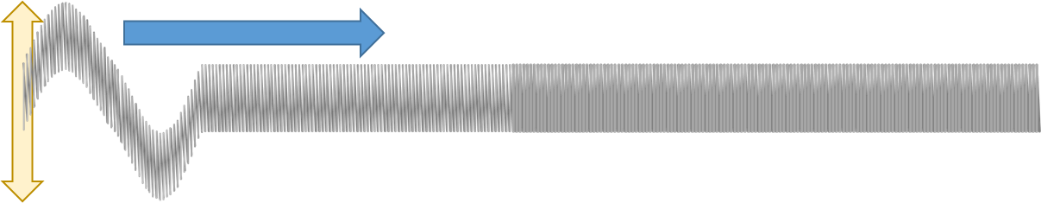
**Spring waves**

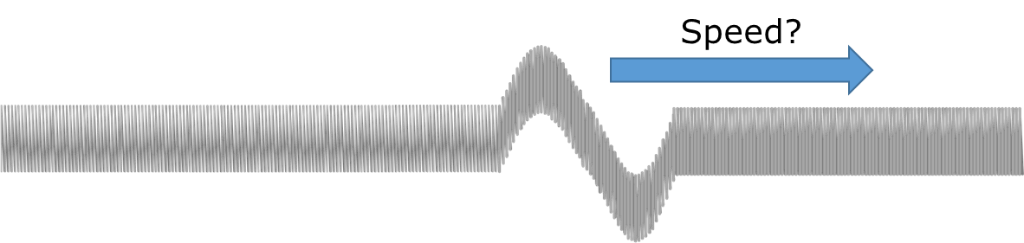
Two slinky springs are joined together.

The second one is made of thicker metal. This makes it heavier.

A wave pulse is made that moves along the springs.



The wave pulse reaches the second spring.



**a.** What is the most likely thing that will happen to its speed as it enters the second spring?

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

|  |  |  |
| --- | --- | --- |
| **A** | It will continue to move at the same speed. |  |
|  |  |  |
| **B** | It will move at a different speed. |  |

The statements below describe changes to the wave pulse as it enters the second spring.

They are all correct.

**b.** Which statement is the best reason for your answer to *part a*?

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

|  |  |  |
| --- | --- | --- |
| **A** | The wave pulse is moving along a different spring. |  |
|  |  |  |
| **B** | The frequency of the wave pulse does not change. |  |
|  |  |  |
| **C** | The amplitude of the wave pulse changes. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Spring waves** |

**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: | Describe how the speed of a wave can, and cannot, be changed. |
| Question type: | Two-tier multiple choice |
| Key words: | Wave, transverse wave, amplitude, wavelength, frequency |

|  |  |
| --- | --- |
| **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?**

The speed of a mechanical wave depends on the properties of the medium it is passing through and is independent of the wave’s frequency or the size of disturbance (amplitude). In a study of (n=598) students aged 15 to 16, Caleon and Subramaniam (2010) found that over 70% held the common misunderstanding that wave speed depends on frequency. Studies by Tongchai et al (2011) of (n=324) senior high school students, Wittmann, Steinberg and Redish (1999) of (n=92) students enrolled onto a university physics course and Tumanggor et al (2020) of trainee physics teachers (n=35) all found similar results.

In these studies (Caleon and Subramaniam, 2010; Tongchai et al., 2011; Wittmann et al., 1999), some students thought that bigger amplitudes sped up waves because the waves had more energy or more force, and others that they slowed down because it took longer for the wave to move up and down. Some thought that a smaller amplitude sped up the wave because smaller pulses slipped more easily through the wave medium.

**Ways to use this question**

Students should complete the questions 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 follow on question will give you insights into how they are thinking and highlight specific misconceptions that some may hold.

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**

a. B b. A

**How to respond - what next?**

The second spring has a different mass for a given length and is likely to have a different elasticity to the first spring. Both these properties of the second spring (wave medium) can affect the speed of a wave. The frequency and amplitude of a wave through the second medium do not affect the speed of a wave through it, but a large proportion of students are likely to think that one or both of them do.

1. Many students think that the way in which a wave is initiated (frequency and/or amplitude) affects its speed. This may lead them to think that the frequency and/or amplitude of a wave helps to determine its speed, irrespective of what it is travelling through.
2. When the wave pulse enters the second spring it is likely that the amplitude of the wave will decrease because the spring is heavier, and may also be stiffer, than the first spring. Its frequency will not change, but its speed will (because the wave medium is different). The change of speed with no change of frequency will alter the wavelength of the wave.

Students who think the frequency of a wave helps to determine its speed are likely to select the correct option for part a, and the wrong option, B, for part b.

Those who are convinced that both frequency and amplitude affect the speed of a wave are most likely to select options B, then C.

If students have misunderstandings about what can, and cannot, affect the speed of a wave, it can help to measure the speed of real waves in order to challenge these misunderstandings.

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).

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