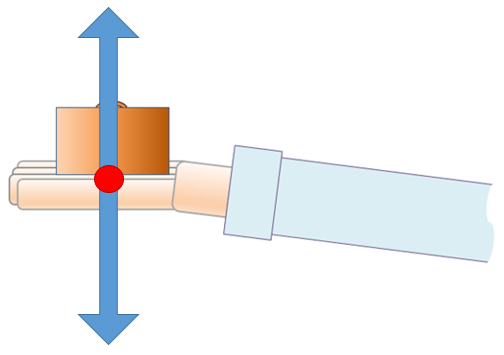
**Adding more weight**

This practical activity is about what happens to the forces needed to hold a weight still.

To hold a weight in my hand, I need to push up with a force.

The weight pushes down with a force.

**Equipment**

* Two weights

**Predict**

What do you think will happen to each force when another weight is added?

**Explain**

Explain why you think this will happen.

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| --- |
| **Hold a weight in your hand, and then double it.** |

**Observe**

Describe what happens to the force you are pushing up with.

**Explain**

Were your prediction and explanation correct?

Try to improve your first explanation to explain this more clearly.

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

|  |
| --- |
| **Response activity** |
| **Adding more 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. |
| Activity type: | Predict, explain, observe, explain (PEOE) |
| 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: A big 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 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. 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 activity**

This activity is the same as the response activity *PFM1.2 Adding weight* used in an earlier key concept.

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.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict what they think will happen, and then to explain why they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical and after the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their explanations and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class-explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

Differentiation

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* Two equal sized masses that can both be held in one hand.

**Technician notes**

200g masses are heavy enough for students to notice the effect, and not too large to fit in one hand.

Two or three 100g slotted masses could be used instead of a single 200g mass, with the same number being added later.

**Health and safety**

Falling masses may be an issue, and completing the practical whilst seated at a bench reduces this risk.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

When the weight doubles the force of the hand pushing up also doubles. It continues to act upwards.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

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