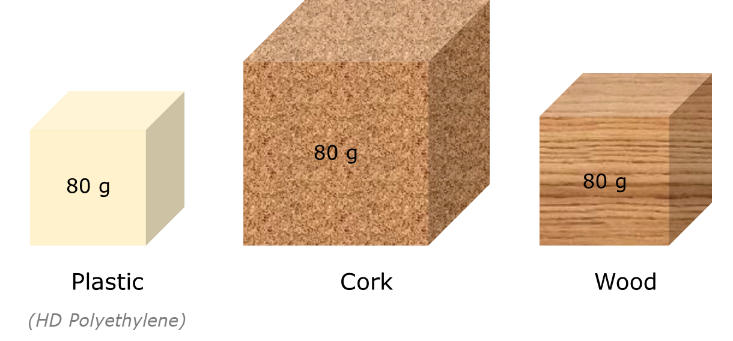
**Block float**

All of these blocks have the same mass.

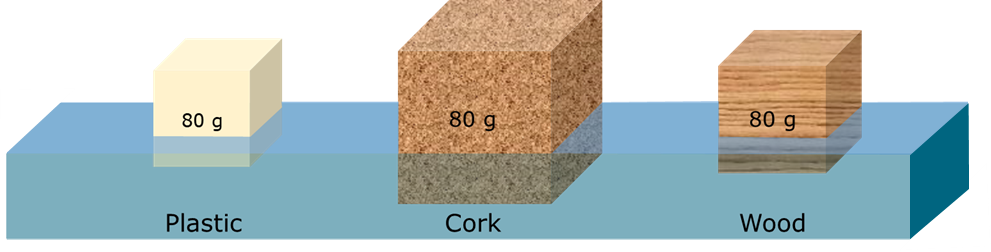
They all float in water.



All the blocks are floating in water.

*For each statement, tick (✓)* ***one*** *column to show what you think.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | The plastic block has the biggest density. |  |  |  |  |
| **B** | Water pushes up on each block with the same sized force. |  |  |  |  |
| **C** | The blocks float like they are shown here:- |  |  |  |  |



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

|  |
| --- |
| **Diagnostic question** |
| **Block float** |

**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 an object determines how well it floats. |
| Question type: | Diagnostic, confidence grid |
| Key words: | Floating, mass, weight, volume, density |

**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.

**Ways to use this question**

Students should complete the confidence grid 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.

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.

**Equipment**

For the class (optional demonstration):

* Glass trough of water
* Three blocks of equal mass, each with a different density.

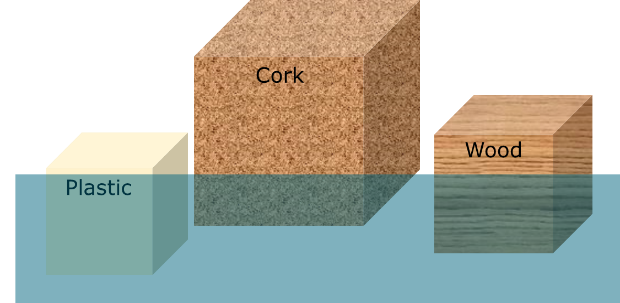
**Expected answers**

Statements A and B are correct.

Statement C is wrong.

**How to respond - what next?**

1. The plastic block has more mass *for its size*, so it has a bigger density than the other blocks. Another way to think about this is that it has the same mass as the other blocks within a smaller volume.
2. All of the blocks are floating because the resultant force acting on each one is zero. The upward force of the water is therefore equal in size, and opposite in direction to the weight of each block – and each block has the same weight. This means that water pushes up on each block with the same sized force.
3. The more water that each block pushes out of the way, the bigger the upwards force of the water on the block. For the water to push up equally on each block, the same amount of water must be pushed out of the way by each block. This means that they will float like this:-



The plastic block is smallest and needs to be lower down in the water, in order to push the same volume of water out of the way as the other blocks.

If students have misunderstandings about how the density of an object determines how well it will float, it can help to observe a demonstration of this question. Careful questioning can elicit the understanding that the further into the water each block is pushed, the harder the water pushes back; and that a larger block pushes water out of the way more quickly as it moves down. This can be experienced by pushing a block deeper than its floating depth and feeling the upwards push of the water. The forces felt with blocks of the same mass, and of different densities, can be compared.

The following BEST ‘response activities’ could also be used in follow-up to this diagnostic question:

* Response activity: Buoyancy
* Response activity: Clay boat

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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.