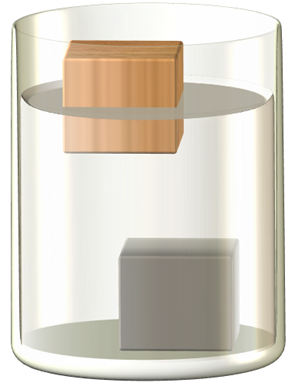
**Defining density**

Objects float in water if their density is less than the density of water.

They sink if their density is higher.



Which statement describes the density of an object?

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | The weight of the object. |  |
|  |  |  |
| **B** | The amount of mass it contains. |  |
|  |  |  |
| **C** | The amount of mass it contains in a particular volume. |  |
|  |  |  |
| **D** | The weight of the object for a particular volume. |  |

*Physics > Big idea PMA: Matter > Topic PMA4: Particle explanations > Key concept PMA4.1: Density*

|  |
| --- |
| **Diagnostic question** |
| **Defining density** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Density, the mass of material in 1m3 or in 1cm3, is dependent on both the mass of its particles and their spatial arrangement. |
| Observable learning outcome: | Explain the equation ρ=m/V and use it to make calculations. |
| Question type: | Simple multiple choice |
| Key words: | Density, mass, volume, weight |

**What does the research say?**

A common misunderstanding amongst students is that mass (weight) and density are the same thing. This is perhaps linked to a tendency to define matter (including density) in terms of tangible properties that can be sensed. Mass (weight) and volume can both be sensed and directly measured. Mass and volume can also be defined as extensive quantities because they change with the amount of material. Density, by contrast, is an intensive quantity because it does not change with the amount of material (Smith, Snir and Grosslight, 1992). Intensive properties cannot be measured directly and are therefore harder to understand.

In a study of (n=296) 12- to 15-year-olds Fassoulopoulos et al. (2003) found that 54% were able to describe density using the correct scientific understanding. These students used phrases like ‘it is heavy for its size’, or ‘it has more mass for the same volume’. By contrast 24% of students in the study sometimes applied an understanding of density that showed they thought it changed in proportion to the amount of a substance.

Seah, Clarke and Hart (2015) suggest that when volume is not mentioned in an explanation of density, it is not necessarily true that a student has not understand what density is. They may instead have not realised that in a scientific definition there is a need to include the condition about comparable volumes in their answer. Definitions of density need to include: per unit volume; if the volume of the objects is equal; or similar.

Modelling clear explanations for density can raise awareness in students of the need to be explicit about volume (Seah et al., 2015). Students need to be actively engaged in thinking about how volume plays a role in determining density and given opportunity to explain density in their own words. Asking students to elaborate on answers in class or small-group discussions allows them to rehearse their use of the language of scientific explanation, as well as indicating their ability to do so.

**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**

C The amount of mass an object contains in a particular volume.

**How to respond - what next?**

Density describes the amount of matter (mass) in a particular volume. In order for the density of different objects or materials to be compared, density is usually taken to be the amount of mass in either one centimetre cubed or in one metre cubed.

Students who choose option A or B probably think about density as an extensive quantity.

Even if students give the correct answer, it is necessary to check that they understand that mass is the amount of matter in a material or object. It is common for students to not distinguish between the weight of an object, which can be described as the force needed to lift it against gravity, and its mass.

If students have misunderstandings about defining density in a way that explains the equation ρ=m/V, it can help to spend time developing a qualitative understanding of density. The BEST diagnostic questions from earlier in this key concept can be used to do this.

Once students understand the definition for density given in option C, they can be challenged to write down an equation for density that can then be used to solve calculations.

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

* Response activity: Measuring density

**Acknowledgments**

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Images: Peter Fairhurst (UYSEG).

**References**

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