**Skydiving**

Eve jumps out of a plane!!!

She is wearing a parachute.

**a.** Eve falls 5m in the first second.

How far does she fall in the following second?

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

|  |  |  |
| --- | --- | --- |
| **A** | Less than 5m |  |
|  |  |  |
| **B** | About 5m |  |
|  |  |  |
| **C** | A little more than 5m |  |
|  |  |  |
| **D** | A lot more than 5m |  |

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

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

|  |  |  |
| --- | --- | --- |
| **A** | She reaches her top speed **very** quickly |  |
|  |  |  |
| **B** | She speeds up quickly at first and then speeds up more slowly |  |
|  |  |  |
| **C** | She speeds up quickly at first and keeps speeding up quickly |  |
|  |  |  |
| **D** | Drag (air resistance) slows her down |  |

*Physics > Big idea PFM: Forces and motion > Topic PFM2: Moving by force > Key concept PFM2.3: Changing motion*

|  |
| --- |
| **Diagnostic question** |
| **Skydiving** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | A resultant force on an object can cause it to speed up or slow down, depending on the direction of the force. |
| Observable learning outcome: | Describe how the speed of an object changes throughout the time that a resultant force is acting on it. |
| Question type: | Two-tier multiple choice |
| Key words: | Gravity, speed, acceleration, drag, air resistance |

**What does the research say?**

Children below the age of about 11 tend to think of speed change as a short intensive effort, followed by constant speed. In a study (Hast and Howe, 2013), children observed a ball falling in free fall, accelerating down a ramp and rolling along a flat surface. In each case they were asked to predict whether the ball was speeding up, slowing down or travelling at a steady speed through the second half of each motion. For the accelerating balls the thirty-six 11-year-olds involved in the study made correct predictions only a little more often than they would have done by chance.

In a study by Dykstra and Sweet (2009) of 9- to 13-year-olds in the United States (n=103), it was found that the majority of students (aged 11-12) described the motion of an object as a snapshot of its direction and speed (moving *quickly this way* or *slowly that way*). Just 11% of this group gave a dynamic description of an accelerating object, in free fall or rolling down a ramp, in terms of a changing speed.

This question investigates students’ understanding of how the speed of an object changes throughout the time that a resultant force is acting on it.

**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.** D: a lot more than 5m

**b.** C: she speeds up quickly at first and keeps speeding up quickly

**How to respond - what next?**

Answers B or C to **part a.** suggest students are thinking of acceleration as a quick increase in speed followed by a steady speed. This is confirmed by answers A or B to **part b.** Answer B suggests students may be adapting their misunderstanding to fit with observations.

Answers A followed by D are less likely, and students selecting these may think gravity speeds Eve up quickly at the start, and then when she is moving quickly air resistance takes over. This thinking considers each force acting separately at different times.

If students have misunderstandings about how the speed of an object changes throughout the time that a resultant force is acting on it, it can help to give students the opportunity to describe and justify what they think will happen, before observing a practical demonstration in order to confirm what really does happen. Working in pairs or small groups can encourage social construction of understanding through dialogue. A further opportunity for each student to correct or improve their explanation will allow them to consolidate their learning.

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

* Response activity: Steady force

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Dykstra, D. and Sweet, D. (2009). Conceptual development about motion and force in elementary and middle school students. *American Journal of Physics,* 77:5**,** 468-476.

Hast, M. and Howe, C. (2013). The Development of Children's Understanding of Speed Change: A Contributing Factor Towards Commonsense Theories of Motion. *Journal of Science Education and Technology,* 22**,** 337-350.