .....[2]

**(ii)** the time that elapses before compression A reaches the barrier.

time = .....[2]

**(c)** On Fig. 6.1, draw the shape and positions of compressions B and C as compression A reaches the barrier. [2]

**(d)** Sound waves can also travel in water.

State how the speed of sound in water compares with the speed of sound in air.

.....[1]

[Total: 8]

**8** 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.

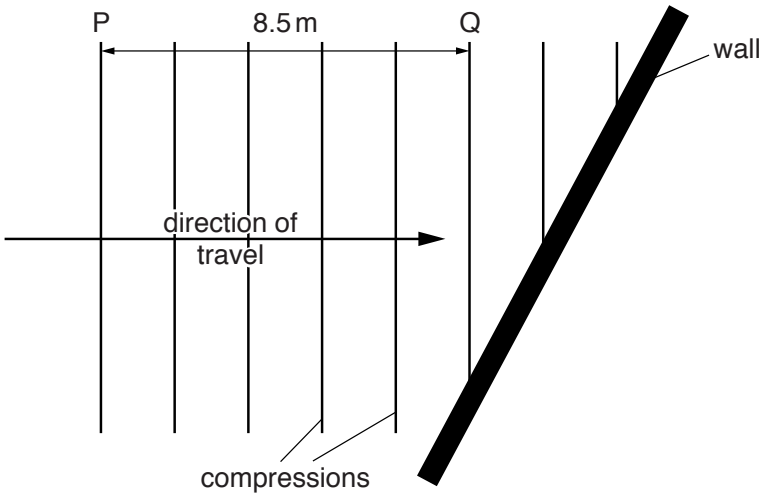


**Fig. 7.1**

**(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]

**9** A dolphin produces a sound wave in water of frequency 7800 Hz.

Fig. 6.1 represents rarefactions of the sound wave travelling in the water and hitting the side of a wooden ship at an angle.

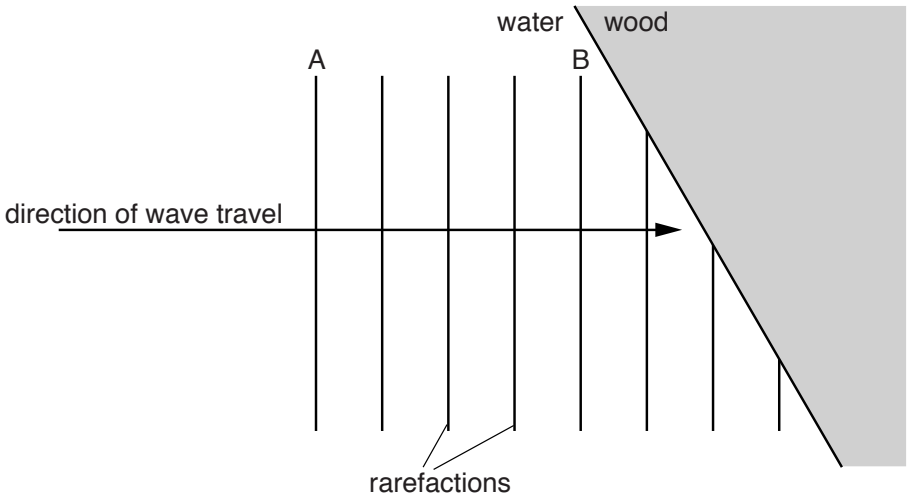


**Fig. 6.1**

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

.....

.....[1]

**(b)** On Fig. 6.1, two rarefactions A and B are labelled. The distance between rarefaction A and rarefaction B is 0.76 m.

Determine

**(i)** the wavelength in water of the sound wave,

wavelength = .....[1]

**(ii)** the time taken for the rarefaction at A to reach the point where rarefaction B is now positioned.

time = .....[2]

**(c)** The sound wave passes from the water into the wood where the speed of sound is greater.

State what happens to

**(i)** the frequency,

.....[1]

**(ii)** the wavelength.

.....[1]

**(d)** On Fig. 6.1, sketch the positions in the wood of the three incomplete rarefactions. [2]

[Total: 8]

**10** **(a)** Draw a straight line from each quantity on the left-hand side to a speed on the right-hand side which is typical for that quantity.

| | |
|---|---|
| | 30 m/s |
| speed of sound in gas | 300 m/s |
| | 3000 m/s |
| speed of sound in solid | 30 000 m/s |
| | 300 000 m/s |

[2]

**(b)** Explain why sound waves are described as *longitudinal*.

.....

..... [2]

**(c)** Fig. 8.1 shows how the displacement of air molecules, at an instant of time, varies with distance along the path of a sound wave.

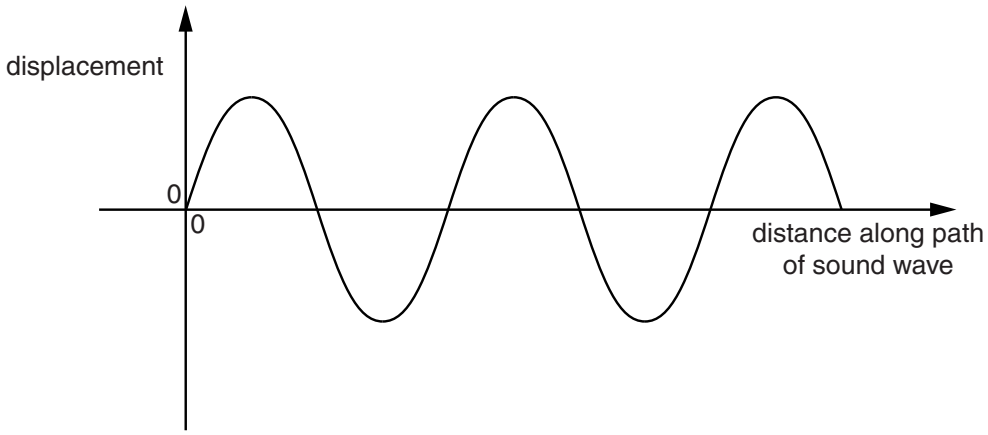


**Fig. 8.1**

**(i)** On Fig. 8.1, sketch two cycles of a sound wave that has a shorter wavelength **and** a greater amplitude. [2]

**(ii)** State **two** changes in the sound heard from this wave compared with the original wave.

1. .....

2. .....
[2]

[Total: 8]