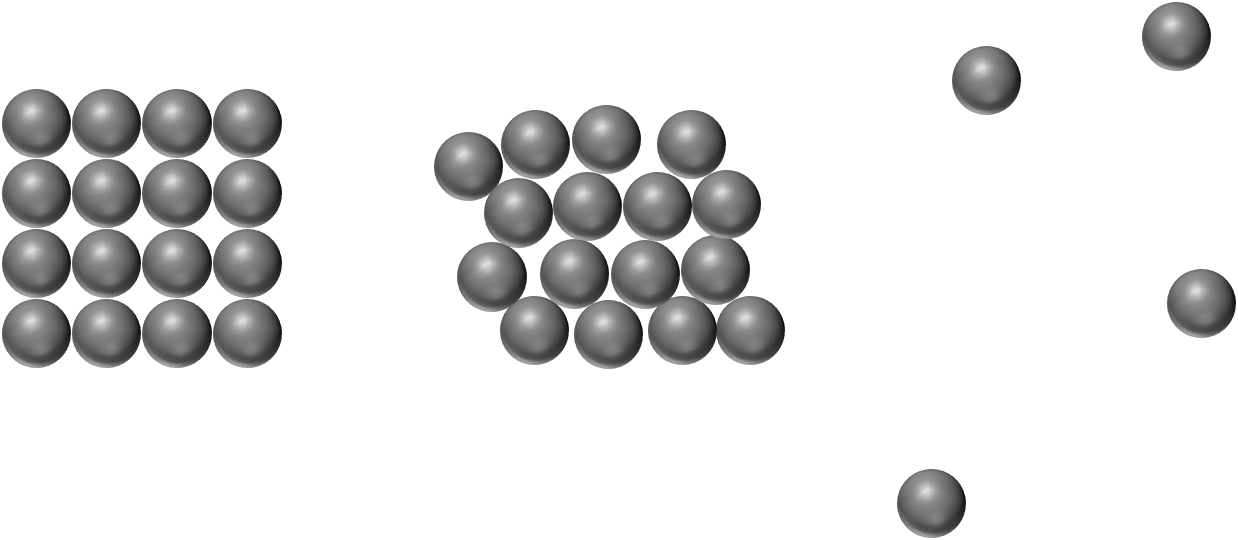
**Particle characteristics**

All matter is made from particles.

The particle model helps us think about the particles in different substances or materials.



Solid

Liquid

Gas

These statements are about particles in the solid, liquid and gas states.

*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** | **All** particles have mass. |  |  |  |  |
| **B** | **All** particles have a volume. |  |  |  |  |
| **C** | A substance or material is made of particles – **nothing** else. |  |  |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Particle characteristics** |

**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: | Use the particle model to explain differences in density. |
| Question type: | Confidence grid |
| Key words: | Particle, mass, volume |

**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 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.

**Expected answers**

All three statements are right.

**How to respond - what next?**

Smith et al. (1997) asked students age 12-13 (n=30) what they thought would happen if piece of expanded polystyrene was repeatedly divided. At some point in the process, 27% thought that the pieces created would have no mass and 33% that they would eventually disappear. Students with these misunderstandings typically think of matter in terms only of what they can directly observe.

The idea that there is ‘nothing’ between particles, even in the gas state, causes difficulties for many students.

If students have misunderstandings about the particle model and the idea that all particles have mass and volume, it may be necessary to spend some time reviewing the particle model. There are useful resources for doing this in the BEST key concept: CPS1.1 Particle model for the solid, liquid and gas states.

Smith et al. (1997) found that engaging students in measuring the mass of individual lentils or grains of rice enabled them to more readily understand that particles have mass and volume. On its own a lentil does not register on a balance, but measuring the mass of a hundred lentils and dividing to find the mass of one appears to help students consider mass to be property of individual particles, which, when many particles are combined, can add to a size that is directly observable.

Careful questioning can lead students to understanding that the mass and physical spacing of particles can explain the density of different materials. The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Modelling density

**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.