2.1 Particles and their Behaviour: Test Pack

Calculator allowed · about 50 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

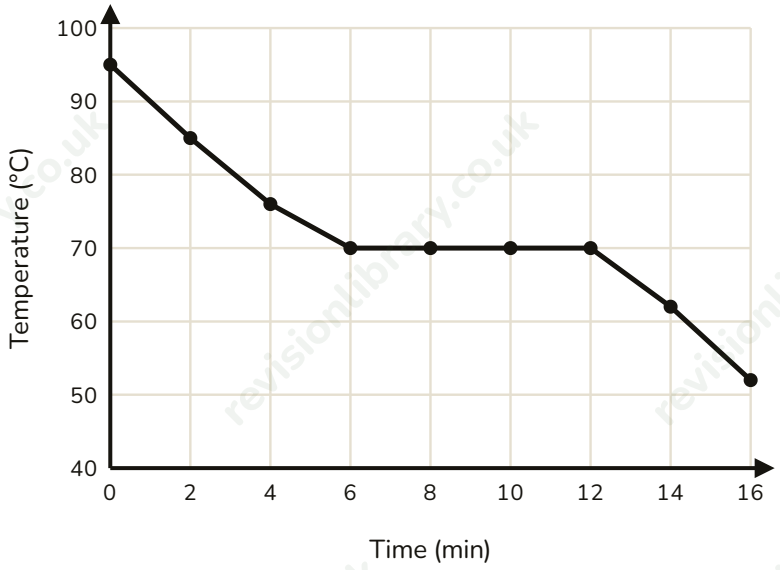
1 Which state of matter has particles that are far apart and move quickly in random directions, filling any container they are put into?

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

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2 Practical activity. Kwame investigates the cooling curve of stearic acid. He records its temperature every 2 minutes as it cools.

Time (min)	**0**	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**
Temperature (°C)	95	85	76	70	70	70	70	62	52



(a) Identify the melting point of stearic acid shown by this data. **(1)**

(b) Explain, in terms of particles, why the temperature stays constant between 6 and 12 minutes even though the substance is still cooling. **(3)**

(c) Describe the overall shape of a graph of temperature against time for this cooling curve, from 0 to 16 minutes, referring to the steepness of the graph in each section. **(2)**

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3 Aluminium has a density of 2.7 g/cm^3. Calculate the mass of an aluminium block with a volume of 50 cm³.

(3)

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4 A rectangular metal block has a mass of 180 g and a volume of 24 cm³.

(a) State the equation linking density, mass and volume. **(1)**

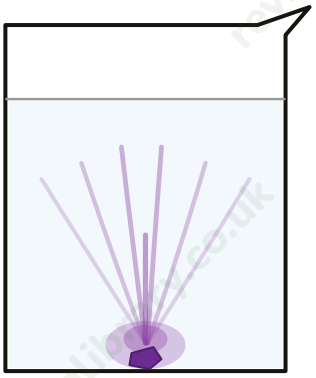
(b) Calculate the density of the metal block. **(2)**

.....

(c) State the correct unit for your answer to part (b) if mass had instead been measured in kg and volume in m^3. **(1)**

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5 Practical activity. Meera drops a single crystal of potassium permanganate into a beaker of cold water and does not stir it. She watches the beaker for 30 minutes.



(a) Describe what Meera would observe over the 30 minutes. **(2)**

(b) Explain this observation in terms of particle theory. **(3)**

(c) Predict and explain the effect on the rate of diffusion of repeating the experiment with warm water instead of cold water. **(2)**

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6 A cube of metal has volume 27 cm^3 and mass 216 g. Calculate its density in g/cm^3 and state which state of matter this shows the sample is.

(a) Calculate density using density = mass / volume. **(2)**

(b) State the state of matter. **(1)**

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7 State one piece of apparatus you would use to measure 50 cm^3 of water for an experiment about dissolving, and explain why it is suitable.

(a) Name apparatus **(1)**

(b) Explain suitability **(1)**

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8 A sample of gas is cooled so that its temperature drops from 100°C to 0°C at constant pressure. Describe, in particle terms, what happens to the particles and how this affects the volume.

(a) Particle motion change **(2)**

(b) Effect on volume at constant pressure **(2)**

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9 A sealed syringe contains gas. A student pushes the plunger so the volume halves. Explain, in particle terms, what happens to the gas pressure inside the syringe.

(a) First point **(1)**

(b) Second point **(2)**

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10 A student is asked to design a fair test to investigate how the size of salt crystals affects the time to dissolve in 100 cm^3 of water at 25°C. List three variables that must be kept the same and explain why for each.

(a) Variable 1 and explanation **(1)**

(b) Variable 2 and explanation **(1)**

(c) Variable 3 and explanation **(2)**

11 Solid carbon dioxide (dry ice) sublimes directly into carbon dioxide gas at normal atmospheric pressure and room temperature, rather than first melting into a liquid.

(a) Suggest what this tells you about the strength of the forces of attraction between carbon dioxide particles, compared with a typical solid like ice. **(2)**

(b) State one advantage of using solid carbon dioxide, rather than ice, to keep food cold during transport. **(2)**

12 Complete each sentence about the particle model by writing the correct word(s) in each gap.

(a) In a solid, particles are packed _____ together in a _____ pattern. **(1)**

(b) In a liquid, particles are close together but can _____ past each other. **(1)**

(c) In a gas, particles are _____ apart and move _____ in random directions. **(1)**

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Mark scheme · 2.1 Particles and their Behaviour: Test Pack

Question 1

C cao **B1**

Answer: **C) Gas**

Question 2

(a) 70 (°C) cao **B1**

(a) Answer: **70°C**

(b) during this time the substance is changing state from liquid to solid (freezing), oe **M1**

(b) energy is still being transferred away from the substance, but this energy is lost as the particles move closer together and form a regular arrangement, rather than from a decrease in their kinetic energy **M1**

(b) so the average kinetic energy of the particles (and therefore the temperature) does not fall until freezing is complete, oe **A1**

(b) Answer: **The substance is freezing during this time. Energy is still being removed, but it comes from the particles forming a more ordered, closer arrangement rather than from a fall in their kinetic energy, so the temperature stays constant until freezing is complete.**

(c) the temperature falls steadily (a sloped line) from 95°C to 70°C between 0 and 6 minutes, as the liquid cools **M1**

(c) the line is then flat (horizontal) from 6 to 12 minutes as the substance freezes, before falling steadily again (a sloped line) from 70°C to 52°C between 12 and 16 minutes, as the solid cools, oe **A1**

(c) Answer: **The curve falls steadily as the liquid cools (0 to 6 minutes), becomes flat at 70°C while it freezes (6 to 12 minutes), then falls steadily again as the solid cools (12 to 16 minutes).**

Question 3

rearrange to mass = density x volume **M1**

mass = 2.7 x 50 **M1**

135 (g) cao **A1**

Answer: **135 g**

Question 4

(a) density = mass / volume, oe (allow rearranged forms) **B1**

(a) Answer: **density = mass / volume**

(b) density = 180 / 24 **M1**

(b) 7.5 (g/cm^3) cao **A1**

(b) Answer: **7.5 g/cm^3**

(c) kg/m^3 cao **B1**

(c) Answer: **kg/m^3**

Question 5

(a) purple colour spreads out from the crystal through the water **B1**

(a) the coloured region keeps growing and the colour becomes more evenly spread (paler further from the crystal) without any stirring; allow 'it would eventually be evenly coloured purple throughout if left long enough', oe **B1**

(a) Answer: **The purple colour gradually spreads out from the crystal through the water without any stirring, getting paler further from the crystal; if left for long enough the whole beaker would become evenly coloured purple.**

(b) water particles and potassium permanganate particles are in constant, random motion **M1**

(b) particles collide and move into the spaces between other particles, moving from a region of higher concentration to a region of lower concentration **M1**

(b) this is called diffusion, and it continues until the particles are evenly spread throughout the water, oe **A1**

(b) Answer: **The constantly moving particles of potassium permanganate spread out (diffuse) from an area of high concentration to low concentration through the randomly moving water particles, until they are evenly spread throughout the beaker.**

(c) diffusion would be faster in warm water **B1**

(c) because the water particles have more kinetic energy and move faster, so they collide with and spread the potassium permanganate particles more quickly, oe **B1**

(c) Answer: **Diffusion would be faster in warm water because the particles have more kinetic energy and move faster, spreading the colour through the beaker more quickly.**

Question 6

(a) substitute 216 / 27 **M1**

(a) 8.0 g/cm^3 cao **A1**

(a) Answer: **8.0 g/cm^3**

(b) solid cao **B1**

(b) Answer: **Solid**

Question 7

(a) measuring cylinder or pipette or burette **B1**

(a) Answer: **Measuring cylinder**

(b) it measures volume accurately enough and is easy to read **B1**

(b) Answer: **It measures volume accurately with scale markings so you can pour exactly 50 cm^3**

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Question 8

(a) particles lose energy and slow down when cooled **M1**

(a) so their average speed decreases cao **A1**

(a) Answer: **Particles lose energy and slow down so their average speed decreases**

(b) slower particles hit walls less often so to keep pressure constant the volume decreases **M1**

(b) so gas contracts and volume falls (Charles law idea) cao **A1**

(b) Answer: **Slower particles hit the walls less often, so to keep pressure constant the volume decreases and the gas contracts**

Question 9

(a) pressure is due to particles colliding with the walls **B1**

(a) Answer: **Pressure comes from particles colliding with the syringe walls**

(b) halving volume doubles collision frequency with walls **M1**

(b) so pressure increases (about doubles) cao **A1**

(b) Answer: **Halving the volume doubles how often particles hit the walls, so the pressure increases (about doubles)**

Question 10

(a) temperature must be kept the same to ensure particle energy is constant (accept any valid control variable, e.g. mass of salt, with a matching reason) **B1**

(a) Answer: **Temperature: keep at 25°C so particle energy and collision rate are constant**

(b) volume of water must be constant so number of solvent particles is same (accept any other valid control variable with a matching reason) **B1**

(b) Answer: **Volume of water: keep at 100 cm^3 so amount of solvent is the same for each test**

(c) method of stirring or agitation must be the same (accept any other valid control variable, e.g. mass of salt) **M1**

(c) different stirring changes how fast particles meet the salt so must be controlled (or a matching reason for the variable given) **A1**

(c) Answer: **Stirring method: use same stirring speed and timing because agitation changes collision frequency and rate of dissolving**

Question 11

(a) the observation alone does not establish whether the attractions between carbon dioxide particles are weaker or stronger than those in ice, oe **M1**

(a) sublimation describes a direct change from solid to gas at the stated pressure and temperature; the absence of a liquid stage does not by itself measure or compare the strengths of the attractions, oe **A1**

(a) Answer: **This observation alone does not tell us whether the attractions between carbon dioxide particles are weaker or stronger than those in ice. Sublimation is a direct change from solid to gas at the stated pressure and temperature; missing out the liquid stage does not by itself establish the strength of the attractions.**

(b) states a valid advantage of solid carbon dioxide over ice, e.g. it is much colder (about -78 C, compared with 0 C for ice), or it sublimes straight to a gas and leaves no liquid behind **M1**

(b) gives the matching consequence, e.g. so it keeps food colder or frozen for longer, or so the food does not get wet, oe **A1**

(b) Answer: **Either: it is much colder than ice (about -78 C), so it keeps food cold or frozen for longer; or it sublimes straight to a gas, leaving no liquid behind, so the food stays dry.**

Question 12

(a) closely (tightly) and regular (fixed), both needed, oe **B1**

(a) Answer: **closely; regular**

(b) move (slide), oe **B1**

(b) Answer: **move (slide)**

(c) far and quickly (fast), both needed, oe **B1**

(c) Answer: **far; quickly**

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