States of matter

Introduction

These questions are designed to help you to develop your mental models (pictures in your head) of the arrangement and movement of particles. Being able to visualise the arrangement and movement of particles in your head will help you to develop your understanding of the properties of different states of matter.

Macroscopic: what we can see. Think about the properties that we can observe, measure and record.

Sub-microscopic: smaller than we can see. Think about the particle or atomic level.

Symbolic: representations. Think about how we represent chemical ideas including symbols and diagrams.

Questions

1. Substances in the solid, liquid or gas state have different properties. The substances below are all at room temperature.

iron nail

helium filled balloon

mercury

(a) Give the state of each substance at room temperature.

- iron: _____
- helium: _____
- mercury: _____

(b) Draw one line from each state of matter to a key property.

solid state	fills shape of container
liquid state	has a fixed shape
gas state	is able to flow

(c) Draw the arrangement of particles of the following substances at room temperature.

iron	mercury	helium

(d) Describe the **movement** of particles in each substance.

i. iron

ii. mercury

iii. helium

(e) Describe how the particle model explains why

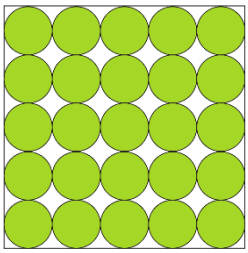
i. an iron nail has a fixed shape

ii. mercury can flow

iii. helium fills the shape of the balloon

2. The particle model can be represented in different ways.

A

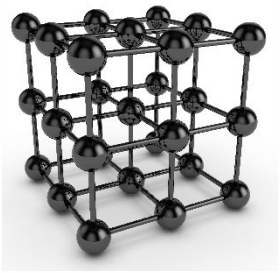


2D diagram

B

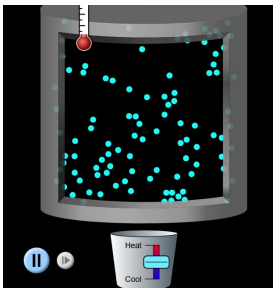
marbles in a glass

C



3D physical model

D



animation

Select the particle model representation that best helps to explain the following. Give reasons for your answer.

(a) Substances in the liquid state can flow.

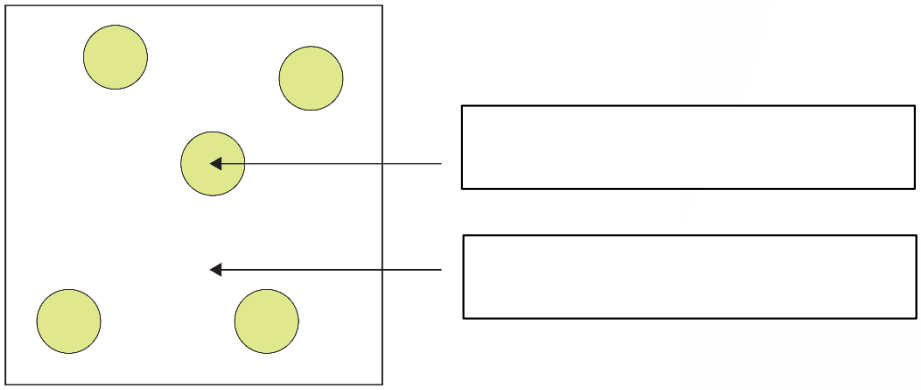
(b) Substances in the solid state have a fixed shape.

(c) Substances in the gas state fill the shape of a container.

3. Liquids cannot be compressed. Gases can be compressed.

(a) Mercury is in the liquid state at room temperature. Use the particle model to explain why substances in the liquid state cannot be compressed.

(b) Neon is in the gas state at room temperature. Add labels to the particle diagram for neon.



(c) Use your diagram to explain why neon can be compressed.

Acknowledgements

Question 2 shows a screenshot from an online animation created by PhET at the University of Colorado. You can access the States of Matter simulation online at: https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.html

Image sources

Question 1: **iron nail** © Shutterstock / Panupong786; **helium filled balloon** © Shutterstock / Soho A Studio; **mercury** © Shutterstock / MarcelClemens

Question 2: **A** © Royal Society of Chemistry; **B** © Shutterstock / RousePhotography; **C** © Shutterstock / 3d-sparrow; **D** © PhET / University of Colorado

Question 3 © Royal Society of Chemistry