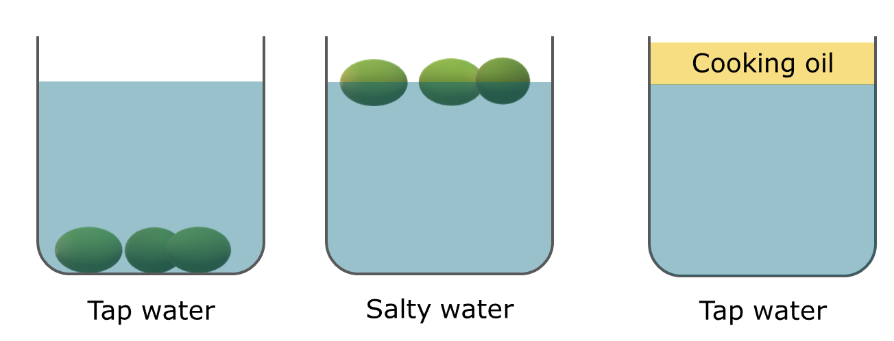
**Grape expectations**

Grapes sink in tap water.

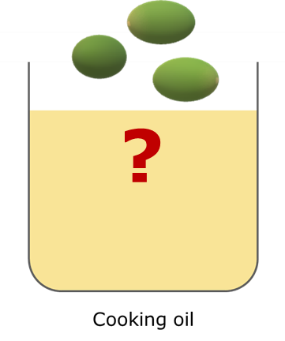
The same grapes float in salty water.

Cooking oil floats on tap water.



**Predict**

Do grapes float on cooking oil?



Cooking oil

**Explain**

Explain why you think this will happen.

|  |
| --- |
| **Observe what happens when grapes are put into cooking oil.** |

**Observe**

Describe what you see.

**Explain**

Were your prediction and explanation correct?

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

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

|  |
| --- |
| **Response activity** |
| **Grape expectations** |

**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: | Explain how the density of a liquid (or gas) determines how well objects float in it. |
| Activity type: | Predict, explain; observe, explain (PEOE) |
| Key words: | Floating, sinking, density |

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

* Diagnostic question: Density column

|  |  |
| --- | --- |
| **B** | **BRIDGING**  This activity explores ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**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.

It is appropriate to teach students how to calculate buoyancy only after they have developed a good qualitative understanding how it works (Gao et al., 2018). Students can use a displacement can to measure the weight of water displaced by an object and compare this to the weight of the object. Buoyancy is equal to the weight of the water (or other fluid) displaced. Objects that float displace their own weight of water. If the weight an object is greater than the weight of the water the object displaces, then the object will sink. In other words: if an object is less dense than the liquid (or gas) that it is placed in it will float; if it is denser it will sink.

**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 the class:

* Beaker of tap water.
* Beaker of salt solution – concentrated enough for a grape to float in.
* Beaker of tap water with a layer of cooking oil on top.
* Beaker of cooking oil.
* About a dozen grapes.

**Technician notes**

Sugar can be used instead of salt.

Check that the grapes you have float in salt-water and sink in the cooking oil.

**Health and safety**

Spillages may make the floor slippery – especially likely if completed as a class practical activity.

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 grapes sink in cooking oil.

The grapes sink in water because they have a higher density than water. Cooking oil floats on water because it has a lower density than water. These facts indicate that grapes have a higher density than cooking oil, which means that they will sink in it.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Gao, Y., et al. (2018). Developing a Learning Progression of Buoyancy to Model Conceptual Change: A Latent Class and Rule Space Model Analysis. *Research in Science Education*.

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.