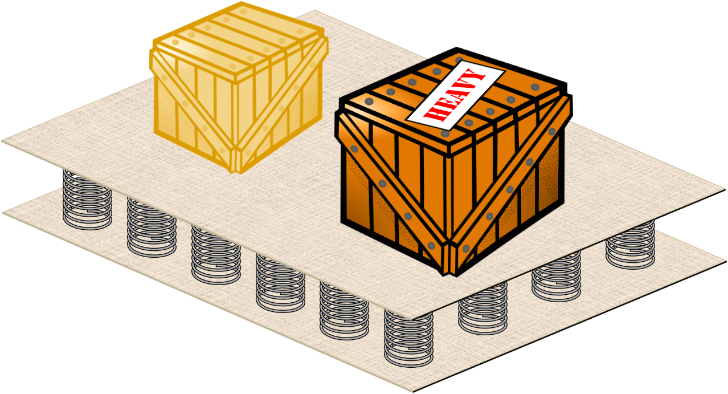
**Squashing a mattress**

Some mattresses contain a lot of springs.

Some students are using a mattress to think about objects resting on the floor.

They are thinking about a light crate and a heavy crate sitting on the floor.

They want to explain the forces acting on the floor and on the crates.

**To answer**

State three ways in which this **is a good representation** of the crates resting on the floor.

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State three ways in which this is **not an accurate representation** of the crates resting on the floor.

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

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| --- |
| **Response activity** |
| **Squashing a mattress** |

**Overview**

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| --- | --- |
| 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: | Explain how objects of different weights can all be supported by the same floor. |
| Activity type: | Critiquing a representation |
| Key words: | balanced, force, weight |

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

* Diagnostic question*: Heavy crate*
* Diagnostic question*: Light crate, heavy crate*

**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 the learner 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 (Bryce and MacMillan, 2005). A target question can be used to make explicit students’ alternative conceptions about the topic under consideration and an analogous case suggested by the teacher to scaffold and develop understanding. Targeted questioning and dialogue can lead students to make connections between the analogy and the target concept, and where necessary additional bridging steps (base analogies) added by the teacher, in order to reach or strengthen understanding of the target concept. (Savinainen, Scott and Viiri, 2004)

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

Philosophically science can be said to be a description of the ‘best model’ we have for the world. In this activity students should identify ways in which this particular model is a good representation of the real world, and ways in which it is not.

Students should work together to answer the questions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

Ending with the students completing the worksheet or questions from the PowerPoint individually, might help them to consolidate their learning.

*Differentiation*

You may choose to use simplified worksheets for some students, for example with gaps to fill in so they can focus on the science. In some situations it may be more appropriate for a teaching assistant to read and/or scribe for one or two students.

**Expected answers**

**Good representation:**

Springs are squashed by the weight of crate, in the same way as the floor is squashed.

Each spring pushes up when it is squashed, and because at a microscopic level it is springy, the floor pushes back on the object with an equal sized force in the opposite direction to the object’s weight.

Springs are squashed more by a heavier object, so they push back more when a heavier object rests on them, in the same way as different parts of the floor.

**Not an accurate representation:**

There are no springs in the floor, instead forces between the atoms stop them from getting too close.

Squashing of the floor is too small to see (usually).

Big movements in the mattress springs can affect other parts of the mattress so heavy objects ‘roll’ together.

A very heavy object would squash the springs flat and the object would rest on the bedframe, floors hold much heavier weights (before they break).

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: spring: <https://pixabay.com/vectors/mathematical-r-spring-1295528/>, Peter Fairhurst (UYSEG).

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