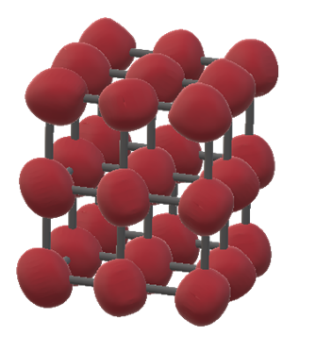
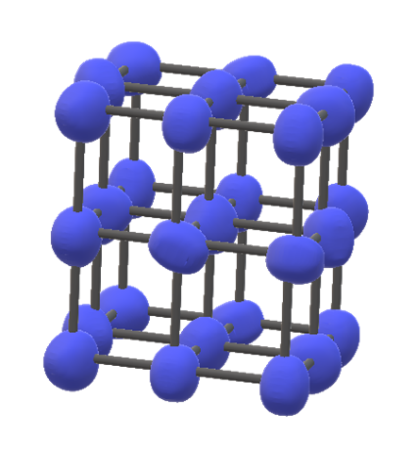
**Modelling density**



Some students are using models to explain why some substances have a higher density than others.

They are using balls of

modelling clay and thin sticks.

**To answer**

1. State three ways in which these **are good models** for explaining density.

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**2.** State three ways in which these are **not accurate models** for explaining density.

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**3.** Use the particle model to explain why some substances have a higher density than others.

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

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| **Response activity** |
| **Modelling density** |

**Overview**

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| 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: | Use the particle model to explain differences in density. |
| Activity type: | Critiquing a representation |
| Key words: | Particle, mass, volume, density |

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

* Diagnostic question: Particle characteristics

**What does the research say?**

An understanding of particles is not necessary to understand density, but to understand *why* the density of one material is different to the density of another, students need to use the particle model. They also need to understand that even sub-microscopic particles have a mass and volume (Smith, Snir and Grosslight, 1992). Smith et al. (1997) found that although these concepts are often assumed when density is taught, 27% of 12- to 13-year-olds (n=30) do not hold them. In their study they found that giving students opportunity to address these concepts directly led to a more robust understanding of density.

The particle model of matter can represent how closely particles are packed together, which together with the mass of each particle explains the density of a material. Density is a joint function of mass of particles and their spatial arrangement, which is affected by temperature and pressure. An understanding of particles provides students with powerful tools for thinking about changes of density. (Smith et al., 1992)

**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.

Philosophically science can be said to be a description of the ‘best model’ we have for the world. In this activity students should identify ways in which this particular model is a good representation of the real world, and ways in which it is not.

Students should work together to answer the questions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

Ending with the students completing the worksheet or questions from the PowerPoint individually, might help them to consolidate their learning.

*Differentiation*

You may choose to use simplified worksheets for some students, for example with gaps to fill in so they can focus on the science. In some situations it may be more appropriate for a teaching assistant to read and/or scribe for one or two students.

**Expected answers**

1. *These are good models for explaining density because:*

* The balls of clay show how particles of different substances (or materials) differ in size and mass. (The red ball are bigger than the blue ones.)
* The sticks show how particles in different substances (or materials) differ in how they are spatially arranged.
* The spacing between particles indicates how closely they are packed together.

2. *These are not accurate models for explaining density because:*

* Particles in a solid are in contact with adjacent particles.
* The sticks indicate there is something between the particles and there is nothing.
* Particles in solids can be found in different arrangements and both models show just one.
* Particles are not always spherical (e.g. polymer chains or water molecules).
* The clay balls suggest different particles have different colours (macroscopic properties) and particles do not individually have colour.

3. Density describes the amount of mass within a particular volume. The amount of mass inside a particular volume is bigger if the particles are closer together so more particles fit inside the volume. The mass contained is also bigger if each particle has more mass to contribute.

The density of a substance (or material) depends both on the mass of the particles it contains and on how closely the particles are packed together.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Smith, C., et al. (1997). Teaching for understanding: a study of students' preinstruction theories of matter and a comparison of the effectiveness of two approaches to teaching about matter and density. *Cognition and Instruction,* 15(3)**,** 317-393.

Smith, C., Snir, J. and Grosslight, L. (1992). Using conceptual models to facilitate conceptual change: the case of weight-density differentiation. *Cognition and Instruction,* 9(3)**,** 221-283.