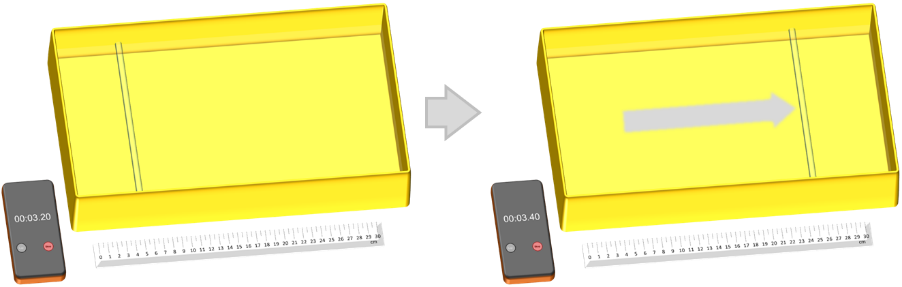
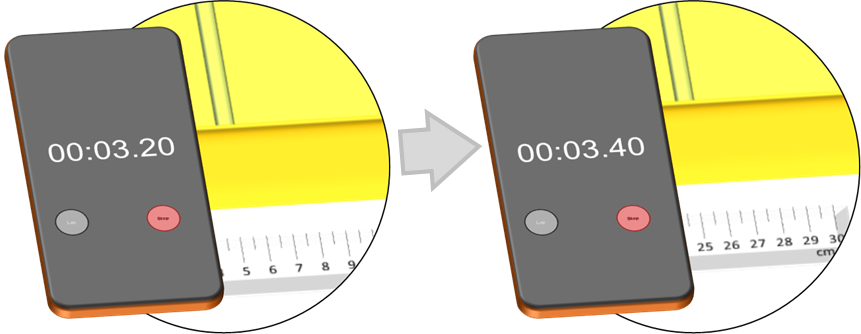
**Slow motion**

Grace is measuring the speed of a water wave in a plastic tray.

She has recorded a slow-motion video of the wave on her phone.

She pauses her video to take measurements.





The wave moves from 5cm to 25cm in 0.2 seconds.

What is the speed of the wave?

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | 4 cm/s |  |
|  |  |  |
| **B** | 5 cm/s |  |
|  |  |  |
| **C** | 20 cm/s |  |
|  |  |  |
| **D** | 100 cm/s |  |
|  |  |  |
| **E** | 125 cm/s |  |

*Physics > Big idea PSL: Sound, light and waves > Topic PSL5: Measuring waves > Key concept PSL5.2: Speed of waves*

|  |
| --- |
| **Diagnostic question** |
| **Slow motion** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The speed of a wave is determined by the wave medium in which it moves and can be calculated by multiplying its frequency and wavelength. |
| Observable learning outcome: | Measure the speed of a wave using v = s/t. |
| Question type: | Simple multiple choice |
| Key words: | Speed, distance, per second |

|  |  |
| --- | --- |
| **P** | **PRIOR UNDERSTANDING**  This diagnostic question probes understanding of ideas that are usually taught at age 11-14, to aid transition from earlier stages of learning. |

**What does the research say?**

When talking about speed the language that we use is important as what is clear to us may be easily misunderstood by students. Constant speed may be seen as ‘moving all the time’ and steady speed may be taken as ‘not too fast’. Going faster is often seen as ‘catching up’ and when one object overtakes another they are often described as having the same speed at the point of overtaking (Driver et al., 1994b). Making sure that students have a clear qualitative understanding of speed is necessary before introducing quantitative approaches (Driver et al., 1994a).

In their studies students are required to use graphical and numerical representations to compare and calculate speeds, and sometimes teachers and textbooks put great attention on the mathematical procedures involved rather than first developing a clear conceptual notion of speed (Stump, 1999; Lingefjard and Farahani, 2018).

‘[Students] need more than a routine manipulation of numbers. They need to think of an object at a greater speed both getting to a particular point in a shorter time and going further in the same time, so as to have an understanding of the practical implications of speed as distance covered in a unit time.’ (Driver et al., 1994b)

**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.

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**

D

**How to respond - what next?**

If students have a clear understanding that speed is the distance travelled in one second, then they should recognise that if the wave travels 20 cm in 0.2 (1/5th) of a second, and that it travels (five times) further in one whole second.

Some students may combine the distance and time given to calculate a number that appears right to them. Answers A and B are obtained by multiplying distance and time; C is the distance travelled; and E is the reading of 25 cm divided by time.

Answers B and E use the final measurement of distance, rather than the distance travelled.

If students have misunderstandings about measuring the speed of a wave using v = s/t, it can help to focus on their thinking about speed as the distance travelled *per* second.

Careful questioning should elicit understanding that:

* the wave has travelled an extra 20 cm in 1/5th of a second
* and that it therefore travels five times further in a whole second.

If it is necessary to consolidate understanding of speed for some students, it may be appropriate to ask students to work in pairs or small groups to work out their own short and clear definition of speed. One that would be understood by other students.

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

* Response activity: Measuring spring waves
* Response activity: Measuring wave speed

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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Stump, S. (1999). Secondary Mathematics Teachers' Knowledge of Slope. *Mathematics Education Research Journal,* 11(2)**,** 124-144.