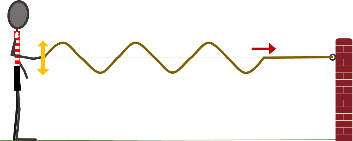
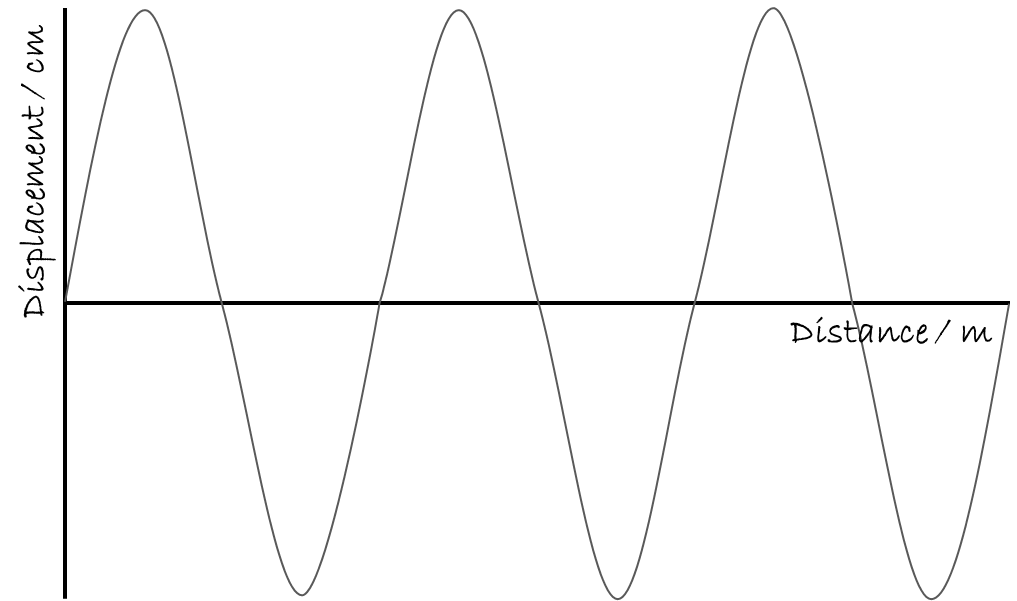
**Rope wave graph**

Albert makes a wave with a rope.

His friends make a graph to represent the wave.



How is the graph related to the wave on the rope?

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** | The graph shows the position of all the rope in the wave at one instant. |  |  |  |  |
| **B** | The graph is the exact shape of the rope. |  |  |  |  |
| **C** | Displacement is the distance of the rope above the ground. |  |  |  |  |

*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-distance graph relates to the transverse 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 A is right; and statements B and C are wrong.

**How to respond - what next?**

A, B The displacement-distance graph is almost a snapshot of the rope wave at one instant of time. It shows the position of all the rope in the wave at one instant, but the vertical axis on the graph is extended so that the graph fills the whole ‘sheet of paper’. It is not the *exact* shape of the rope.

C Displacement is a vector measurement: the distance from a reference or starting point *in a particular direction*. In this case it is measured from the undisturbed position of the rope (assuming the rope is elastic and does not sag), with displacement positive above this line, and negative below it.

If students think of the graph as a picture of the wave shrunk to fit on the graph paper, they may disregard (or not understand) the label on the vertical axis and consider that the vertical axis shows a distance, such as that from the floor, and perhaps that the x-axis represents the undisturbed rope.

If students have difficulty explaining how a displacement-distance graph relates to the wave it describes, it can help to give students a range of graphs that represent different waves and to ask them to describe in detail the wave that is represented by each.

Careful questioning should elicit the understanding that:

* a positive displacement represents the movement of the medium in one direction (perhaps up or to the right) and that a negative displacement represents movement of the medium in the opposite direction.
* the vertical and horizontal scales are both important
* and a graph is not necessarily an *exact* copy of a wave because one axis may be scaled differently to the other, to maximise the size of the graph on a piece of paper.

**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.