**Particle explanations – gas state**

The box below contains some statements about the particle model for the gas state.

All the statements are correct.

**A** Most of the particles are far from each other.

**B** The particles move around rapidly in all directions.

**C** The particles collide with the walls of the container they are in.

**D** Most of the particles are too far apart to exert any force on each other.

**E** If you heat a gas, the average speed of the particles gets bigger.

Which of the statements above help to explain each of the following?

**1** Substances in the gas state are fairly easy to compress.

**2** Substances in the gas state spread out to fill the whole   
space they are in.

**3** Substances in the gas state don’t settle to the bottom   
of a container, but fill the whole space.

**4** The gas state is less dense than the solid and liquid states

*Chemistry > Big idea CPS: Particles and structure > Topic CPS1: Substances and mixtures > Key concept CPS1.1: Particle model for the solid, liquid and gas states*

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| --- |
| **Diagnostic question** |
| **Particle explanations- gas state** |

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| --- | --- |
| Learning focus: | Understand a basic particle model of matter that can explain the properties of substances in the gas state. |
| Observable learning outcome: | Use the basic particle model to explain the properties of gases |
| Question type: | simple multiple choice |
| Key words: | gas, state, particles |

**What does the research say?**

Johnson (1998) identifies three alternative models of matter held by students:

1. Substances are continuous (with no recognition of particle ideas)
2. Particles are located within a continuous substance (rather than being the substance)
3. Particles are the substance (but macroscopic properties are given to the particles)

These contradict the standard particle model in which the particles are the substance but where the macroscopic properties of the substances arise collectively from the particles. The standard particle model can successfully explain some properties of a substance in the gas state.

**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.

**Expected answers**

**1**  A **2**  B and D

**3**  A, B and D **4**  A

**How to respond - what next?**

If students select incorrect answers this suggests that they are not able to link the descriptions of the particles in the particle model to the bulk properties of the material.

If students have misunderstandings about how the particle model can be used to explain the properties of substances in the gas state, it may help for students to look at a simulation such as that at <https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.html> . This simulation takes the model further to include molecules so at this stage selection of neon or argon would be appropriate as the particles are single atoms.

This animation may be easier for students to understand than a static diagram.

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Images: EPSE

**References**

Johnson, P. 1998. Progression in children’s understanding of a ‘basic’ particle theory: a longitudinal study. *International Journal of Science Education.* 20 (4) 393-412

Johnson, P. (2012). Introducing particle theory. In Taber, K. (ed.) *ASE Science Practice: Teaching Secondary Chemistry.* New edition ed. London: Hodder Education.