**Weight**

On Earth British astronaut Tim Peake has weight.

In space he has no weight.



This box is on Earth.



What can you say about the weight of the box?

For each statement, tick (✓) **one** column to show what you think*.*

|  |  |  |
| --- | --- | --- |
| **A** | Its weight is the force needed to lift it. |  |
|  |  |  |
| **B** | Its weight is the force it presses down with. |  |
|  |  |  |
| **C** | Its weight is the amount of stuff it is made of. |  |
|  |  |  |
| **D** | Its weight is measured in kilograms. |  |

*Physics > Big idea PFM: Forces and motion > Topic PFM3: More about force > Key concept PFM3.1: Mass and weight*

|  |
| --- |
| **Response activity** |
| **Weight** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Mass is a measure of the amount of matter an object or substance is comprised of and weight is the force needed to support the object or substance. |
| Observable learning outcome: | Describe weight as the force needed to support an object or substance. |
| Activity type: | Simple multiple choice |
| Key words: | force, gravity, weight |

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

* Diagnostic question: Which weighs more?

**What does the research say?**

Galili and Bar (1997) detected two common ways in which students aged 5-11 think about weight. Some misunderstood that “weight is a pressing force that some objects have (stones, sticks, etc.) and some do not (air, dust, etc.)”; others misunderstood that “weight is the amount of matter” that an object contains. The latter misunderstanding is understandable as teachers are often advised not to distinguish between weight and mass in presecondary teaching (e.g. National Academy of Sciences, 2012).

Driver et al. (1994) note several studies that show students do not generally think of weight as a force of gravity (Stead and Osborne, 1980; Ruggiero et al., 1985; Watts, 1982) instead this is a concept that is introduced through teaching. Watts (1982) found secondary students do not use the concept of gravity consistently, applying gravity differently to different objects and not always in the same way at all times to a particular object. When weight is defined as equal to mass multiplied by gravitational field strength and students understand that mass is unchanging, then it becomes necessary for them to apply a non-scientific and flexible approach in order to make sense of situations such as the weightlessness of an astronaut in Earth orbit.

To avoid teaching students about weight in a way that leads to misunderstandings, it is important to distinguish between weight caused by a gravitational force and weight caused by relative motion (Galili, 1995; Tural, Akdeniz and Alev, 2010). At an introductory stage it is sufficient to teach that the weight of a mass is equal to force needed to support the mass (Galili and Kaplan, 1996; Stein, Galili and Schur, 2015).

A widespread view of gravity amongst 11-to-17-year-olds, is that it is a ‘holding’ force rather than a pulling force. This thinking is bound up with the idea that gravity is linked to the atmosphere, and with air pressing down to stop things floating away (Stead and Osborne, 1980; Driver et al., 1994). This can lead to the misunderstanding that there must be air for there to be gravity. This has implications for thinking about gravity acting in space, on other planets and on the Moon.

**Ways to use this activity**

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**

Answers A and B are both correct. These can be combined to say that weight is the force needed to support an object or substance.

Answers C and D refer to the mass of the box. The BEST diagnostic question: *The biggest mass*, and the BEST response activity: *Mass cans* explore the concept of mass more fully.

**Acknowledgments**

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Images: Official NASA portrait of British astronaut Timothy Peake a member of Expedition 45 and 46: NASA; spacewalk: Tim Peake’s twitter account; box: <https://pixabay.com/vectors/cardboard-box-box-cardboard-package-155479/>.

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