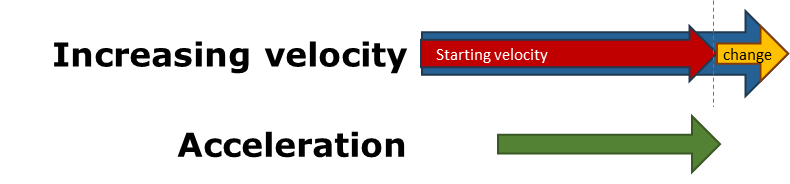
**Which way now?**

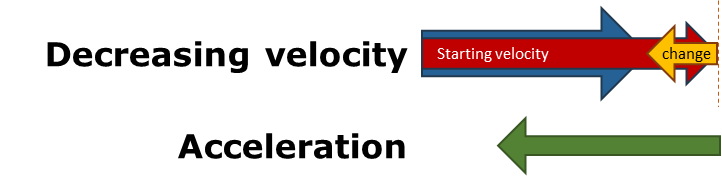
Acceleration is a vector. It has a size and a direction.

If velocity is increasing towards the right, acceleration is to the right.



If velocity is decreasing towards the right, acceleration is to the left.

This is because the **change in velocity** is towards the left.



**To answer**

**1.** A car is speeds up from 20m/s to 30 m/s in ten seconds.

A picture containing shape

Description automatically generated

*a.* Draw an arrow to show the change in its velocity.

*b.* In which direction is the car accelerating?

**2.** A car slows down from 30 m/s to 20 m/s in ten seconds.

**Shape, arrow

Description automatically generated**

*a.* Draw an arrow to show the change in its velocity.

*b.* In which direction is the car accelerating?

c. How does the magnitude of its acceleration compare to the acceleration in question 1?

**3.** A car turns around and 30 s later travels in the opposite direction.

**Shape, arrow

Description automatically generated**

*a.* Draw an arrow to show the change in its velocity.

*b.* In which direction is the car accelerating?

c. How does the magnitude of its acceleration compare to the acceleration in question 2?

**4.** A car travels along a straight road.

**Shape

Description automatically generated with medium confidence**

Explain why the acceleration of this car is equal to zero.

Use the vectors arrows to help think about the questions.

Cut out and arrange them to work out each change in velocity. The arrows are drawn to scale.

|  |
| --- |
| 10 m/s |
| 20 m/s |
| 30 m/s |
| 40 m/s |
| 50 m/s |

Use the vectors arrows to help think about the questions.

Cut out and arrange them to work out each change in velocity. The arrows are drawn to scale.

|  |
| --- |
| 10 m/s |
| 20 m/s |
| 30 m/s |
| 40 m/s |
| 50 m/s |

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

|  |
| --- |
| **Response activity** |
| **Which way now?** |

**Overview**

|  |  |
| --- | --- |
| 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: | Recognise that in one dimension, velocity and acceleration may be in different directions. |
| Question type: | Application and practice |
| Key words: | Velocity, acceleration |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Down, up, down
* Diagnostic question: Going in the right direction

**What does the research say?**

Students may not differentiate clearly between speed, velocity and acceleration when thinking about motion, merging different scientific concepts into a general idea of ‘motion’, not always realising the important differences between them (de Winter, 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.

In everyday language, ‘acceleration’ may be taken to mean ‘speeding up’, rather than describing the rate of change of velocity, which can lead to misunderstanding (Reif and Allen, 1992). Referring to change in *velocity*, rather than a change in *speed*, is more accurate and can help students to understand that acceleration can refer to speeding up, slowing down, and changing direction.

Students need to be clear about the vector nature of quantities such as displacement, velocity, change in velocity and acceleration. This understanding becomes increasingly important as students develop their understanding of physics, but 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).

**Ways to use this question**

This activity gives students the opportunity to practise applying their understanding and to clarify their thinking through discussion. To support this, students should answer the questions in pairs or small groups.

Brief notes on adding and subtracting vectors geometrically are provided; students may need additional explanation of these ideas. Teachers may wish to use large cut-out arrows stuck on a white board, or a similar electronic version, so that students can see how these can be moved about, without changing their orientation, in order to place them tip-to-tail or tail-to-tail. A one dimensional example may also be useful for students.

Listening to individual groups as they work often highlights any difficulties they might have. These can often be overcome through a whole class clarification or redirection part way through the activity.

Allowing only one student in each pair or small group to write down the answer on behalf of the group encourages discussion of both the science and of the presentation of the answer. Mini-white boards allow groups to show you their answers for immediate feedback.

*Differentiation*

If some students are working with a teaching assistant, then a list of prompt questions for the TA could help to make this activity more purposeful.

**Expected answers**

1. The change in velocity is 10 m/s to the right.

2. The change in velocity is 10 m/s to the left.

3. The change in velocity is 50 m/s to the left.

4. As both velocity vectors are equal in both magnitude and direction, subtracting them gives zero. If the velocity change is zero, then so is the acceleration.

**Acknowledgments**

Developed by Simon Carson (UYSEG)

Images: Simon Carson (UYSEG)

**References**

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