Wave Basics

Waves transfer energy from one place to another without transferring any matter (stuff). Clever so and so's.

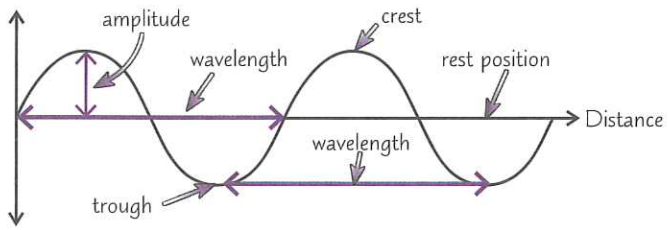
Waves Transfer Energy and Information in the Direction they are Travelling

When waves travel through a medium, the particles of the medium vibrate and transfer energy and information between each other. BUT overall, the particles stay in the same place.

For example, if you drop a twig into a calm pool of water, ripples form on, and move across, the water's surface. The ripples don't carry the water (or the twig) away with them though.

Similarly, if you strum a guitar string and create a sound wave, the sound wave travels to your ear (so you can hear it) but it doesn't carry the air away from the guitar — if it did, it would create a vacuum.

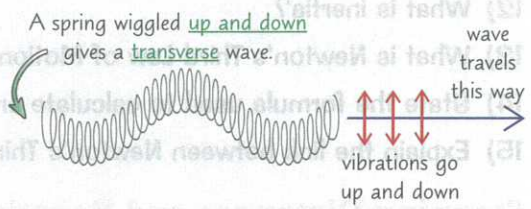
1) The amplitude of a wave is the displacement from the rest position to a crest or trough.
2) The wavelength is the length of a full cycle of the wave (e.g. from crest to crest, or from compression to compression — see below).
3) Frequency is the number of complete cycles of the wave passing a certain point per second. Frequency is measured in hertz (Hz). 1 Hz is 1 wave per second.
4) The period of a wave is the number of seconds it takes for one full cycle. Period = 1 ÷ frequency.



Transverse Waves Have Sideways Vibrations

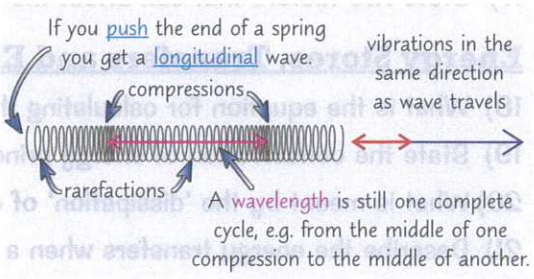
In transverse waves, the vibrations are perpendicular (at 90°) to the direction the wave travels. Most waves are transverse, including:

1) All electromagnetic waves, e.g. light (p.168).
2) S-waves (a type of seismic wave).
3) Ripples and waves in water (see p.165).



Longitudinal Waves Have Parallel Vibrations

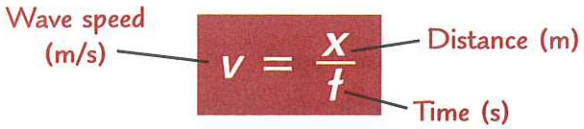
1) In longitudinal waves, the vibrations are parallel to the direction the wave travels.
2) Examples are sound waves and P-waves (a seismic wave).
3) Longitudinal waves squash up and stretch out the arrangement of particles in the medium they pass through, making compressions (high pressure, lots of particles) and rarefactions (low pressure, fewer particles).

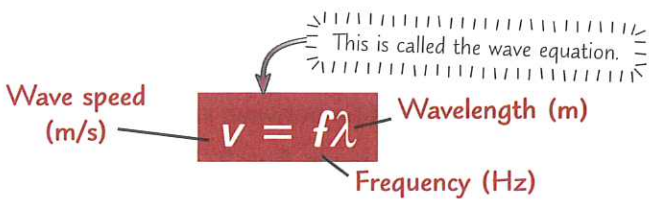


Wave Speed = Frequency × Wavelength

Wave speed is no different to any other speed — it tells you how quickly a wave moves through space.

There are two ways to calculate wave speed:





What about Mexican waves...

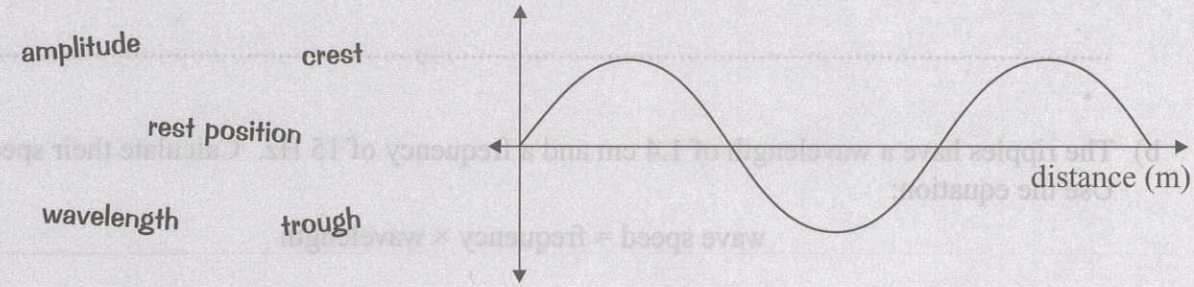
You won't get far unless you understand these wave basics. Try a question to test your knowledge.

Q1 A wave has a speed of 0.15 m/s and a wavelength of 7.5 cm. Calculate its frequency. [3 marks]

Wave Basics

Warm-Up

Add the labels below to the diagram of the wave.



1 Which of the following is **not** a transverse wave? Grade 4-6

☐ **A** S-waves ☐ **B** light waves ☐ **C** P-waves ☐ **D** ripples in water

[Total 1 mark]

2 Which of these is equal to the frequency of a longitudinal wave? Grade 6-7

☐ **A** The maximum displacement from the rest position.

☐ **B** The number of compressions passing a point per second.

☐ **C** The number of compressions plus the number of rarefactions passing a point per second.

☐ **D** The number of rarefactions passing a point per minute.

[Total 1 mark]

3 Waves can be either transverse or longitudinal. Grade 6-7

a) State **one similarity** between longitudinal and transverse waves.

.....

.....

[1]

b) Describe **one difference** between longitudinal and transverse waves.

.....

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.....

.....

[2]

[Total 3 marks]

4 A child throws a stone into a pond. The stone creates ripples when it hits the water, which spread across the pond.

Grade 6–7

a) The ripples pass a leaf floating on the pond.
Explain why the ripples do not carry the leaf to the edge of the pond.

.....

.....

[1]

b) The ripples have a wavelength of 1.4 cm and a frequency of 15 Hz. Calculate their speed.
Use the equation:

wave speed = frequency × wavelength

Speed = ... m/s

[2]

c) The ripples have a period of 0.25 s. Explain what is meant by the period of a wave.

.....

[1]

[Total 4 marks]

5 A violinist is practising in a village hall. Her teacher sits at the back of the hall to listen. As she plays, the vibrating violin string produces a sound wave.

Grade 6–7

a) i) State the equation that links wave speed, distance and time.

.....

[1]

ii) The violinist's teacher sits 17 m away from her. The sound waves travel at a speed of 340 m/s. Calculate the time taken for the teacher to hear the sound produced by the violin when the student begins playing.

Time = ... s

[2]

b) The violinist then plays a note with a frequency of 220 Hz.
The violinist plays this note for 5.0 seconds.
Calculate how many complete sound waves are produced by the vibrating string in this time.

..... waves

[2]

[Total 5 marks]

Exam Practice Tip

Be careful with units when you're working with waves. You need to remember to convert everything into the right units before you do any calculations, or your answers will come out either too big or too small, and you won't get full marks.