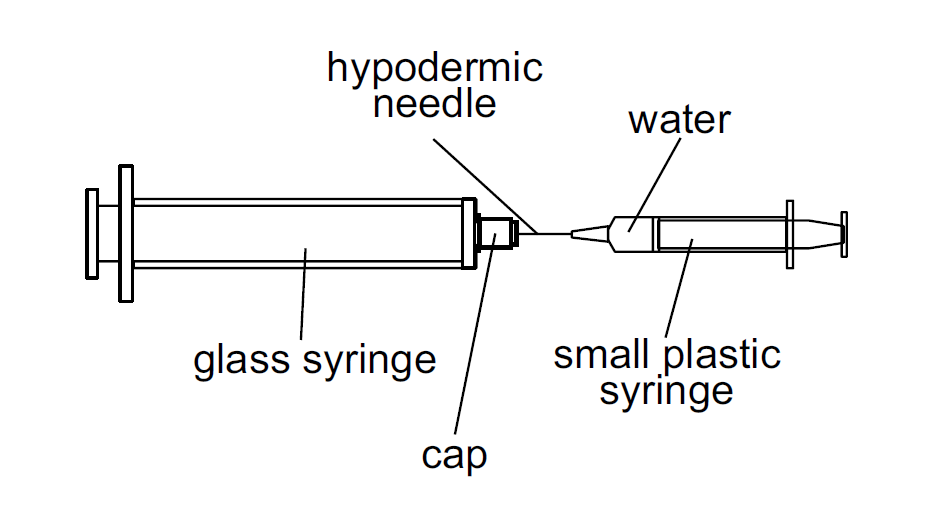
**Water in syringe**

You are going to use the particle model to predict and explain what will happen in this demonstration.

A glass syringe is heated in an oven to 150 ºC. A small drop of water will be injected into the cap at the end of the glass syringe.



**Predict**

What will happen when the drop of water is injected into the hot syringe?

Write down your **prediction**.

**Explain**

Write down the thinking behind your prediction.

**Observe**

Describe what happens.

**Explain**

Were your prediction and explanation correct?

If not, can you explain what you observed?

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

|  |
| --- |
| **Response activity** |
| **Water in syringe** |

|  |  |
| --- | --- |
| Learning focus: | Understand a basic particle model of matter that can explain the properties of substances in the gas state. |
| Observable learning outcome: | Describe how the arrangement and movement of particles alters when a substance changes from the liquid to gas state. |
| Activity type: | predict explain observe explain |
| Key words: | gas, state , particles, volume |

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

* A particle model for the gas state

**What does the research say?**

Johnson and Papageorgiou (2010) suggest that the use of a ‘solids, liquids and gases’ framework for teaching may give rise to students misunderstanding the states of matter by inferring that solids, liquids and gases are three different types of matter. ‘Gases’ at room temperature are in fact substances where the forces of attraction between particles are very weak and therefore these forces are overcome, even at room temperature.

Research has found that students often have a very weak understanding of what ‘a gas’ actually is. Evidence suggests that students may benefit from extrapolating the particle model to predict the arrangement and movement of particles that form a substance in the gas state. This particle model may then help students to think of ‘a gas’ as being a substance thereby improving their conceptual understanding of ‘a gas’. Linking the model to the arrangement and movement of particles forming a substance in the liquid states may also help students understand changes of state.

**Ways to use this activity**

This is a predict-explain-observe-explain (PEOE) activity, which should be carried out as a demonstration.

Prior to the demonstration, one glass syringe should be placed in an oven and warmed to 150°C.

Show students the second, cold, syringe and explain the demonstration to them. This will give students time to make and explain their predictions.

Using thermal gloves, remove the other syringe from the oven and place it on a heatproof mat. Immediately inject a small (0.05 cm3) drop of water through the rubber cap. The water will evaporate and the plunger of the gas syringe should be pushed out. This shows the difference in volume taken by a substance in the gas state compared with the liquid state. You may also wish to ask students what they think will happen as the syringe cools to room temperature.

There is a video included in the Stuff and Substance materials available from the National STEM Centre website. <https://www.stem.org.uk/rxvpc> The video is a useful guide for a teacher who has not carried out this demonstration before.

*Differentiation*

Students could be provided with a physical model (marbles in a tray) to help them to predict how the arrangement and movement of particles might change when a substance changes from the liquid to the gas state.

**Equipment**

For the demonstration:

* 2 glass gas syringes, 100 cm3, fitted with a rubber cap
* plastic syringe, 1 cm3 (or smaller), fitted with a hypodermic needle
* thermostatically controlled oven
* heatproof mat
* water in a beaker
* thermal gloves

**Technician notes**

The glass syringe will take some time to be heated to 150 °C and should be placed in the oven well ahead of the lesson. The demonstration should be practised ahead to ascertain the size of water drop needed to prevent the plunger coming right out.

**Health and safety**

The glassware will be very hot and should be handled with thermal gloves. The movement of the plunger of the syringe should not be restricted; it must be free to come out if too much gas is formed.

The hypodermic needle can penetrate the skin and should be capped when not in use.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

Students should be able to use the particle model predict that the water particles, having entered the hot syringe, are able to overcome the forces of attraction between them. This will allow them to move further apart and they will take up more space. The water will then be in the gas state.

**Acknowledgments**

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This demonstration was developed by Philip Johnson for the Science Enhancement Programme and is published in *Stuff and Substance* which can be downloaded from the STEM learning website <https://www.stem.org.uk/rxwwm>

Images: Diagram on student sheet and in presentation from page 48 *Stuff and Substance* Author Philip Johnson, ©Gatsby Science Enhancement Programme ISBN 978-1-907168-09-3

**References**

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