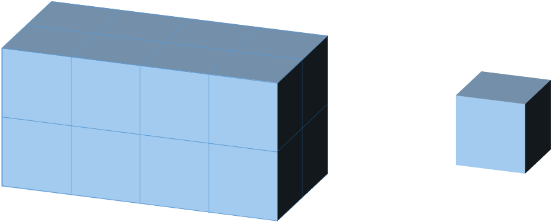
**Measuring density**

Density of an object is the amount of mass it contains in a particular volume.

**Density**

**Mass**

**Volume**

**=**

**÷**

**ρ**

**m**

**V**

**=**

**÷**

Some students are discussing the units that density is measured in.

**Sana:** volume can measured in cm3 or m3.

**Violet:** density has two different units. The number calculated is the same for both.

**Ursula:** mass can be measured in kg or g.

**Teagan:** density is usually measured in kg/m3 or kg/cm3.

**Wiktoria:** 1 litre of water has a mass of 1 kg, so the density of water is

1 g/cm3.

**To answer**

1. Who is right about measuring density?
2. Who is wrong about measuring density?
   * *Explain your answer.*
3. Write your own description of the units used to measure density.
   * *Include all the important detail.*

|  |  |
| --- | --- |
| Cards for  **Measuring density** | **Sana:**  Volume can measured in  cm3 or m3. |
| **Teagan:**  Density is usually measured in kg/m3 or kg/cm3. | **Ursula:**  Mass can be measured in  kg or g. |
| **Violet:**  Density has two different units. The number calculated is the same for both. | **Wiktoria:**  1 litre of water has a mass of  1 kg, so the density of water is  1 g/cm3. |

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

|  |
| --- |
| **Response activity** |
| **Measuring 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. |
| Activity type: | Talking heads |
| Key words: | Density, mass, volume, weight, g/cm3, kg/m3 |

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

* Diagnostic question: Defining density

**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.

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.

The difficulty in students being able to use maths in physics may be that they can’t do the maths, but it could also be to do with students struggling with the way symbols in equations are used to make meaning differently in maths and physics (Redish and Kuo, 2015). Smith et al. (1997) found that students (n=30, age 13-14) were more than twice as likely to give correct units in a density calculation if they had first been taught to understand density qualitatively.

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*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 the 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.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

1. Sana, Ursula and Wiktoria are right about measuring density.

2. Teagan and Violet are wrong.

Density is usually measured in kg/m3 or in g/cm3 and not in kg/cm3. These units are helpful because for most objects or materials the values produced are easy to understand. For example, it is easier to appreciate that a sugar lump sized piece of material has a mass of 8 g rather than it having a mass of 0.008 kg.

Density does have two different units, but the number calculated is different for each. A density of 1g/cm3 is the same as a density of 1000 kg/m3.

3. Density is measured in kg/m3 or in g/cm3.

The unit g/cm3 describes the number of grams of mass in a 1cm x 1cm x 1cm piece of material.

The unit kg/m3 describes the number of grams of mass in a 1m x 1m x 1m piece of material.

Water has a density of 1 g/cm3 = 1000 kg/m3.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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