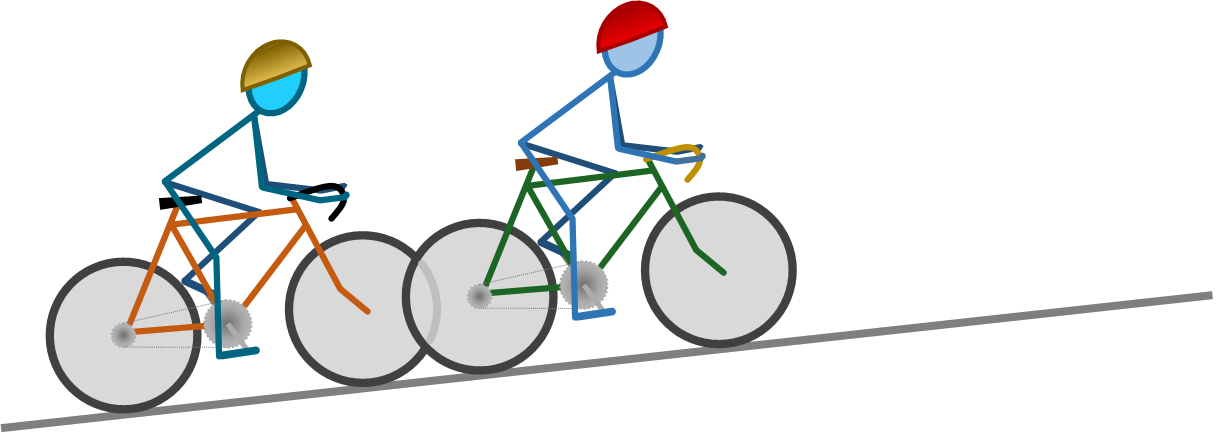
**Speed or acceleration?**

Each morning Matthew cycles to school with his friend.

Matthew has become very fit because there is a big hill on the way.



*Fill in the gaps to describe Matthew’s journey to school.*

*You should only use the words* ***speed*** *and* ***acceleration****.*

In the morning Matthew cycles to school.

He sets off with steady \_\_\_\_\_\_\_\_\_\_\_ until he reaches the \_\_\_\_\_\_\_\_\_\_\_ he wants. Round the corner he sees his friend ahead. He catches up because he has a higher \_\_\_\_\_\_\_\_\_\_\_. They carry on together.

On the way they cycle up a steep hill. They have to push much harder on their pedals to keep going with the same \_\_\_\_\_\_\_\_\_\_\_.

Down the hill they keep pedalling hard so they have \_\_\_\_\_\_\_\_\_\_\_ all the way down. At the bottom they have a lot of \_\_\_\_\_\_\_\_\_\_\_. If they don’t use their brakes they can freewheel all the way to school. As they freewheel they slowly lose their \_\_\_\_\_\_\_\_\_\_\_.

If they stop quickly they have a big \_\_\_\_\_\_\_\_\_\_\_!

*Physics > Big idea PFM: Forces and motion > Topic PFM2: Forces > Key concept PFM2.1: Describing speed*

|  |
| --- |
| **Diagnostic question** |
| **Speed or acceleration?** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Speed is a measure of how fast an object travels: how far it goes in a given time |
| Observable learning outcome: | Identify when speed is changing the most quickly and acceleration is biggest |
| Question type: | Focused cloze |
| Key words: | Speed, acceleration |

**What does the research say?**

Students tend to equate getting faster with ‘catching-up’ and when one object catches up with another it is common for them to think that at the point of overtaking both objects are moving at the same speed. This may fit with a student’s experience: of accelerating when they set off in pursuit; of running at a steady (albeit faster) speed as they catch up; and then often falling into pace with the person they have chased. What is missing from this experience is an account of time, which students often do not consider when thinking about motion. (Driver et al., 1994)

Introducing and rehearsing vocabulary that allows students to describe observations accurately is an essential first step towards understanding motion. Students do not usually make a clear distinction between speed and acceleration. Often students do not use the word acceleration outside of their science lessons, and instead talk about speeding up or slowing down. Acceleration may be seen as ‘going fast’ (Driver et al., 1994).

This question investigates the aspects of acceleration that students often confuse with speed and their understanding of acceleration as a *change* in speed.

**Ways to use this question**

Students should complete the activity individually as a pencil and paper exercise. The large text on the worksheet allows it to be copied A5 size, which fits a standard exercise book.

How students fill in the gaps will show you whether they 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 sentences 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**

*(These are revealed one by one on the PowerPoint presentation)*

In the morning Matthew cycles to school.

1. He sets off with steady **acceleration** until he reaches the **speed** he wants. Round the corner he sees his friend ahead. He catches up because he has a higher **speed**. They carry on together.

2. On the way they cycle up a steep hill. They have to push much harder on their pedals to keep going with the same **speed**.

3. Down the hill they keep pedalling hard so they have **acceleration** all the way down. At the bottom they have a lot of **speed**. If they don’t use their brakes they can freewheel all the way to school. As they freewheel they slowly lose their **speed**.

4. If they stop quickly they have a big **acceleration**!

**How to respond - what next?**

1. He sets off at a steady ***speed*** suggests students imagine acceleration to be instantaneous, which is a common in students at age 11.

Students often associate catching up with ***acceleration*** by linking this to their experience of increasing speed in order to catch somebody up. Again it is the timescale of the acceleration that is often misjudged. In this case acceleration happens at the start of the journey and a faster steady speed is maintained to catch up.

2. The clue here is ‘to keep going with the same’ – speed, because they had no acceleration, although students could argue the acceleration can remain the same - at zero, which shows understanding!

3. Downhill they get faster and faster which is a common way of thinking about acceleration. At the bottom they slow down and this is also acceleration.

4. Stopping quickly causes speed to change quickly which means acceleration is big (in magnitude). It is likely that a proportion of students will feel that neither speed nor acceleration are appropriate here. This can be a good starting point to thinking about what is *really* meant by acceleration.

If students have misunderstandings about identifying acceleration in different situations, it can help to discuss with the class what happens to a car when it accelerates. It is easy to find video clips of cars accelerating that describe acceleration in terms of the time it takes to speed up from 0-60 mph, say. Discussing what this means in pairs or small groups could encourage social construction of new ideas through dialogue. Giving students the opportunity to write a definition of acceleration in their own words can consolidate learning and check individual understanding. This can be extended to explain why slowing down is also acceleration.

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

* Response activity: Is it accelerating?

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Driver, R., et al. (1994). *Making Sense of Secondary Science: Support Materials for Teachers,* London: Routledge.