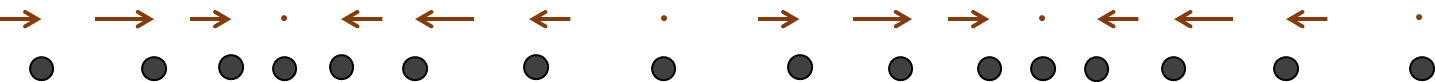
**Explaining longitudinal waves**

The particles in a longitudinal wave move forwards and backwards.

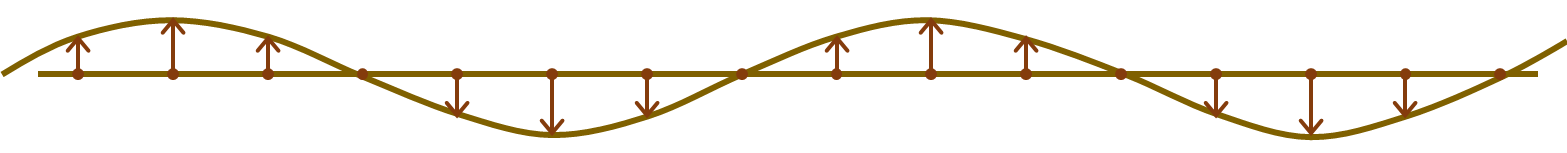
Average position of undisturbed particles.



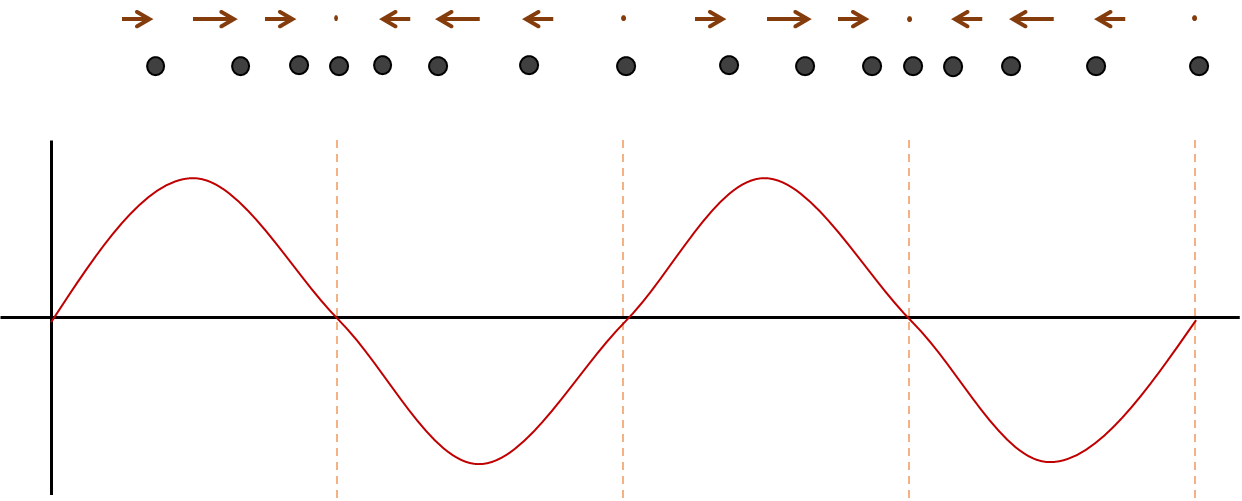
Longitudinal wave



The movement of particles in a longitudinal wave can be compared to movement in a rope wave.



The graph drawn below represents this longitudinal wave.



**To do:**

1. Make a copy of the graph and add labels to each axis.
2. Explain how the graph shows the movement of particles in a longitudinal wave.

*Physics > Big idea PSL: Sound, light and waves > Topic PSL5: Measuring waves > Key concept PSL5.1: Visualising waves*

|  |
| --- |
| **Response activity** |
| **Explaining longitudinal waves** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The motion of particles in a wave can be represented by a displacement-distance or a displacement-time graph, from which the wave’s amplitude and wavelength or time period can be found. |
| Observable learning outcome: | Identify wavelength and amplitude on pictures of longitudinal waves.  Explain how a displacement-distance graph relates to the longitudinal wave it describes. |
| Activity type: | Clarifying - demonstration |
| Key words: | Wavelength, amplitude, longitudinal wave |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Longitudinal measurements
* Diagnostic question: Spring wave graph

**What does the research say?**

About two thirds of students age 15 and 16 in Caleon and Subramaniam’s study (2010) struggled to identify the wavelength of a longitudinal wave from a picture or description of its particles. They did not have any significant misunderstandings, but were unsure of how particle positions in a longitudinal wave related to wavelength. This may be because they are trying to make direct connections with the wavelength shown in the wave picture of a transverse wave. Tumanggor et al. (2019) found that about half of trainee physics teachers (n=35) had a similar uncertainty

**Ways to use this activity**

This demonstration on the PowerPoint presentation gives you the opportunity to re-teach a challenging concept, and show your students how it builds up from simpler ideas, using a structured teacher-led discussion.

You should use carefully selected questions to check your students’ understanding of each step, before progressing onto the next one.

The steps you follow in this demonstration might be:

* Identify the motion of a ‘particle’ in a longitudinal wave by observing the motion of a small piece of sting or ribbon tied to one turn of a slinky spring. This is best observed with a continuous wave, rather than a pulse, and with a marker on the desktop to indicate the position of the string when there is no wave.
* Use the diagrams on first slide of the PowerPoint presentation for this activity to show how the amount of forward and backward movement of each ‘particle’ results in the overall spacing of particles in a longitudinal wave. Each step is revealed by a mouse click.
* Use the diagrams on the second slide of the PowerPoint presentation to compare and contrast the movement of ‘particles’ in a longitudinal wave with those in a rope (a transverse wave).
* Students complete the activity on the third slide, in small groups or individually.

In addition, there are available online animations of longitudinal waves and pieces of demonstration kit that can be used to compare motion of ‘particles’ in longitudinal and transverse waves.

*Differentiation*

You could challenge different individuals by asking them follow-up questions to clarify or to extend their original answer. If a student is having difficulty with a particular question, it is often helpful to break it into smaller *chunks*, to lead them to a fuller answer. This technique models more thorough answers, and can be used to support an open classroom culture in which students are encouraged to ‘have a go’.

**Equipment**

For the class

* Long slinky spring, piece of ribbon or string tied to one turn of the slinky.
* If available: apparatus to compare motion of ‘particles’ in longitudinal and transverse waves.

**Expected answers**

1. Vertical axis: distance of particle from its usual position, or words to that effect (owtte) / unit of length. Horizontal axis: distance along the wave (owtte) / unit of length.
2. The graph shows how far the particles (on average) have moved out of position because of the wave. The distance particles have moved forward from their usual position is show above the horizontal axis. The distance particles have moved backward from their usual position is shown below it.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Caleon, I. S. and Subramaniam, R. (2010) 'So Students Know What They Know and What They Don't Know? Using a Four-Tier Diagnostic Test to Assess the Nature of Students' Alternative Conceptions', *Research in Science Education,* 40 (3), pp. 313-337.

Tumanggor, A. M. R., Supahar, Kuswanto, H. and Ringo, E. S. (2019) 'Using four-tier diagnostic test instruments to detect physics teacher candidates’ misconceptions: Case of mechanical wave concepts'. *The 5th International Seminar on Science Education*, Yogyakarta, Indonesia Journal of Physics: Conference Series, Institute of Physics.