



Section 1- Communicating Through the Air and Through Wires

Light and Sound

In this section you can use the equation:

$$\text{average speed} = \frac{\text{distance}}{\text{time}}$$

also written as

$$\bar{v} = \frac{d}{t}$$

where d = distance in metres (m).

\bar{v} = average speed in metres per second (m/s)

t = time in seconds (s).

Helpful Hint

The speed of light is much faster than the speed of sound. In fact light from distant objects appears to reach us almost instantaneously.

In this section use:

speed of light = 3×10^8 m/s and speed of sound = 340 m/s.

1. Find the missing values in the following table.

	Distance (m)	Average speed (m/s)	Time (s)
(a)		3×10^8	5
(b)		340	5
(c)	500		1.47
(d)	8 600		25.3
(e)	6 500	3×10^8	
(f)	255	340	

2. Calculate how far light travels in:

(a) 1 second (b) 3 seconds (c) 10 seconds.

3. Calculate how far sound travels in:

(a) 1 second (b) 3 seconds (c) 10 seconds.

4. A golfer is worried about the dangers of being out on the course during a thunder and lightning storm. He suddenly sees a flash of lightning and then counts 4 seconds before he hears the clap of thunder. How far away is the storm?
5. A group of physics students set out to measure the speed of sound. The pupils stand a distance of 200 metres from the teacher who has a flash gun and starter pistol. The pupils have to start their stopcock when they see the flash and stop it when they hear the bang. The experiment is carried out three times and the results are shown in the table below.

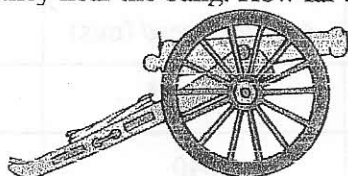
Distance from gun to pupils (m)	Time recorded (s)	Average speed (m/s)
200 m	0.58	
200 m	0.56	
200 m	0.59	

Calculate the speed of sound for each time recorded.

6. Spectators are told to stay behind a barrier which is 100m away from where fireworks are being set off at a display. How long will it take spectators to hear a 'banger' after they have seen it explode?



7. During the Edinburgh Tattoo, tourists on Princes Street see the canon smoke from the castle 3 seconds before they hear the bang. How far are they from the castle?



8. A plane spotter sees a military jet and then 4.5 seconds later hears the roar from its engine. How far away is the jet?
9. In a 100m sprint race the timers start timing when they hear the starter pistol and stop timing when they see the sprinters cross the finishing line.



- (a) Does this method overestimate or underestimate their sprint times? Explain your answer.
- (b) How could the accuracy of the timing be improved?
10. During the demolition of the high rise flats in the Gorbals, spectators saw the explosion first and heard it 7 seconds later.
- (a) Why was there a delay?
- (b) How far from the explosion were they standing?



Section 2 - Waves

Frequency

In this section you can use the equation:

$$\text{frequency} = \frac{\text{number of waves}}{\text{time taken}}$$

where **frequency** is measured in Hertz (Hz)
time is measured in seconds (s).

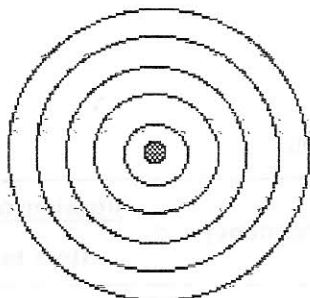
1. Find the missing values in the following table.

	<i>Frequency (Hz)</i>	<i>Number of Waves</i>	<i>Time (s)</i>
(a)		10	5
(b)		30	60
(c)	800	3 200	
(d)	12	9 600	
(e)	50		90
(f)	20 000		15

2. If a wave machine produces 5 waves each second what is the frequency of the machine?
3. A man stands on a beach and counts 40 waves hitting the shore in 10 seconds. What is the frequency of these waves?
4. In 100 seconds a particular smoke alarm emits 1 000 000 sound waves. What is the frequency of the sound waves?
5. A girl is sitting on the edge of a pier. It takes 0.625 seconds for one complete wave to pass underneath her. What is the frequency of the waves?
6. A girl stands on a beach and counts 15 waves crashing onto the shore in a time of 1 minute. What is the frequency of the waves?

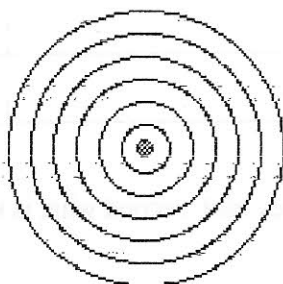


7. A rock is thrown into a pond and an overhead photograph is taken 2 seconds later. The photograph, as shown in the diagram below, reveals that 5 waves were produced in the 2 second period.



What was the frequency of these water waves?

8. In a swimming pool a wave machine creates waves with a frequency of 2 Hz. How many waves are produced in 5 minutes?
9. A smoke alarm sends out high-pitched sound waves with a frequency of 12 000 Hz. If the alarm is on for 30 seconds how many waves does it emit?
10. A pebble was thrown into a still pond and wave ripples were produced at a rate of 3 waves per second. The diagram below represents the wave pattern in the pond a short time after the pebble was dropped.



- (a) What was the frequency of the waves, in Hertz?
- (b) How many waves are represented in the diagram above?
- (c) How long did it take for this wave pattern to form?

Wavelength

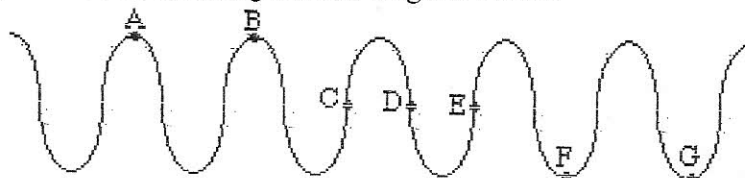
Helpful Hint

Wavelength (symbol λ) means the **length of a wave**. It is measured as the distance from one point on a wave to an identical point on the next wave.

e.g.

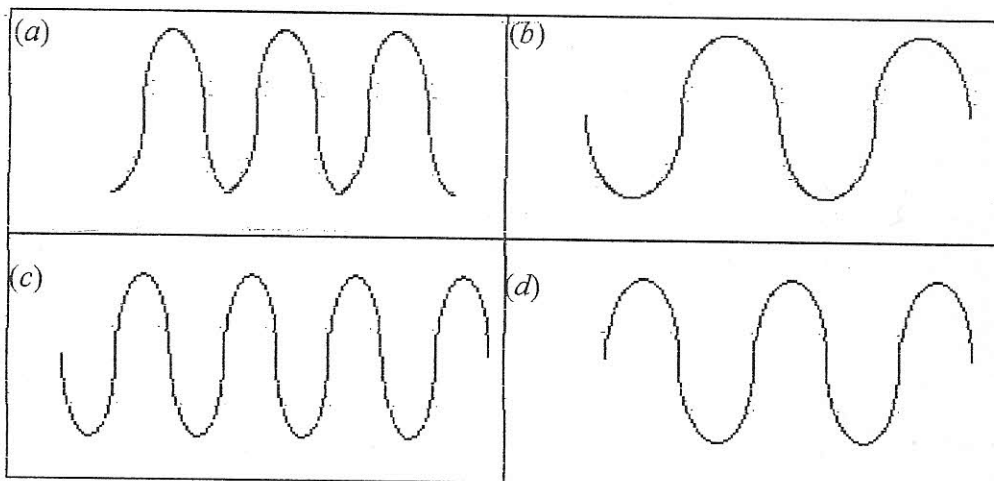


1. 'A-B' represents one wavelength in the diagram below.



State two other pairs of letters which represent one wavelength.

2. How many waves are shown in each of the diagrams below?

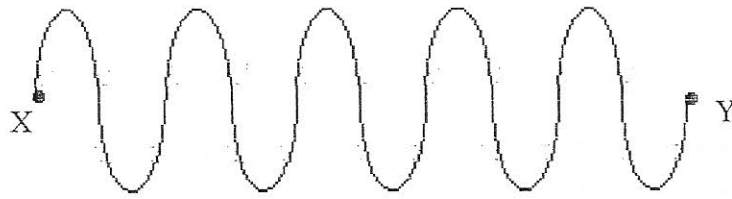
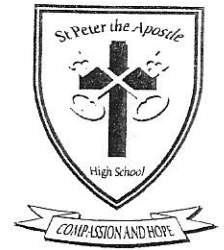


3. The wave train shown below is 20 metres long. How long is each wave?

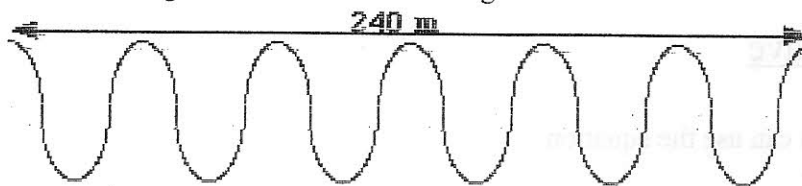


4. The wavelength of the waves in the diagram below is 3 cm. What is the distance between X and Y?

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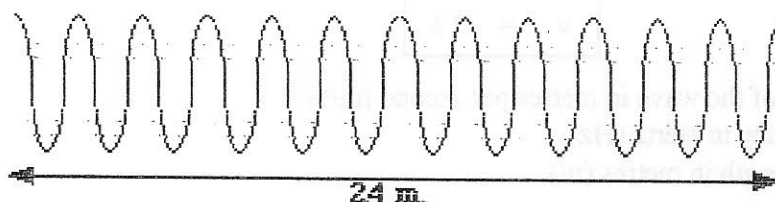


5. What is the wavelength of the waves in the diagram below?

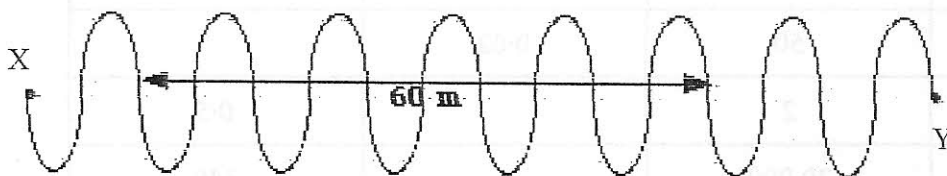


6. Draw a wave train consisting of 2 waves. Put the labels **wavelength** and **amplitude** on your diagram in appropriate places.

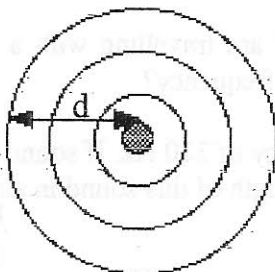
7.



- (a) How many waves are shown in the diagram above?
 (b) What is the wavelength of each of these waves?
8. (a) Calculate the wavelength of the waves shown below.



- (b) What is the distance from X to Y in this wave train?
9. A stone is thrown into a pond, and a wave pattern is produced as shown below. The wavelength of the waves is 6 cm.



Calculate the distance, d , travelled by the outside wave.

10. Red light from a laser has a wavelength of 4×10^{-7} m in a certain glass. How many waves, from this laser, would cover a length of 2 cm in this glass?



Speed of a Wave

In this section you can use the equation:

$$\text{speed} = \text{frequency} \times \text{wavelength}$$

also written as

$$v = f\lambda$$

where v = speed of the wave in metres per second (m/s)

f = frequency in Hertz (Hz)

λ = wavelength in metres (m).

1. Find the missing values in the following table.

	Frequency (Hz)	Wavelength (m)	Speed (m/s)
(a)	5	3	
(b)	50	0.02	
(c)	2		0.5
(d)	20 000		340
(e)		20	600
(f)		5.5×10^{-7}	3×10^8

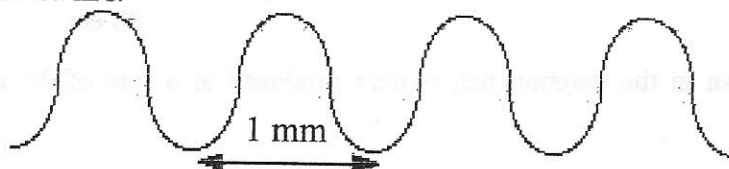
2. Water waves in a swimming pool are travelling with a speed of 2 m/s and have a wavelength of 0.8 m. What is their frequency?
3. The musical note 'E' has a frequency of 320 Hz. If sound travels with a speed of 340 m/s in air calculate the wavelength of this sound in air.



4. Sound of frequency 440 Hz has a wavelength of 3.41 m in water. Calculate the speed of sound in water.
5. What is the speed of waves which have a frequency of 50 Hz and a wavelength of 3 m?



6. A wave machine in a swimming pool produces waves with a frequency of 1 Hz. If they travel across the pool at 1.5 m/s what is their wavelength?
7. A wave generator in a ripple tank creates waves which have a wavelength of 0.02 m. If the speed of these waves is 1.2 m/s what is their frequency?
8. The speed of sound in steel is 5 200 m/s. What is the wavelength of a sound wave which has a frequency of 6 500 Hz in steel?
9. How fast will waves with a frequency of 15 000 Hz and a wavelength of 2.2 cm travel?
10. What is the wavelength of waves which have a frequency of 6×10^6 Hz and a speed of 1 800 m/s?
11. Waves produced by a wave generator in a ripple tank have a wavelength of 16 mm. At what frequency is the wave generator operating if the wave speed is 0.64 m/s?
12. Calculate the frequency of the waves shown in the diagram below given that they have a speed of 0.05 m/s.



13. A boy counts 40 complete waves along the length of a swimming pool. The pool is 50 m long and the waves are travelling with a speed of 3.75 m/s. Calculate:
 - (a) the wavelength of the waves
 - (b) the frequency of the waves
 - (c) the number of waves produced in 1 minute.

14. Waves, like the ones shown in the diagram below, are produced at a rate of 8 000 Hz. Calculate the speed of these waves.

