**Bathroom scales**

Bathroom scales measure the force that pushes down on them.

They automatically change the number of Newton into kilogram.

Do bathroom scales measure mass or weight – or both?



*Fill in the gaps to describe what happens to John when he flies to the Moon.*

*You should only use the words* ***mass*** *and* ***weight****.*

**Mass or weight?**

John stands on his bathroom scales.

He is pushing down with a force of 436 Newton. This means he has a \_\_\_\_\_\_\_\_ of 436 N. The scales tell him he has a \_\_\_\_\_\_\_\_ of 43.6 kg.

John visits the Moon. On the way he floats inside his space-ship because he has no \_\_\_\_\_\_\_\_. He still has \_\_\_\_\_\_\_\_.

John likes space food and eats a lot. His body is now made of more matter, so he has a bigger \_\_\_\_\_\_\_\_. On the Moon he can be lifted with just 90 Newton. On the Moon he has a smaller \_\_\_\_\_\_\_\_.

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

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| **Response activity** |
| **Bathroom scales** |

**Overview**

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| --- | --- |
| 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: | Explain the relationship between the weight and mass of an object that is caused by a gravitational force. |
| Activity type: | Focused cloze |
| Key words: | mass, weight |

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

* Diagnostic question: Weight on the Moon
* Diagnostic question: Moon food

**What does the research say?**

A mass of one kilogram is properly defined by Newton’s second law, as the mass one Newton of force will cause to accelerate at the rate of one metre per second squared. At this stage it is sufficient to define mass of an object or substance as the amount of matter it contains, and to reinforce the understanding that mass does not change unless material is added or taken away from the object.

Students often confuse the terms weight and mass, which is understandable as teachers are often advised not to distinguish between weight and mass in presecondary teaching (e.g. National Academy of Sciences, 2012).

Students aged 11-14 are typically taught that weight is a force and that a particular mass will weigh different amounts on different planets or moons because of changes in the gravitational force. This is true, but teaching that weight is caused by *just* the gravitational force (whether explicitly or implicitly) leads to misunderstandings that prevent students developing a good understanding of weightlessness, of how gravitational forces extend into space, and about other related ideas they encounter later in their studies (Gonen, 2008; Stein, Galili and Schur, 2015). For example, Sharma et al. (2004) found that half of physics undergraduates (n=200) wrongly defined weightlessness as an absence of gravity.

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.

**Ways to use this activity**

Students should complete the activity individually as a pencil and paper exercise. The large text on the worksheet allows it to be copied A5 size, which fits a standard exercise book.

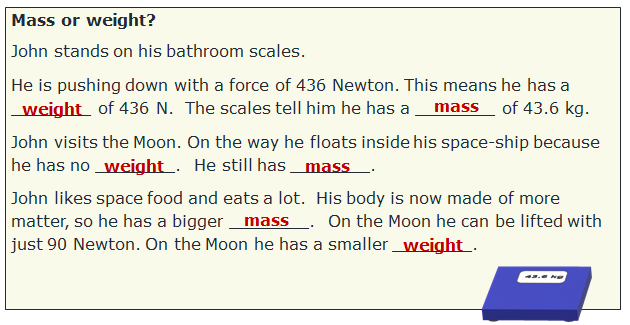
How students fill in the gaps will show you whether they understood the concept sufficiently well to apply it correctly.

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**

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**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG); Moon: <https://pixabay.com/vectors/moon-big-full-moon-big-moon-1898047/>

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