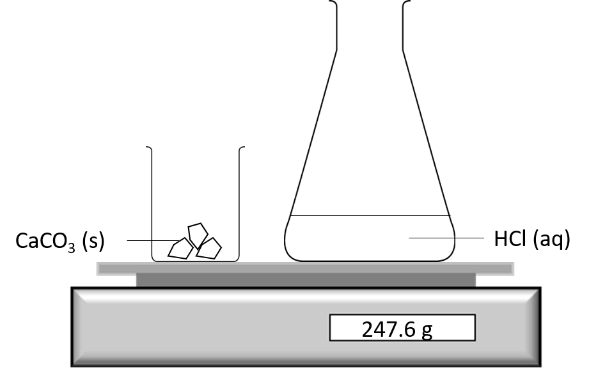
**Final mass**

1. The reactants are placed on a balance.



The total mass is 247.6g.

The chemical equation for the reaction is:

CaCO3 (aq) + 2HCl (aq) → CaCl2 (aq) + CO2 (g) + H2O (l)

The reactants are mixed. A chemical reaction takes place,

Predict the final mass.

A 246.8g

B 247.6g

C 248.1g

*Chemistry > Big idea CPS: Particles and structure > Topic CPS4: Understanding reactions > Key concept CPS4.2: Conservation of mass*

|  |
| --- |
| **Diagnostic question** |
| **Final mass** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | During a chemical reaction no atoms are created or destroyed. Mass is conserved. |
| Observable learning outcome: | Use a symbolic chemical equation to predict and explain an apparent change of mass in an open system where a product is in the gas state. |
| Question type: | simple multiple choice |
| Key words: | chemical reaction, mass |

**What does the research say?**

The questions devised for research by Barker and Millar (1999) consider student understanding of conservation of mass both in closed systems (such as a precipitation reaction) and open systems (such as the combustion of fuels). For a combustion reaction, students need to understand that the measured starting mass does not include both reactants. Therefore, the final measured mass will be greater than the starting mass. If the mass of oxygen were included, mass would still be conserved.

In this example one of the products is in the gas state. Johnson (2012) describes student difficulties in recognising that a gas is substance. He suggests that an understanding of the arrangement of particles can help students to understand that a gas is a substance. Only then can a student appreciate that the escape of a product in the gas state, in an open system, will result in a decrease in measured mass.

**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.

*Differentiation*

It may help some students to interpret the method described in the questions if they are shown the actual experiment.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS. In particular care should be taken with lead nitrate and all safety advice followed (including to wash hands after use).

**Expected answers**

A

**How to respond - what next?**

A student who selects option B may have correctly recalled the idea of conservation of mass but has not noticed or recognised the implications of a product being in the gas state.

It is possible that a student has realised that the carbon dioxide will escape the system but still holds misunderstandings about a substance in the gas state having mass. Asking students to give reasons for their answer will help to establish what misunderstandings, if any, they hold.

If students have misunderstandings about when the measured mass will and will not change during a reaction it may help to discuss the difference between and open and closed system and the implications when a product is in the gas state. A practical demonstration and discussion may also help.

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

* Mass prediction

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden and Alistair Moore

**References**

Barker, V. and Millar, R. (1999). Students' reasoning about chemical reactions: what changes occur during a context-based post-16 chemistry course? *International Journal of Science Education,* 21(6)**,** 645-665.

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