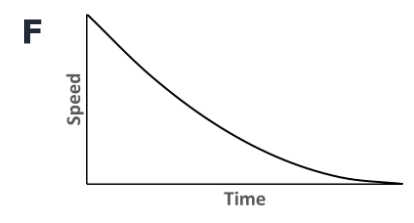
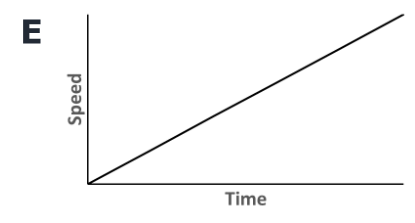
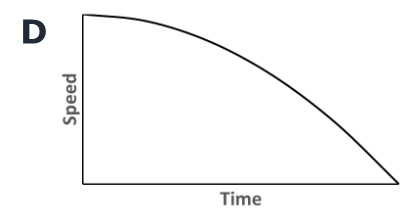
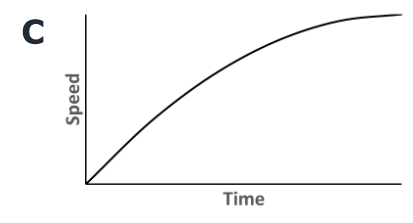
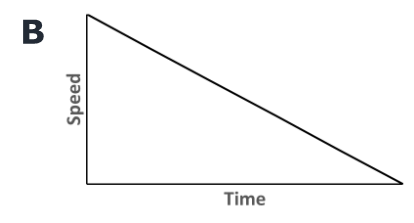
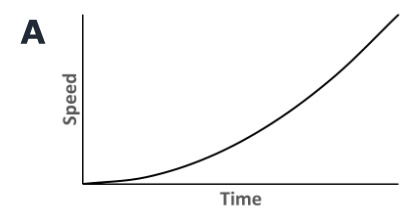
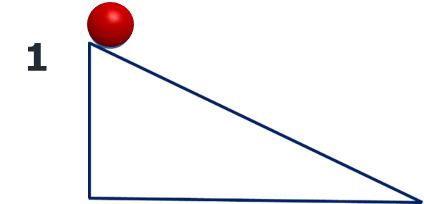
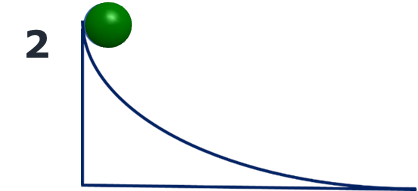
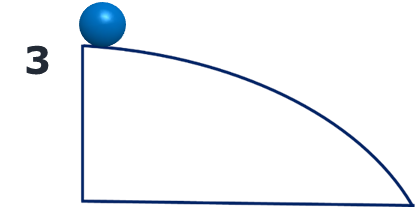
**Choosing the graph**

A ball rolls down each slope.

Which graph *best* shows the motion of each ball?



*Rule a line from the slope to the best graph.*

*Physics > Big idea PFM: Forces and Motion > Topic PFM4: Measuring and calculating motion > Key concept PFM4.3: Velocity-time graphs*

|  |
| --- |
| **Diagnostic question** |
| **Choosing the graph** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | A velocity-time graph of an object moving in one dimension can be read to find the object’s velocity at any moment of time. The gradient of the graph at a given time gives the object’s acceleration; and the area under the graph between any two times gives the change in the object’s displacement, or the distance it has travelled. |
| Observable learning outcome: | Describe the motion of an object from a velocity-time graph, and identify the velocity-time graph from a description of motion. |
| Question type: | Linking ideas |
| Key words: | Speed, time, graph |

**What does the research say?**

The visual presentation of data in graphical form makes graphs valuable for analysing data and, perhaps more importantly, for showing relationships between data sets (Rogers, in Carson, 1999). It is common for teachers to assume students can readily extract information from graphs when this is not necessarily the case (Beichner, 1994). Misunderstandings and difficulties in interpreting graphs arise even when students have a good understanding of kinematic concepts (position, displacement, velocity and acceleration) and are evident amongst different student populations and across different academic levels (McDermott, Rosenquist and van Zee, 1987). Even when students have the necessary mathematical knowledge about how to plot and read graphs, and how to calculate gradients and areas, they may struggle with the same skills in a physics context (McDermott, Rosenquist and van Zee, 1987; Bollen et al., 2016).

A common error that some students make is to see a graph as a literal picture of a physical situation and, rather than viewing a graph as a mathematical representation of a motion, they may see it as a sort of ‘photograph’ that duplicates the motion (Clement, 1985; Leinhardt, Zaslavsky and Stein, 1990; Beichner, 1994; Bollen et al., 2016). This can make it hard for them to describe qualitatively a motion represented by a graph, or to draw the shape of a graph from a description of a motion.

**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.

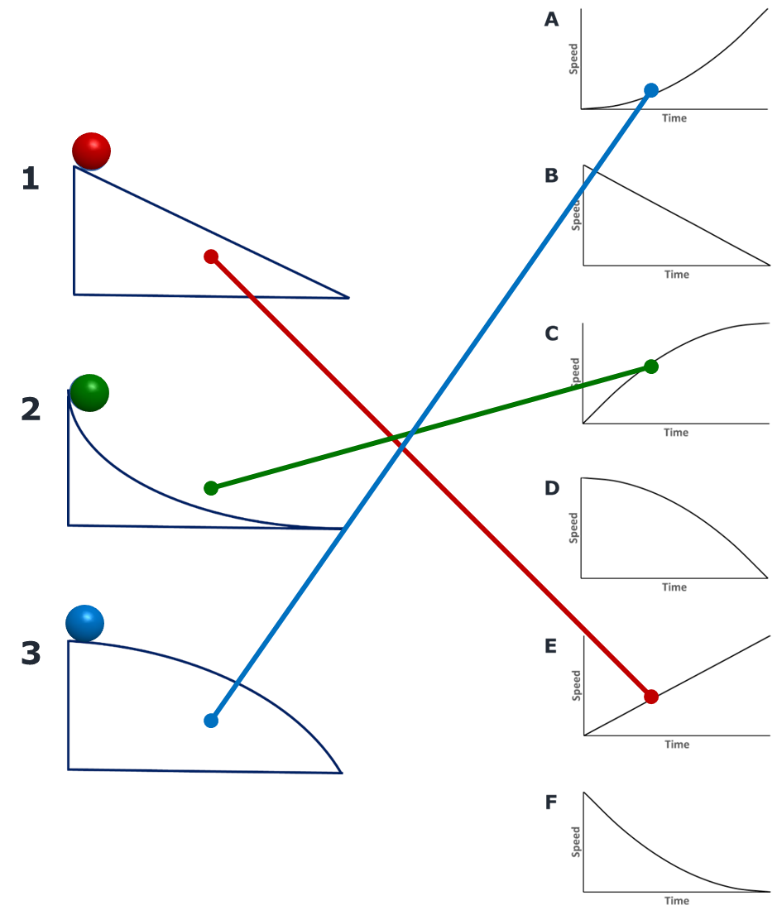
The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

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**

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**How to respond - what next?**

The graphs here are speed-time rather than velocity-time graphs as the motion takes place in two dimensions for two of the slopes and it is not possible to show velocity on a two-dimensional velocity-time graph. There are no numbers on the graphs so that students have to think qualitatively about the graphs and how they represent the physical situation.

Students who choose the speed-time graph that is the same shape as the slope probably have the graph-as-a-picture misconception about motion graphs. They see the shape of the slope and choose the graph that has the same shape without thinking about how the speed of the ball changes.

In the case of the first slope, the ball accelerates steadily, so that the speed-time graph is a straight line. If students do not choose the graph with the same shape as the slope, they are likely to choose the correct straight-line graph.

When rolling down the second slope, the ball will accelerate quickly at first, and then more and more slowly, so that the speed-time graph is initially steep, and then less and less so. If students avoid the distractor that is the same shape as the slope, they then have to think about how the speed changes in order to select the correct curve. Ask students about their choices to ensure it is not just a guess.

For the third slope, the acceleration increases as the ball rolls down the slope, and the gradient of the speed-time graph similarly increases. As for the second slope, if students avoid the distractor, it is important to explore students’ thinking to ensure that they are not just guessing.

In all cases here, if the ball is released from rest, then the graph must start from a speed of zero.

If students have misunderstandings about the shape of the graph, they may see the graph as a literal picture or need support to understand how the speed of the ball changes down the different slopes.

The following BEST ‘response activity’ could be used to develop these aspects of understanding in follow-up to this diagnostic question:

* Response activity: Shaping the graph

**Acknowledgments**

Developed by Simon Carson (UYSEG), based on EPSE question F6-32.

Images: Simon Carson (UYSEG)

**References**

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