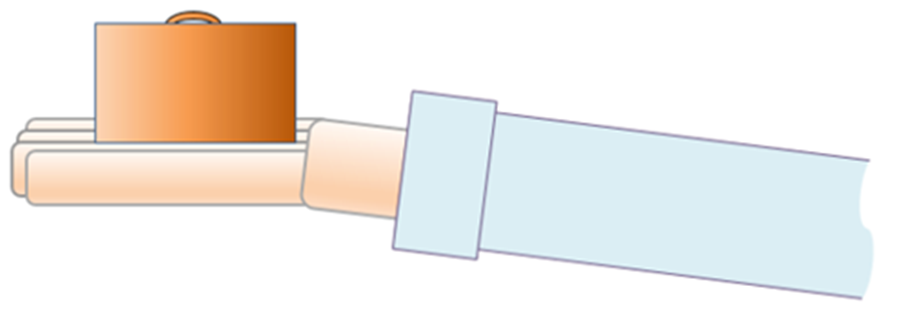
**A big weight**

Alice has picked up a big weight.

Her friends are talking about the forces that hold it steady.



1. What forces hold the big weight steady?

Put a tick (✓) in the box next to the best answer.

|  |  |  |
| --- | --- | --- |
| **A** | It is not moving, so there are no forces. |  |
|  |  |  |
| **B** | The only force is gravity, pushing it onto Alice’s hand. |  |
|  |  |  |
| **C** | The only force is Alice pushing up, to hold it steady. |  |
|  |  |  |
| **D** | Gravity pushes the weight down *and* Alice pushes it up. |  |

*Physics > Big idea PFM: Forces and motion > Topic PFM3: More about force > Key concept PFM3.2: Hidden forces*

|  |
| --- |
| **Diagnostic question** |
| **A big weight** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | An object resting on the floor squashes it a little and, because at a microscopic level the floor is springy, it pushes back on the object with an equal sized force in the opposite direction to the object’s weight. |
| Observable learning outcome: | Describe how a person’s hand uses force to support different sized weights. |
| Question type: | Simple multiple choice |
| Key words: | force, gravity, weight |

**What does the research say?**

Research by Terry *et al (1985)* has shown that expressing Newton’s third law in the form: “for every action (force) there is an equal and opposite reaction” is confusing for students aged 11-16. It is far clearer to describe in full: the force of object A on object B is equal in size, and opposite in direction to the force of object B pushing on object A.

When thinking about one object resting on a surface, students typically apply a concept of force that is different to the one they use for objects in motion. In a study of 1000 Norwegian upper secondary students, Sjoberg and Lie (1981) found that just 50% of the young people recognised ‘passive’ forces acting when there was no movement.

When Minstrell (1982) asked two US high school physics classes (aged 14+) about forces on an object resting on a table, most of the students understood that gravity was exerting a downwards force on the object, but only about half described the table exerting an upwards force. Students who did not identify an upwards force mostly described the table as ‘getting in the way’ (Driver et al., 1994). Typically those who recognised an upwards force from the table described the downwards force as bigger. In a further study, Montanero et al. (2002) found that only a very small minority of 11- to 16-year-olds (n=240) consistently applied the correct scientific understanding that the upwards force of a surface is the same size (and in the opposite direction) to the weight of an object that it supports.

Bridging analogies gradually take learners through a series of easily understood ‘base analogies’, in order to lead them to an understanding of a challenging ‘target concept’, which is outside the realm of their usual experience or understanding. Holding a weight on an outstretched hand and feeling the upwards force necessary to hold it still appears to help learners understand that an upwards force is necessary to keep an object at rest on a table (Bryce and MacMillan, 2005).

This question investigates students’ ideas about what their own hand is doing when it is holding a weight, which is a starting point for developing an understanding of the forces involved in supporting an object resting on a surface.

**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**

**D** Gravity pushes the weight down *and* Alice pushes it up.

**How to respond - what next?**

Most students will recognise that gravity pulls the weight down, and in this situation most will also realise that Alice is pushing up with a force.

It is likely that only about fifty percent of students would identify the upwards force if instead of Alice, the weight were resting on a table. This example introduces students to a particular example in which they can imagine the forces because they have felt them.

Unpicking the forces and making them explicit in this example can help students apply their understanding to new situations more confidently.

If students have misunderstandings about the forces acting on the weight to keep it still, it can help to give them a range of different weights to hold steady whilst encouraging them to describe and compare the forces they experience each time. The following BEST ‘response activities’ could be used in follow-up to this diagnostic question:

* Response activity: Adding more weight
* Response activity: Holding a book

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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