2.1 Particles and their Behaviour: 30-minute Pack

Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Solids, liquids and gases have very different densities and can be compressed to very different extents. Explain, using ideas about particles, why a gas can be squashed into a much smaller volume but a solid or a liquid cannot.

(6)

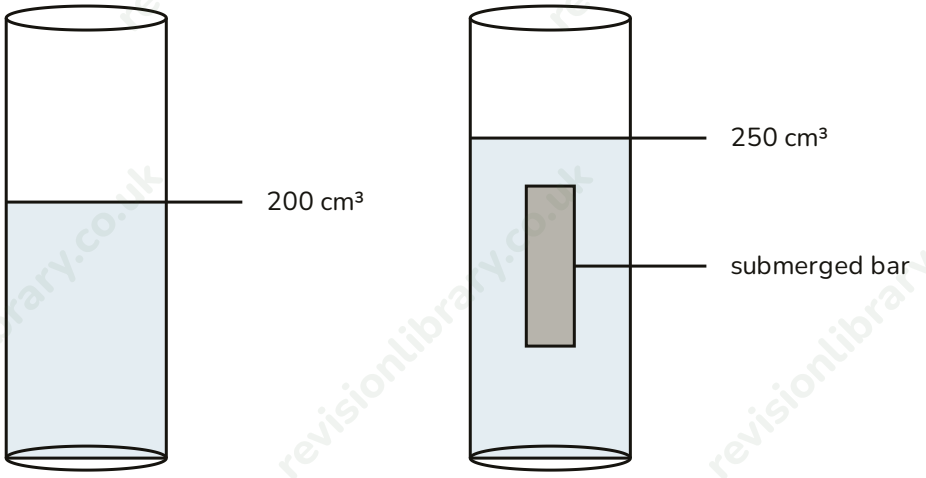
2 Freya watches a hot air balloon take off at a local fete. The balloon rises after the air inside its envelope is heated by a burner.

(a) State what happens to the air particles inside the balloon as they are heated, and what happens to the density of the air as a result. **(2)**

(b) Use this idea to explain why the hot air balloon rises into the air. **(2)**

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3 A jeweller called Priya has bought a gold-coloured bar and wants to check whether it is pure gold. The bar has a mass of 965 g. When lowered into a measuring cylinder containing 200 cm³ of water, the water level rises to 250 cm³. The density of pure gold is 19.3 g/cm^3 and the density of pure silver is 10.5 g/cm^3.



(a) Calculate the volume of the bar. **(1)**

.....

(b) Calculate the density of the bar in g/cm^3. **(2)**

.....

(c) Compare your answer to part (b) with the densities given and conclude whether the bar is likely to be pure gold, pure silver, or a mixture of the two metals. Justify your answer. **(2)**

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(d) State one reason why measuring density is a useful test for identifying whether a material is a pure substance. **(1)**

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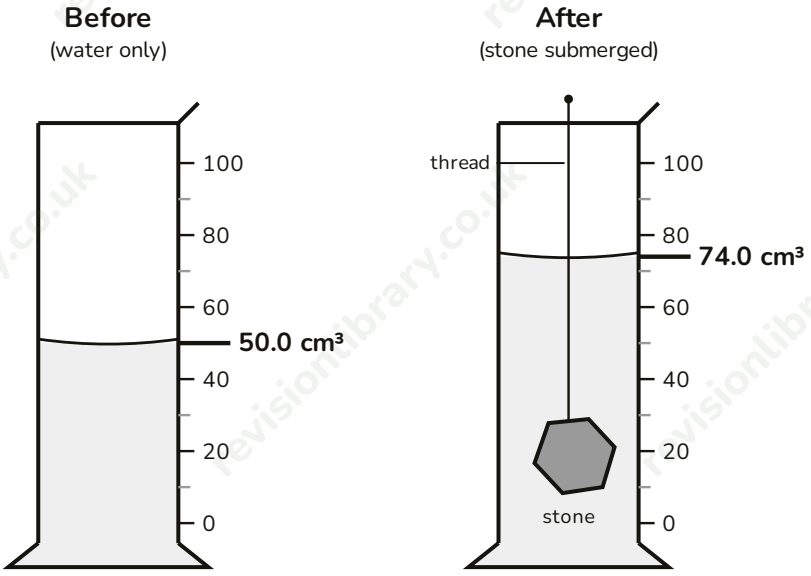
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4 Practical activity. Chidinma is finding the density of an irregularly shaped stone. She records the mass of the stone as 64 g. She then places 50.0 cm³ of water into a measuring cylinder and lowers the stone in on a thread, fully submerging it. The water level rises to 74.0 cm³.



(a) Describe how Chidinma should use the equipment to find the volume of the stone. **(2)**

(b) Calculate the volume of the stone from the readings given. **(2)**

(c) Calculate the density of the stone. Give your answer to 2 significant figures. **(2)**

(d) Suggest one source of error in this method and how it could affect the calculated density. **(1)**

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5 Which state of matter has particles that are arranged in a fixed pattern, vibrate in place and keep a definite shape?

- ☐ A) Solid
- ☐ B) Liquid
- ☐ C) Gas
- ☐ D) Plasma

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6 Explain why evaporating from the surface can occur at temperatures below a liquid's boiling point.

(a) Key idea **(1)**

(b) Consequence **(1)**

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Mark scheme · 2.1 Particles and their Behaviour: 30-minute Pack

Question 1

Level 1 Basic, isolated statements are made about the arrangement or spacing of particles in one or two states, with little or no explanation linked to compressibility. **1-2**

Level 2 A clear description is given of particle arrangement and spacing in at least two states, with some explanation linking spacing to ease (or difficulty) of compression. **3-4**

Level 3 A full, logically linked explanation of particle arrangement, spacing and energy in solids, liquids and gases is given, clearly explaining why gases compress easily (large spaces between fast-moving particles) while solids and liquids do not (particles already close together, with little space to reduce). **5-6**

Indicative content:

- In a solid, particles are arranged in a fixed, regular pattern, very close together (touching), and only vibrate about fixed positions.
- In a liquid, particles are close together (similar spacing to a solid) but arranged randomly and are free to move/slide past each other.
- In a gas, particles are far apart, with large spaces between them, and move quickly in random directions.
- Because solid and liquid particles are already touching or very close together, there is almost no space between them to remove, so they cannot be compressed by very much.
- Because gas particles have large spaces between them, pushing the particles closer together reduces the volume by a large amount, so gases can be compressed easily.
- Density depends on how much mass is packed into a given volume; because gas particles are spread far apart, gases have a much lower density than the same substance as a solid or liquid.
- A correct, explicit link is made between reduced particle spacing under pressure and reduced volume, specifically for the gas state.

Question 2

(a) the air particles gain kinetic energy and move faster/further apart, so the air expands, oe **B1**

(a) as the same mass of air now occupies a larger volume, its density decreases, oe **B1**

(a) Answer: **The heated air particles move faster and spread further apart, so the air expands; since the same mass now fills a larger volume, its density decreases.**

(b) the heated air inside the balloon is less dense than the cooler air outside the balloon, ft from (a) **M1**

(b) because the balloon (and the less dense air inside it) is less dense than the surrounding air, it experiences an upward force and rises, similar to a less dense object floating in a denser fluid, oe **A1**

(b) Answer: **The heated air inside the balloon is less dense than the cooler air outside; because it is less dense than its surroundings, the balloon experiences an upward force and rises.**

Question 3

(a) 50 (cm^3) cao **B1**

(a) Answer: **50 cm^3**

(b) density = 965 / 50, ft from (a) **M1**

(b) 19.3 (g/cm^3) cao, ft from (a) **A1**

(b) Answer: **19.3 g/cm^3**

(c) the calculated density (19.3 g/cm^3, ft from (b)) is very close to (matches) the density of pure gold (19.3 g/cm^3), and is much higher than the density of pure silver (10.5 g/cm^3) **M1**

(c) so, of the three possibilities given, the bar is very likely to be pure gold (there is no evidence it is silver or a silver mixture), oe; also allow 'consistent with pure gold, but density alone cannot prove it is pure, as another dense metal could have a similar density' **A1**

(c) Answer: **The calculated density (19.3 g/cm^3) matches the density of pure gold exactly and is far higher than silver's density, so of the three possibilities the bar is very likely to be pure gold (density alone cannot prove it is pure, because another dense metal could have a similar density).**

(d) density is a fixed/characteristic property of a pure substance, regardless of the size or shape of the sample tested, oe **B1**

(d) Answer: **Density is a fixed property of a pure substance, so the same value should be obtained no matter the size or shape of the sample tested.**

Question 4

(a) lower the stone fully into the water on a thread so that it is completely submerged, without touching the sides **B1**

(a) read the water level before and after adding the stone, at eye level from the bottom of the meniscus, and take the difference in readings as the volume, oe **B1**

(a) Answer: **Fully submerge the stone on a thread and read the water level before and after; the difference in readings is the volume of the stone.**

(b) volume = 74.0 - 50.0 **M1**

(b) 24.0 (cm^3) cao **A1**

(b) Answer: **24.0 cm^3**

(c) density = 64 / 24, ft from (b) **M1**

(c) 2.7 (g/cm^3) awrt 2 sf, ft from (b) **A1**

(c) Answer: **2.7 g/cm^3**

(d) any one of: air bubbles trapped on the stone would make the recorded volume too large, giving a density that is too low; parallax error when reading the meniscus could make the volume too big or too small; the stone touching the side of the cylinder could give an inaccurate reading, oe **B1**

(d) Answer: **Air bubbles trapped on the stone's surface would make the recorded volume too big, giving a calculated density that is too low.**

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Question 5

A cao **B1**

Answer: **A) Solid**

Question 6

(a) some surface particles have enough energy to escape into gas **B1**

(a) Answer: **Some surface particles have enough energy to escape into the gas**

(b) so evaporation can occur at lower temperatures because only some particles need sufficient energy **B1**

(b) Answer: **Therefore evaporation can occur below the boiling point because only a fraction of particles need enough energy**

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