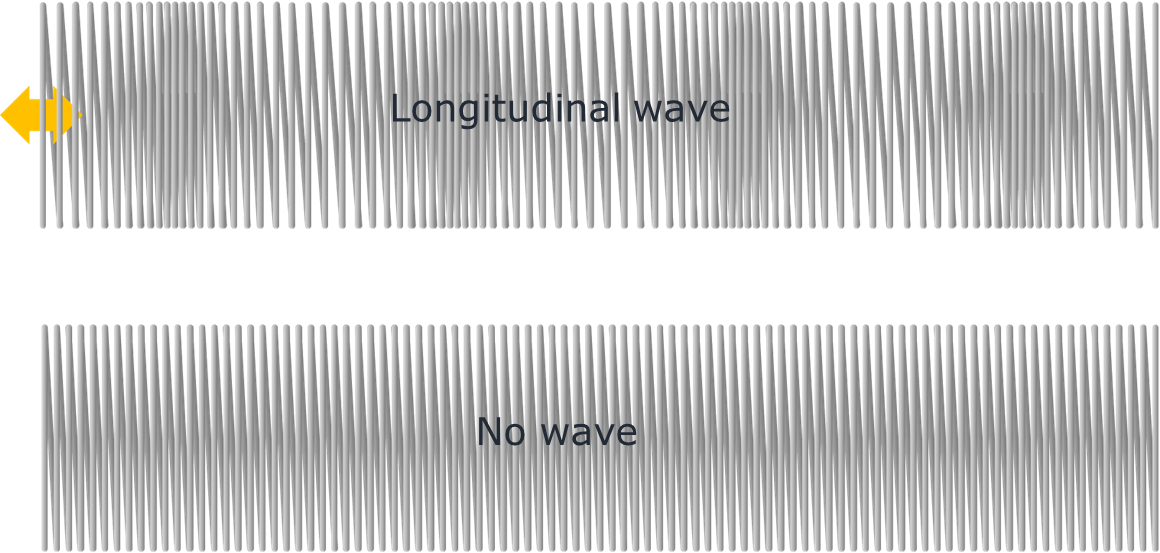
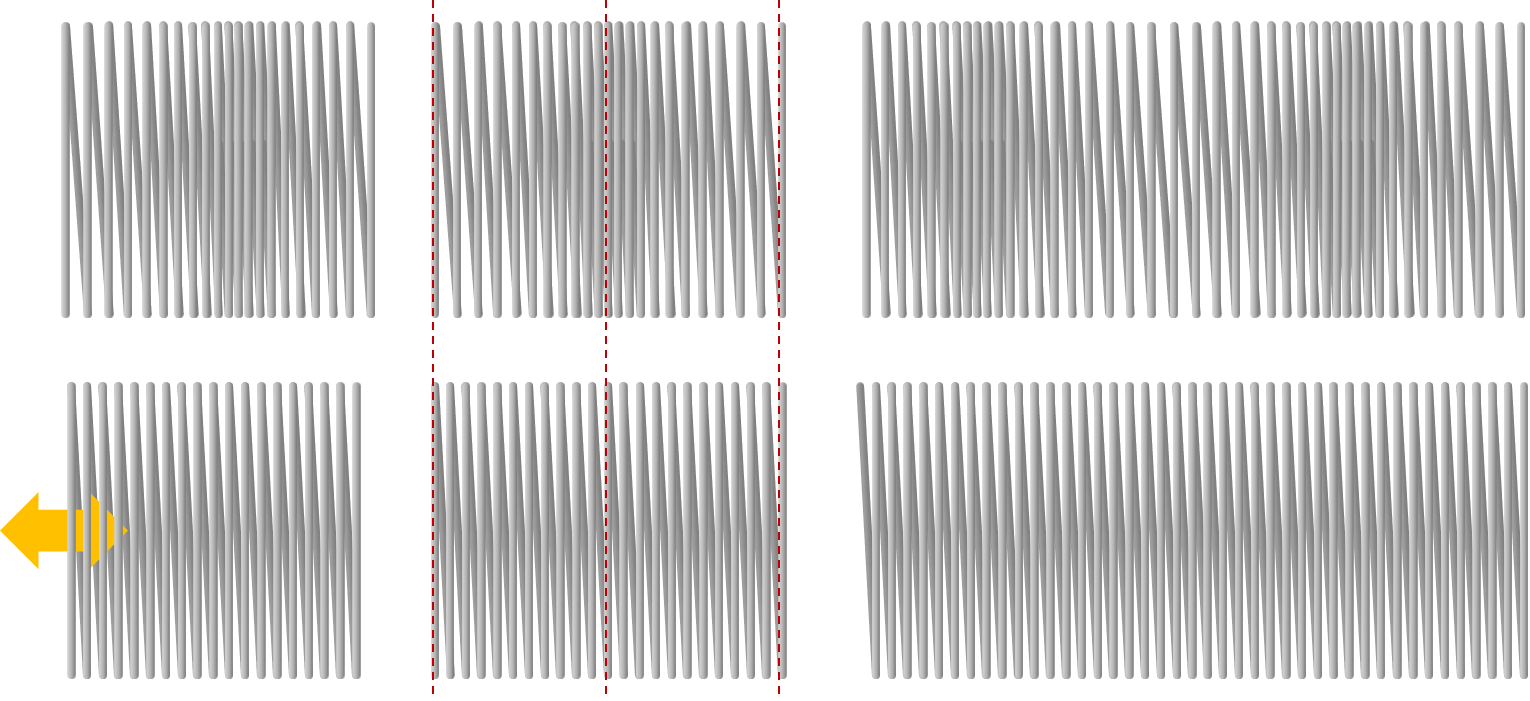
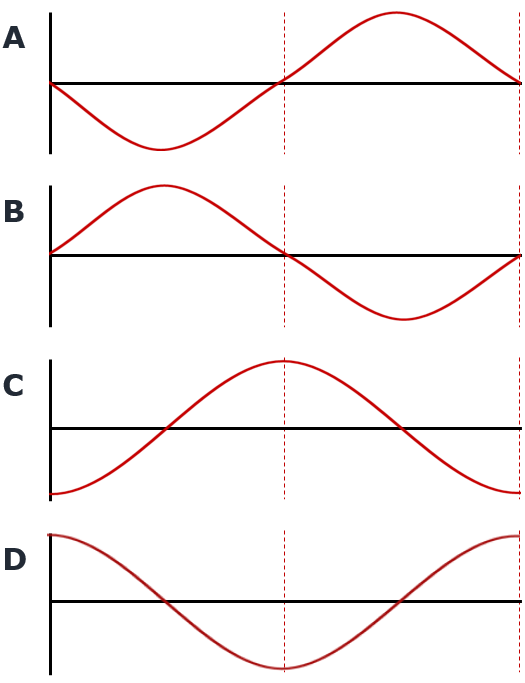
**Spring wave graph**

Moving one end of a slinky forwards and backwards can make a wave.



Which graph represents the longitudinal wave on the part of slinky shown below?



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

|  |
| --- |
| **Diagnostic question** |
| **Spring wave graph** |

**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: | Explain how a displacement-distance graph relates to the longitudinal wave it describes. |
| Question type: | Simple multiple choice |
| Key words: | Displacement, longitudinal wave |

**What does the research say?**

There are two common ways to represent a wave in the form of a graph (Caleon and Subramaniam, 2010). The first shows either a snapshot of a transverse wave, such as a wave on a rope, or the forwards and backwards displacement of particles in a longitudinal wave. The second graph shows how the displacement of one particle of a wave changes over time. On this graph the peak-to-peak separation on the graph is the time period of the wave. Caleon and Subramaniam (2010) found that the majority of students aged 15 and 16 (n=598) do not clearly distinguish between these two representations.

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. (2020) found that about half of trainee physics teachers (n=35) had a similar uncertainty.

There was no research found about how students relate the movement of particles in a longitudinal wave to a displacement-distance graph.

**Ways to use this question**

Students should complete the question individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

* On the PPt presentation for this question there are two slides with the question. It is intended that students select their answer using the first slide and then are given the opportunity to change their answers after seeing the extra information shown on the second question slide.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations, it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

B

**How to respond - what next?**

The extra lines shown on the final slide of the PPt presentation for this question show how each turn of the coil has been displaced because of the longitudinal wave. The red lines show the turns that are in their original positions. Close examination shows that the turns to the left of the compression have all moved forward from their original position and those to the right of the compression have moved left. The angles of the extra lines on this slide also show the size of the displacement of each turn.

The vertical axis on graph B shows the size and direction of movement of the turns of the coil along the length shown, with forwards movement of a turn being in the positive direction on the graph.

Graph A shows the same movement, but with the y-axis showing backwards movement in the positive direction. It is usually assumed that forward is positive, unless otherwise stated.

Graphs C and D are the more likely wrong answers that students will give. Compared to the correct answer, each of these graphs is a closer representation of what the slinky *looks like*, but neither corresponds to the displacement of the ‘particles’ in the wave. Students selecting one of these options are unlikely to fully understand how the graph relates to the physical situation.

If students have misunderstandings about explaining how a displacement-distance graph relates to the longitudinal wave it describes, it is likely that they will require step-by-step support in developing their understanding of the connections between the two and the opportunity to rehearse their own explanations.

The following BEST ‘response activity’ supports the development and consolidation of this understanding and could be used in follow-up to this diagnostic question:

* Response activity: Explaining longitudinal waves

**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. (2020) '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.