**Accelerating tortoise**

A tortoise is accelerating.



What is the best description of the tortoise’s acceleration?

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

|  |  |  |
| --- | --- | --- |
| **A** | A measure of how quickly its speed changes. |  |
|  |  |  |
| **B** | A measure of how quickly its speed increases. |  |
|  |  |  |
| **C** | A measure of how quickly its velocity changes. |  |
|  |  |  |
| **D** | A measure of how quickly its velocity increases. |  |

*Physics > Big idea PFM: Forces and Motion > Topic PFM4: Measuring and calculating motion > Key concept PFM4.2: Acceleration*

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| --- |
| **Diagnostic question** |
| **Accelerating tortoise** |

**Overview**

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| --- | --- |
| Learning focus: | Acceleration, like displacement and velocity, is a vector quantity. Acceleration measures by how much velocity changes in a given time interval. |
| Observable learning outcome: | Describe acceleration and differentiate between displacement, velocity and acceleration. |
| Question type: | Simple multiple choice |
| Key words: | Velocity, acceleration, rate of change |

**What does the research say?**

Students may not differentiate clearly between distance, speed and acceleration when thinking about motion, merging different scientific concepts into a general idea of ‘motion’ (de Winter, 2021). They can find the concepts very difficult, partly because their prior ideas are established through experience, and partly because the formal scientific ideas are difficult to understand (Driver et al., 1994).

In everyday language, ‘acceleration’ may be taken to mean ‘speeding up’, rather than describing the rate of change of velocity. (An object moving in a circle at a constant speed is accelerating.) This means that misinterpretations about acceleration, due to students' pre-existing knowledge, are very common (Reif and Allen, 1992). The use of correct language (referring to change in *velocity*, not change in *speed*) can help students to understand that to a physicist, acceleration can refer to speeding up, slowing down, or changing direction.

**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 answer**

C.

**How to respond - what next?**

Acceleration is the rate of change of the tortoise’s velocity. As its velocity changes, the tortoise may speed up, slow down, and/or change direction.

B or D It is common for students to think of acceleration only as an increase in speed or velocity.

A or B In everyday language, acceleration is used to describe a change in speed and not a change in direction. It is common for students to not distinguish between speed and velocity.

If students have misunderstandings about describing acceleration in terms of velocity, it can help to lead a discussion of what the tortoise is doing as it accelerates.

Careful questioning can elicit the understanding that:

* The tortoise must be pushing in the direction in which it is accelerating,
* Forces cause a change in speed (an increase or a decrease) and/or direction,
* Velocity describes both speed and direction,
* Force therefore cause a change in velocity.

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

* Response activity: To the top of the hill and down again

**Acknowledgments**

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Image: Susann Mielke from Pixabay.

**References**

de Winter, J. (2021). Forces. In de Winter, J. & Hardman, M. (eds.) *Teaching Secondary Physics.* 3rd ed. London: Hodder Education.

Driver, R., et al. (1994). *Making Sense of Secondary Science: Research into Children's Ideas,* London, UK: Routledge.

Reif, F. and Allen, S. (1992) Cognition for Interpreting Scientific Concepts: A Study of Acceleration, *Cognition and Instruction*, 9(1), pp. 1–44. doi: 10.1207/s1532690xci0901\_1.