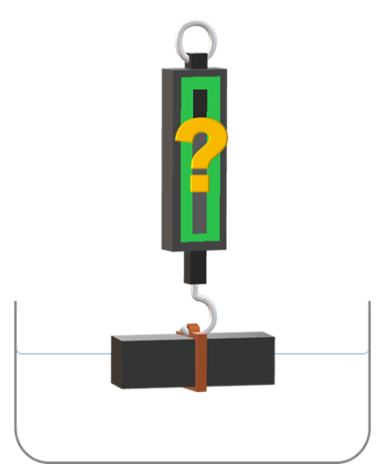
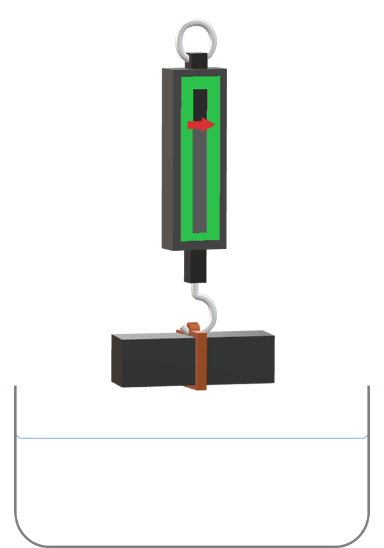
**Buoyancy**



A metal block is hanging on a force meter.

The metal block is lowered into water.

**Predict**

What will happen to the force measured when the block is half in the water?

What will happen to the force measured when the block is under water?

**Explain**

Explain why you think this will happen.

|  |
| --- |
| **Observe what happens to the force when the block is lowered into water.** |

**Observe**

|  |  |
| --- | --- |
| **Where the block is** | **Force / N** |
| Not in water |  |
| Half in water |  |
| Under water |  |

**Explain**

Were your prediction and explanation correct?

Try to improve your first explanation to explain what happens more clearly.

*Physics > Big idea: PMA Matter > Topic PMA2: Floating and sinking > Key concept PMA2.1: Floating, sinking and density*

|  |
| --- |
| **Response activity** |
| **Buoyancy** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | An object that is surrounded by a fluid (liquid and/or gas) floats if its overall density is less than the density of the fluid. |
| Observable learning outcome: | Describe how the shape of an object affects how well it floats.  Explain how the density of an object determines how well it floats. |
| Activity type: | Predict, explain; observe, explain (PEOE) |
| Key words: | Floating, sinking, weight, volume, density |

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

* Diagnostic question: Flipping iceberg
* Diagnostic question: Block float

**What does the research say?**

Paik et al. (2017) describe a learning progression for buoyancy that begins with the basic concepts of weight and volume, before starting to develop the scientific concepts of density and buoyancy. In their progression, the density of an object is introduced as the object being *heavy (or light) for its size*. This working definition of density allows students to develop understanding of how volume and weight combine to give an object its buoyancy, and provides descriptive tools that help explain why boat-shaped objects (that are filled with air) are more buoyant than other more compact shapes. This idea is also linked to the understanding that buoyancy increases as the volume of liquid (or gas) displaced increases. Buoyancy is defined as the resultant upward force of the liquid (or gas) around an object, on the object.

When an object sinks in a liquid, Cepni and Şahin (2012) found that most 13- to 14-year-olds (n=48) did not think that the object had buoyancy. In some cases students labelled the buoyancy of a sinking object as downward: they thought that the liquid was pushing it downward. Conversely some students may think that a floating object has no weight (Allen, 2014). Buoyancy always acts vertically upward; the resultant force is determined by comparing the force of the water pushing the object up, with the force of gravity pulling the object down.

**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.

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, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

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:

* Force meter (0-10 N)
* Metal density block
* Elastic band
* Plastic bowl (of water)

**Technician notes**

The density blocks are to be hung on the force meters. Elastic bands selected need to be robust enough to minimise the risk of blocks falling off. Large aluminium blocks give the best results.

A half-kilogram hanging mass could be used as an alternative.

**Health and safety**

Risk of water on the floor and slipping.

Risk of potentially heavy density blocks falling.

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**

The force reduces by a small amount when the block is half in the water.

The force reduces by the same amount again when it is completely under water.

The reduction in force is equal to the buoyancy. (Buoyancy is equal to the weight of the water displaced by the block.)

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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Cepni, S. and Sahin, C. (2012). Effect of different teaching methods and techniques embedded in the 5E instructional model on students' learning about buoyancy force. *Eurasian Journal of Physics and Chemistry Education,* 4(2)**,** 97-127.

Paik, S.-H., et al. (2017). Developing a Four-level Learning Progression and Assessment for the Concept of Buoyancy. *Eurasia journal of mathematics, science and technology education,* 13(8)**,** 4965-4986.