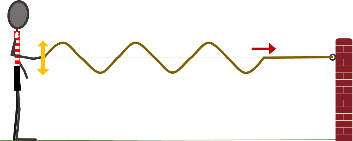
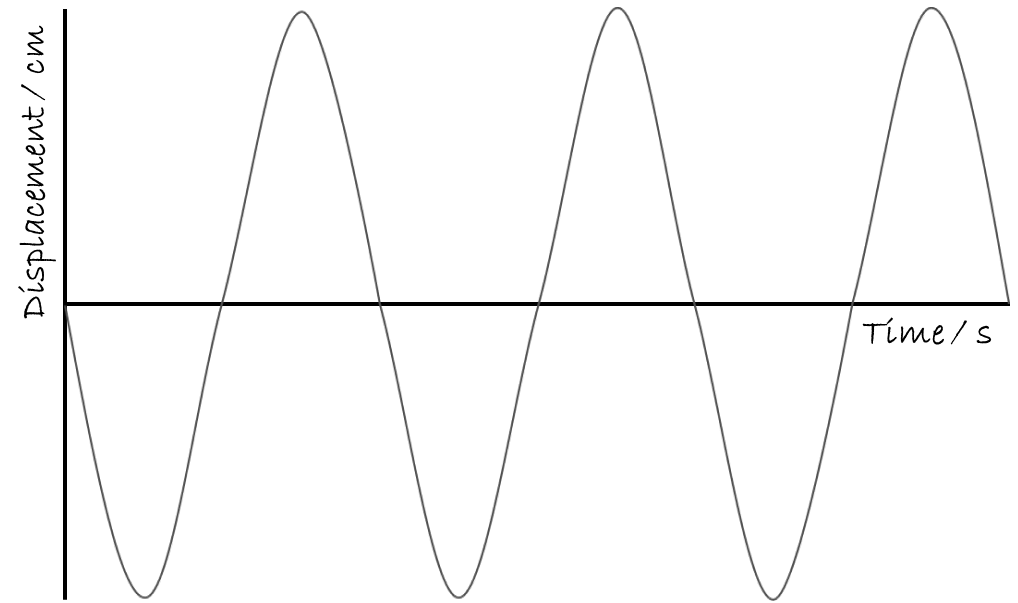
**New wave graph**

Albert makes a wave with a rope.

His friends make a graph to represent the wave.

The graph has time on the horizontal axis.



What does the displacement-time graph show?

For each statement, tick (✓) **one** column to show what you think*.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | A snapshot of the wave on the rope. |  |  |  |  |
| **B** | The movement of one point on the rope. |  |  |  |  |
| **C** | Three complete wavelengths. |  |  |  |  |

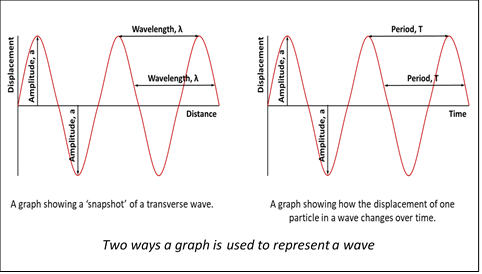
*Physics > Big idea PSL: Sound, light and waves > Topic PSL5: Measuring waves > Key concept PSL5.1: Visualising waves*

|  |
| --- |
| **Diagnostic question** |
| **Rope 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-time graph relates to the wave it describes. |
| Question type: | Confidence grid |
| Key words: | Displacement |

**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.

Some students may think of a wave’s graph as a picture of the wave drawn to scale, which in most cases it is not. This way of thinking about graphs of waves can get in the way of understanding graphs of longitudinal waves and of interpreting displacement-time graphs.

**Ways to use this question**

Students should complete the confidence grid 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.

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**

Statement B is right; and statements A and C are wrong.

**How to respond - what next?**

The graph represents the movement of the rope at Albert’s hand and how it changes over time. The front of the wave shows that Albert moved his hand downwards to start the wave, which corresponds to the graph at times just greater than zero.

A The wave has been deliberately chosen to produce a displacement-time graph that does not look like a snapshot of the wave on the rope. It is common for students to think of a wave-graph or wave-diagram as a ‘picture’ of a wave.

C The majority of students do not readily distinguish between the two types of wave graph and frequently assign wavelength wrongly to the separation of consecutive peaks on a displacement-time graph.

If students have misunderstandings about explaining how a displacement-time graph relates to the wave it describes, it can help to use a slinky spring to demonstrate the difference between a displacement-time graph and a displacement-distance graph for a transverse wave.

1. Nominate a student to move the slinky side to side, but not yet.
2. Ask the class to sketch how the student’s hand will move on a displacement-time graph – as the hand moves from the middle, to the left, over to the right and back to the middle.
3. The nominated student now makes the pulse on the slinky.

*They should make it from left to right as the class is watching – so as their hand moves the spring left it is moving away from the class, which corresponds to upwards on graph paper.*

1. The pulse should be an inverted version of the wave pulse the students have drawn.
2. Careful questioning should elicit the understanding that the first movements of the hand control the front of the wave pulse and that a displacement-time graph is different to a displacement-distance graph.

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Oscilloscope graph

**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.