Waves: modelling P and S waves using a slinky spring

Key stage 3

The scenario

In order for scientists to locate a crater on Mars using seismometers, they need to understand the properties of the two types of wave that they will observe on the seismometer trace. This demonstration allows students to understand the basic properties of waves, and using images of the waves produced, analyse different waves.

The activity

What is a wave? Ask students to give a definition of what they think a wave is. They may physically wave, they may do a Mexican wave. They may say it's a way of transferring energy. However the key point is that a wave is a method of transferring energy **without transferring matter.**

By far the easiest way to demonstrate longitudinal and transverse waves is with the use of a slinky spring.

Select a volunteer from the class and ask them to hold one end of the spring. Move apart so that the spring is stretched out on the floor.

Attach a piece of coloured tape to the top of one of the coils to allow you to easily observe the movement of that single coil.

Demonstrating a longitudinal wave: You are now going to demonstrate a longitudinal, or a push-pull wave. Pull a couple of the coils nearest to you towards you, compressing them. When you release them they relax, moving apart and compressing the coils ahead of them. As these relax they compress the coils ahead of them and so on. The movement of the coils is signifying the movement of the particles in a longitudinal wave.

Now repeat this, but get students to look at the piece of coloured tape. They should notice that it oscillates backwards and forwards around a point, but the coil itself does not permanently move from its position. The wave has travelled through the slinky, transferring energy, but no single coil has permanently changed its position.

Ask students to give an example of a longitudinal wave e.g. sound. Note that longitudinal waves require a medium to travel through.

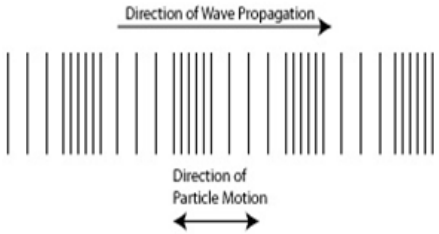
Learning objectives

- definition and properties of transverse and longitudinal waves
- what do we mean by a wave?
- definition of wavelength, amplitude and frequency

Equipment needed

- slinky spring
- piece of coloured tape
- camera

Slinky springs are a useful tool to demonstrate longitudinal and transverse waves.



A longitudinal wave is made up of compressions, where particles are close together and rarefactions, where particles are spread out. The particles move in a direction that is parallel to the direction of wave propagation.

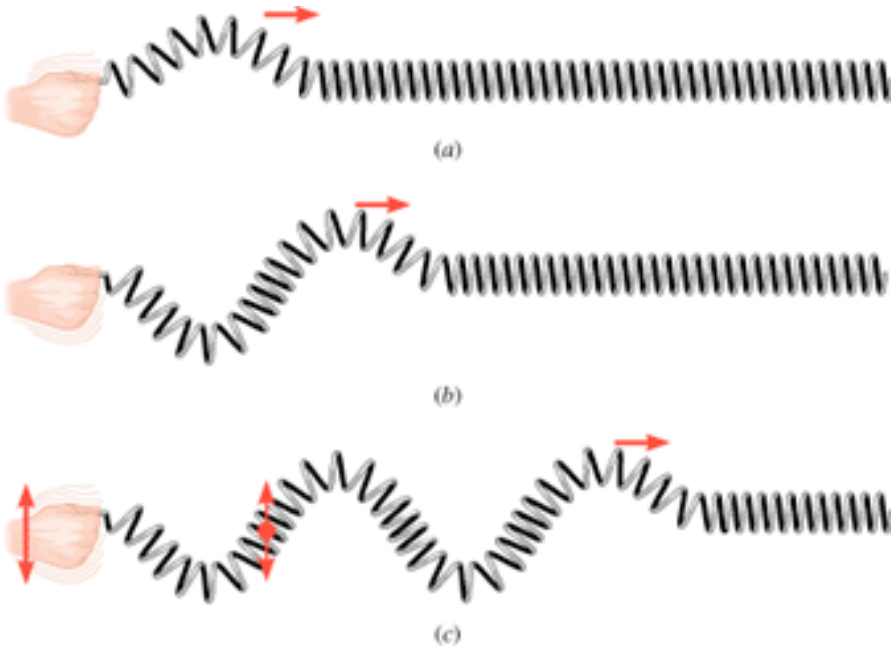
MarsQuake

Take a picture of the wave as it progresses through the slinky.
Can students work out what one wavelength will be on this image?

(One wavelength is the distance between the centre of a compression to the centre of the next compression).

Demonstrating transverse waves: You will now use the same set up to demonstrate a transverse wave – one where the oscillation of the particles is perpendicular to the direction of propagation (advancement) of the wave. Move your hand side to side once, allowing a wave pulse to travel down the slinky. Again, get students to identify what the motion of the tape is. This time it oscillates up and down, while the wave travels along the spring. Show students that if you continue oscillating, you can set up a standing wave.

In transverse waves, the particles oscillate in a plane perpendicular to the direction of propagation of the wave. While most transverse waves require a medium to travel through, some, such as electromagnetic waves (light waves) do not. In an electromagnetic wave, it is the electric and magnetic fields that are 'oscillating'.



Amplitude: Introduce the concept of amplitude by increasing the distance you move your hand up and down. You can then show damping by sending a few waves through the spring and asking students to observe over time what happens. As energy is lost to the surroundings, the amplitude of the wave decreases.

Measuring wavelength and amplitude

Take a picture of the wave as it progresses through the slinky.
Can students label the wavelength and amplitude of this wave?