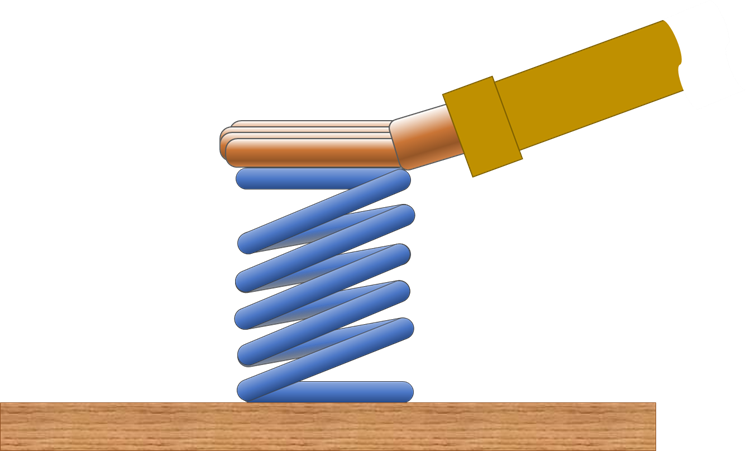
**Squashing a spring**

Sam pushes down on a spring.

The spring squashes a bit.



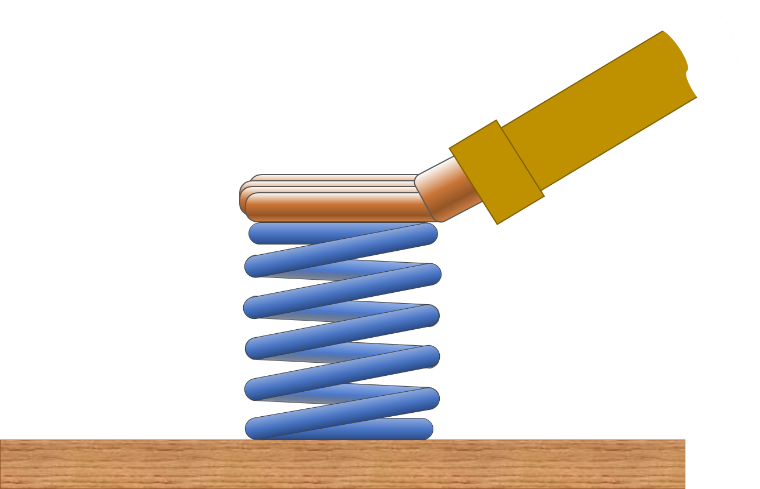
Sam does not move and the spring stays squashed.

1. What forces are pushing?

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

|  |  |  |
| --- | --- | --- |
| **A** | There are no forces. |  |
|  |  |  |
| **B** | Sam pushes down - the spring does not push up. |  |
|  |  |  |
| **C** | The spring pushes up - Sam pushes down harder. |  |
|  |  |  |
| **D** | The spring pushes up - Sam pushes down with the same sized force. |  |

Sam presses down harder.

The spring squashes more.

2. How hard does the spring push now?

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

|  |  |  |
| --- | --- | --- |
| **A** | It does not push up. |  |
|  |  |  |
| **B** | It pushes up with a smaller force than before. |  |
|  |  |  |
| **C** | It pushes up with the same sized force as before. |  |
|  |  |  |
| **D** | It pushes up with a bigger force than before. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Squashing a spring** |

**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 the size of force exerted by a spring changes as it is squashed. |
| Question type: | Simple multiple choice |
| Key words: | force |

**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. Squashing a spring or seeing a ruler flex more as extra weight is added seems to make it plausible to them that a table surface flexes in a similar way in order for an upward force to be created (Bryce and MacMillan, 2005).

This question investigates students’ understanding of the forces exerted when a spring is squashed by different amounts.

**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**

1. **D** The spring pushes up - Sam pushes down with the same sized force.

2. **D** It pushes up with a bigger force than before.

**How to respond - what next?**

In question 1, a few students may think there are no forces acting because there is no movement. In both examples the spring pushes back with the same sized force as Sam pushes down with and there is no resultant force (no force left over).

Answer B suggests students do not recognise that inanimate objects at rest can exert a force.

Answer C suggests the misunderstanding that the ‘bigger force wins’. In this case by squashing the spring.

In question 2 Sam is pushing harder and so the spring squashes more. As it squashes it pushes back with more and more force until the force it pushes back with is the same size as Sam’s squashing force.

Some students may think that the spring does not push up, because it is not moving, or that it pushes up with a smaller force because it has been squashed more (and is smaller). Other students may see the force that a spring pushes with as being an inherent property of the spring, and that a particular spring always pushes with the same sized force.

If students have misunderstandings about the forces involved in squashing a spring, it can help to have some springs for them to experience squashing. This is perhaps best done as a demonstration, in order to avoid ‘spring mayhem’. A spring-loaded pop up toy is ideal for this. Careful questioning should lead to the ideas that: the spring pushes back with a force when it is squashed; and that the more it is squashed, the harder it pushes back.

An analogy can also be drawn between the force of the spring and the forces that other objects push back with. Pressing down on an exercise book for example will show students that both it and their finger are squashed. Pressing harder squashes both the book and the finger more. This example takes the students closer to the idea that the floor pushes back with an equal sized force to the weight of an object resting on it, even though it cannot usually be seen to distort.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Bryce, T. and MacMillan, K. (2005). Encouraging conceptual change: the use of bridging analogies in the teaching of action-reaction forces and the 'at rest' condition in physics. *International Journal of Science Education,* 27(6)**,** 737-763.

Driver, R., et al. (1994). *Making Sense of Secondary Science: Research into Children's Ideas,* London, UK: Routledge.

Minstrell, J. (1982). Explaining the "aqt rest" condition of an object. *The Physics Teacher,* 20**,** 10-14.

Montanero, M., et al. (2002). Implicit theories of static interactions between two bodies. *Physics Education,* 37 (4)**,** 318-323.

Sjoberg, S. and Lie, S. (1981). Ideas about force and movement among Norwegian pupils and students. *Institute of Physics Report Series: Report 81-11.* University of Oslo.

Terry, C., Jones, G. and Hurford, W. (1985). Children's conceptual understanding for force and equilibrium. *Physics Education,* 20(4)**,** 162-165.