**Going in the right direction?**

**1.** This passage is about distance and displacement.

*Fill in the gaps using the best word.*

*You should only use the words* ***distance*** *or* ***displacement.***

**Distance and displacement**

When an object moves, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a measure of how far it has travelled along its path. The direction it has travelled in does not matter.

The length of a line drawn from the starting point to the end of a journey, together with the direction from start to finish, is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

A black and yellow logo

Description automatically generated with low confidence

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ has a magnitude only. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ has both a magnitude and a direction.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a scalar quantity. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a vector quantity.

When I write down a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, I always have to give both its magnitude and its direction.

Both distance and displacement can be measured in metres.

**2.** This passage is about average speed and average velocity.

*Fill in the gaps using the best word.*

*You should only use the words* ***speed*** *or* ***velocity.***

**Average speed, average velocity**

The average \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of an object measures how far it travels in a given time interval. To calculate the average \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ I divide the distance travelled by the time taken.

I can write this as a word equation:

Logo

Description automatically generated

The average \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of an object measures its total displacement in a given time interval. To calculate the average \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, I divide the total displacement by the time taken. I can write this as a word equation:

**3.** This passage is about speed and velocity.

*Fill in the gaps using the best word.*

*You should only use the words* ***speed*** *or* ***velocity.***

**Speed, velocity, scalars and vectors**

Because distance has a magnitude only, so does \_\_\_\_\_\_\_\_\_\_. Because displacement has both a magnitude and a direction, so does \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a scalar quantity. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_is a vector quantity. When I write down a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, I always have to give both its magnitude and its direction.

Both speed and velocity can be measured in metres per second.

Icon

Description automatically generated with medium confidence

*Physics > Big idea PFM: Forces and motion > Topic PFM4: Measuring and calculating motion > Key concept PFM4.1: Velocity*

|  |
| --- |
| **Diagnostic question** |
| **Going in the right direction?** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Velocity and displacement are vector quantities. Velocity measures by how much displacement changes in a given time interval. |
| Observable learning outcome: | Explain the difference between distance and displacement, and between speed and velocity |
| Question type: | Focused CLOZE |
| Key words: | Distance, displacement, speed, velocity |

**What does the research say?**

Students have a somewhat undifferentiated understanding of the kinematical terms speed, velocity and acceleration and often merge them together into a general idea of ‘motion’. They may conflate words that have related meanings, such as distance and displacement, or speed and velocity, not always realising the important differences between them (de Winter and Hardman, 2021). Although these terms are connected, the differences matter, and teachers should use terms carefully, taking care to be precise in their use of language.

Students need to be clear about the vector nature of quantities such as displacement, velocity and acceleration. Despite being taught about vectors at school, very many students on undergraduate introductory physics courses in the USA have no *useful* knowledge of vectors (Aguirre, 1988; Knight, 1995). Understanding two dimensional motion, such as the orbits of planets and circular motion, requires an understanding of vectors, both mathematically and intuitively, and has been a subject of research for school students (Mihas and Gemousakakis, 2007; Tairab *et al.*, 2020), and at university level, where both undergraduates and expert physicists struggled with some aspects of the vector nature of acceleration when asked to reason qualitatively (Reif and Allen, 1992).

It is important, therefore, to establish a good understanding of displacement and velocity as vectors before studying accelerations and forces. Students need to develop their confidence in using these terms correctly when describing motion.

**Ways to use this question**

Students should complete the activity individually as a pencil and paper exercise.

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**

**1. Distance and displacement**

When an object moves, **distance** is a measure of how far it has travelled along its path. The direction it has travelled in does not matter.

The length of a line drawn from the starting point to the end of a journey, together with the direction from start to finish, is called the **displacement**.

**Distance** has a magnitude only. **Displacement** has both a magnitude and a direction.

**Distance** is a scalar quantity. **Displacement** is a vector quantity.

When I write down a **displacement**, I always have to give both its magnitude and its direction.

Both distance and displacement can be measured in metres.

**2. Average speed, average velocity**

The average **speed** of an object measures how far it travels in a given time interval. To calculate the average **speed** I divide the distance travelled by the time taken. I can write this as a word equation:

The average **velocity** of an object measures its total displacement in a given time interval. To calculate the average **velocity**, I divide the total displacement by the time taken. I can write this as a word equation:

**3. Speed, velocity, scalars and vectors**

Because distance has a magnitude only, so does **speed**. Because displacement has both a magnitude and a direction, so does **velocity**.

**Speed** is a scalar quantity. **Velocity** is a vector quantity. When I write down a **velocity**, I always have to give both its magnitude and its direction.

Both speed and velocity can be measured in metres per second.

**How to respond - what next?**

Being clear about the use of language is important in developing an understanding of the terminology used in describing motion and in using it confidently and correctly.

If students have misunderstandings about the differences between distance and displacement and between speed and velocity, they should practise using the terms correctly. Ask them to watch a student moving from one point in the room to another by a winding route and then ask them to describe the motion using the terms ‘distance’ and ‘displacement’.

Asking them to write their own definitions of these terms, and comparing them with their peers, may help to consolidate their understanding and to identify each other’s mistakes. The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: How fast are they going

**Acknowledgments**

Developed Simon Carson (UYSEG)

Images: Simon Carson (UYSEG)

**References**

Aguirre, J. M. (1988) Student preconceptions about vector kinematics, *The Physics Teacher*, 26(4), pp. 212–216. doi: 10.1119/1.2342490.

de Winter, J. and Hardman, M. (2021) *Teaching secondary physics.*

Knight, R. D. (1995) The vector knowledge of beginning physics students, p. 6.

Mihas, P. and Gemousakakis, T. (2007) Difficulties that students face with two-dimensional motion, *Physics Education*, 42(2), pp. 163–169. doi: 10.1088/0031-9120/42/2/005.

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.

Tairab, H. *et al.* (2020) Examining Grade 11 science students’ difficulties in learning about vector operations, *Physics Education*, 55(5), p. 055029. doi: 10.1088/1361-6552/aba107.