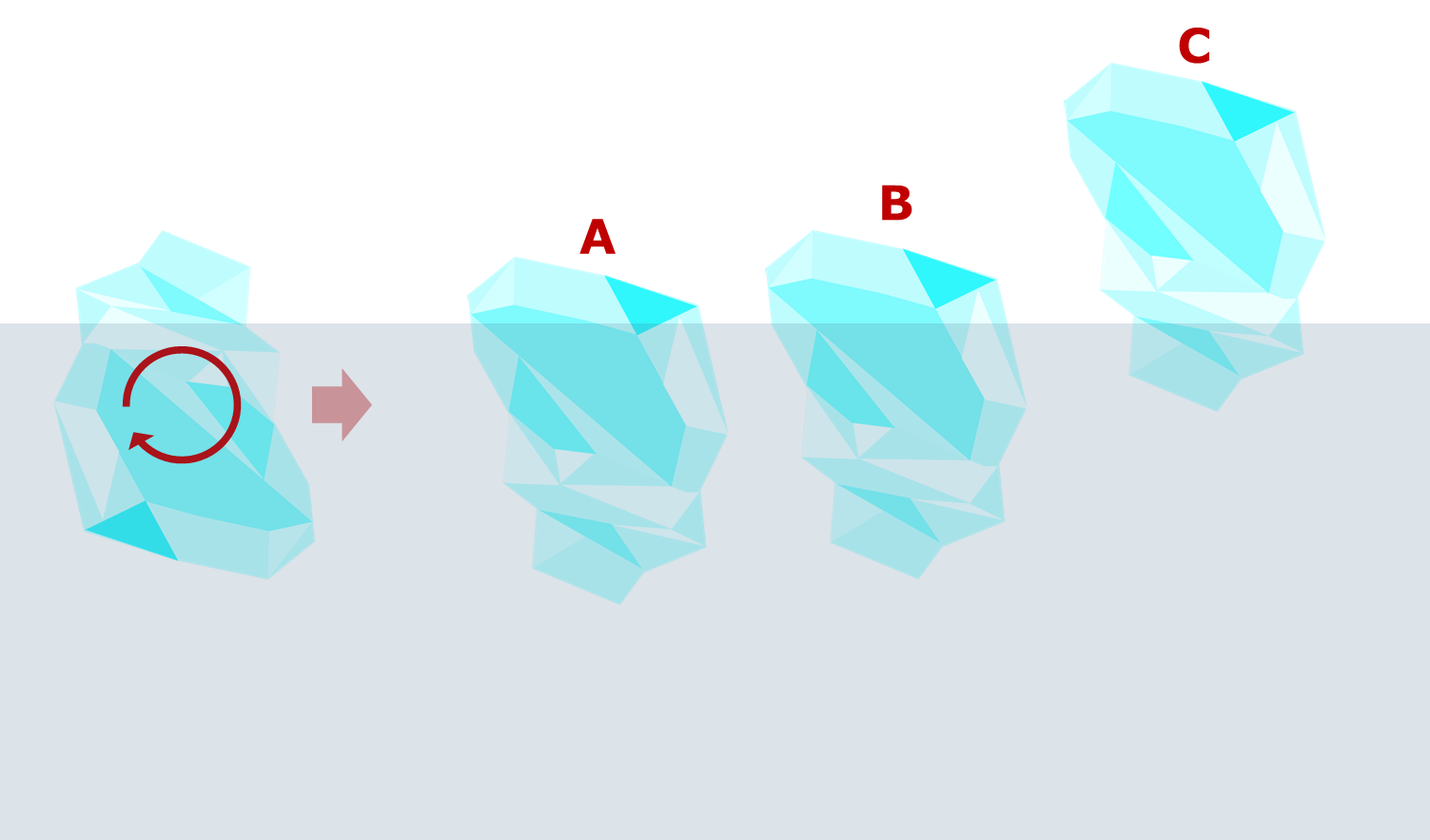
**Flipping iceberg**

Most of this iceberg is under the water.

A violent storm flips the iceberg over.





The upside-down iceberg is floating.

What does the iceberg look like now?

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

|  |
| --- |
| **Diagnostic question** |
| **Flipping iceberg** |

**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. |
| Question type: | Simple multiple choice |
| Key words: | Floating, sinking, 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 question 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.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

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.

**Expected answers**

Iceberg A

**How to respond - what next?**

Iceberg A has the same *proportion* above the water as the un-flipped iceberg had.

Iceberg B is floating at the same height above the water and is likely to be the most common wrong answer. It is likely that several students will ‘guess’ between icebergs A and B, so it is important to elicit reasons for their choice. The key idea is that the water pushes up against the downward push of the iceberg; and the more water that is pushed out of the way, the harder the water pushes back on the iceberg. The iceberg does not change its weight, so the same volume of water needs to be pushed out of the way, both before and after it turns over, to provide enough force to balance its weight.

Iceberg C shows the originally submerged section appearing above the waterline.

If students have misunderstandings about how the shape of the iceberg affects how well it floats, it can help to give them the opportunity to observe how changing the shape of a boat made from modelling clay affects how high it floats in water (without changing the amount of clay).

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.