K6D Particles and their Behaviour: Exam Drill

AQA AQA KS3 Chemistry · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 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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2 Complete the sentence. In the particle model, when a substance is heated its particles gain _____ and tend to move _____.

(a) First blank **(2)**

(b) Second blank **(1)**

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3 Give the name of the change of state when a gas becomes a liquid, and give one real-life example of this change.

(a) Name the change of state. **(1)**

(b) Give one real-life example. **(3)**

4 A sample of ice has a mass of 250 g. It melts and the resulting water still has mass 250 g. State why the mass is unchanged, using particle ideas.

(a) First point **(2)**

(b) Second point linking to particle motion **(2)**

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5 A student measures the time for sugar to dissolve in 200 cm^3 of water at three temperatures. Results: 15 degrees C -> 180 s, 30 degrees C -> 90 s, 60 degrees C -> 30 s. Explain these results using particle ideas.

(a) State what happens to particle motion as temperature increases. **(1)**

(b) Explain why dissolution time decreases at higher temperatures. **(3)**

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6 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)**

7 State whether each of the following is a physical change or a chemical change: a) Melted chocolate, b) Burning paper, c) Boiling water, d) Rusting iron.

(a) Melted chocolate **(1)**

(b) Burning paper **(1)**

(c) Boiling water **(1)**

(d) Rusting iron (not painted) **(1)**

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8 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 degrees 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)**

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9 A thermometer measured the temperature of a sealed container of gas at two times: 20 degrees C and 80 degrees C. The pressure rose from 100 kPa to 200 kPa. Suggest why this supports the particle model and explain any assumptions made.

(a) Why does pressure increase when temperature rises? **(2)**

(b) State an assumption made when comparing the two measurements. **(1)**

10 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)**

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

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11 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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12 The graph shows a heating curve for a pure substance. Temperature (degrees C) against time (minutes): from 0 to 4 min temperature rises from 20 to 60, from 4 to 8 min temperature stays at 60, from 8 to 12 min rises from 60 to 100. Explain what is happening between 4 and 8 minutes and why the temperature is constant.

(a) Identify the process between 4 and 8 minutes. **(1)**

(b) Why is temperature constant during this time? **(2)**

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13 A sealed container holds 0.50 kg of a substance whose density is 1000 kg/m^3. Calculate the volume of the substance in litres. (1 m^3 = 1000 litres).

(a) Calculate the volume in m^3 and convert to litres. **(2)**

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14 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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15 A beaker contains 150 cm^3 of a mixture of oil and water. The oil floats on top. Explain, using particle ideas, why oil floats on water.

(a) First point about density **(2)**

(b) Second point about immiscibility **(2)**

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16 Extended response: A student investigates how long it takes for different solids to dissolve in 100 cm^3 of water. She tests sugar, salt and sand at 25 degrees C with the same stirring and particle size. Her times are: sugar 30 s, salt 150 s, sand does not dissolve. Evaluate what these results show about the particle model, discuss any limitations of the experiment and suggest two improvements. Use particle ideas and working scientifically points in your answer.

(6)

17 A sample of gas is cooled so that its temperature drops from 100 degrees C to 0 degrees 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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18 Data handling: An experiment measures time taken for 1 g of a powdered solid to dissolve in 100 cm^3 water with stirring. Five repeats gave times (s): 28, 31, 29, 32, 30. Calculate the mean time and identify any reading you might consider an anomaly, giving a reason.

(a) Calculate the mean time. **(3)**

(b) Identify any anomaly and explain why. **(2)**

Mark scheme · K6D Particles and their Behaviour: Exam Drill

Question 1

- **B1** A cao
- Answer: **A) Solid**

Question 2

- (a) **M1** gain energy or gain kinetic energy
- (a) **A1** energy (or kinetic energy) cao
- (a) Answer: **energy**
- (b) **B1** faster or more quickly
- (b) Answer: **faster**

Question 3

- (a) **B1** condensing or condensation cao
- (a) Answer: **Condensing**
- (b) **M1** clear correct example given
- (b) **A1** example shows gas to liquid process (eg: water vapour on a cold window, steam forming droplets on a cold surface, dew forming on grass) cao
- (b) **B1** reason or short explanation linking example to cooling of gas to form liquid
- (b) Answer: **Water vapour on a cold window forming droplets**

Question 4

- (a) **M1** mass measures amount of matter so particles are the same in number
- (a) **A1** particles remain the same number so mass stays the same cao
- (a) Answer: **The amount of matter (the number of particles) stays the same when ice melts**
- (b) **M1** describe particles gaining energy and moving more but not leaving the sample
- (b) **A1** so mass is unchanged because particles are still present in the melted water
- (b) Answer: **When ice melts particles gain energy and move apart into a liquid but they remain in the sample so mass is unchanged**

Question 5

- (a) **B1** particles move faster as temperature increases
- (a) Answer: **Particles move faster at higher temperatures**
- (b) **M1** faster water particles collide more often with sugar, breaking it apart
- (b) **A1** this increases rate of dissolving so time is shorter (eg: 180 to 90 to 30 s) cao
- (b) **B1** explicit link to given data showing shorter times at higher temperatures
- (b) Answer: **Faster-moving water particles collide more and break sugar apart quicker, so dissolving time falls from 180 s to 90 s to 30 s as temperature rises**

Question 6

- (a) **B1** pressure is due to particles colliding with the walls
- (a) Answer: **Pressure comes from particles colliding with the syringe walls**
- (b) **M1** halving volume doubles collision frequency with walls
- (b) **A1** so pressure increases (about doubles) cao
- (b) Answer: **Halving the volume doubles how often particles hit the walls, so the pressure increases (about doubles)**

Question 7

- (a) **B1** physical change
- (a) Answer: **Physical change**
- (b) **B1** chemical change
- (b) Answer: **Chemical change**
- (c) **B1** physical change
- (c) Answer: **Physical change**
- (d) **B1** chemical change
- (d) Answer: **Chemical change**

Question 8

- (a) **B1** temperature must be kept the same to ensure particle energy is constant
- (a) Answer: **Temperature: keep at 25 degrees C so particle energy and collision rate are constant**
- (b) **B1** volume of water must be constant so number of solvent particles is same
- (b) Answer: **Volume of water: keep at 100 cm^3 so amount of solvent is the same for each test**
- (c) **M1** method of stirring or agitation must be the same
- (c) **A1** different stirring changes how fast particles meet the salt so must be controlled
- (c) Answer: **Stirring method: use same stirring speed and timing because agitation changes collision frequency and rate of dissolving**

Question 9

- (a) **M1** particles gain energy and move faster when heated
- (a) **A1** faster motion gives more frequent and harder collisions so pressure increases approximately from 100 to 200 kPa
- (a) Answer: **Particles gain energy and move faster, causing more frequent and stronger collisions with the container walls so pressure rises from 100 kPa to 200 kPa**
- (b) **B1** assume volume of container is constant and amount of gas is unchanged
- (b) Answer: **Assume the container volume and amount of gas stayed the same**

Question 10

- (a) **M1** substitute 216 / 27
- (a) **A1** 8.0 g/cm^3 cao
- (a) Answer: **8.0 g/cm^3**
- (b) **B1** solid cao
- (b) Answer: **Solid**

Question 11

- (a) **B1** some surface particles have enough energy to escape into gas
- (a) Answer: **Some surface particles have enough energy to escape into the gas**
- (b) **B1** so evaporation can occur at lower temperatures because only some particles need sufficient energy
- (b) Answer: **Therefore evaporation can occur below the boiling point because only a fraction of particles need enough energy**

Question 12

- (a) **B1** the substance is changing state (melting or boiling) depending on context
- (a) Answer: **The substance is changing state (a phase change) between 4 and 8 minutes**
- (b) **M1** energy is used to break bonds/overcome forces between particles rather than raise temperature
- (b) **A1** so temperature stays constant until the change of state is complete
- (b) Answer: **Energy input is used to overcome forces between particles during the change of state rather than increase particle energy, so temperature remains constant**

Question 13

- (a) **M1** use volume = mass / density = 0.50 / 1000 = 0.0005 m^3
- (a) **A1** 0.5 litres cao
- (a) Answer: **0.5 litres**

Question 14

- (a) **B1** measuring cylinder or pipette or burette
- (a) Answer: **Measuring cylinder**
- (b) **B1** it measures volume accurately enough and is easy to read
- (b) Answer: **It measures volume accurately with scale markings so you can pour exactly 50 cm^3**

Question 15

- (a) **M1** state oil is less dense than water or oil particles are less closely packed
- (a) **A1** so oil floats on water because less dense materials sit above denser materials cao
- (a) Answer: **Oil is less dense because its particles are less closely packed, so it floats on denser water**
- (b) **M1** oil and water do not mix because their particles do not form strong attractions with each other
- (b) **A1** so oil stays as a separate layer on top rather than dispersing into the water
- (b) Answer: **Oil and water do not mix because their particles do not attract strongly to each other, so oil stays as a separate top layer**

Question 16

- **Level 3** (5-6): Detailed evaluation: clear use of particle model to explain why sugar dissolves fastest, salt slower and sand does not dissolve; identifies at least two limitations and gives two practical, relevant improvements; logical structure and links to data; scientific vocabulary used accurately.
- **Level 2** (3-4): Some explanation using particle ideas linking results to collision frequency and solubility; at least one limitation and one improvement suggested; answer is generally clear.
- **Level 1** (1-2): Simple statements, for example that sugar dissolves and sand does not, with little or no explanation and no realistic improvements.
- **Indicative content:**
  - Explain that dissolving requires solvent particles to pull solute particles apart and carry them away; sugar dissolves quickly because it forms bonds with water and its particles disperse; salt dissolves more slowly because ionic bonds require more disruption; sand is insoluble because its particles do not interact with water and remain solid.
  - Use data: sugar 30 s, salt 150 s, sand does not dissolve to support explanations about relative solubility and rate.
  - Limitations: only one particle size tested, only one temperature, human timing error, possible contamination or different crystal densities, stirring not precisely controlled.
  - Improvements: repeat trials and calculate mean; test different temperatures to see effect on rate; use controlled mechanical stirring at fixed rpm; measure mass dissolved rather than visual end point.
  - Working scientifically points: consider anomalous results, control variables, record uncertainties, explain assumptions (equal particle size), and link conclusions clearly to data.

Question 17

- (a) **M1** particles lose energy and slow down when cooled
- (a) **A1** so their average speed decreases cao
- (a) Answer: **Particles lose energy and slow down so their average speed decreases**
- (b) **M1** slower particles hit walls less often so to keep pressure constant the volume decreases
- (b) **A1** so gas contracts and volume falls (Charles law idea) cao
- (b) Answer: **Slower particles hit the walls less often, so to keep pressure constant the volume decreases and the gas contracts**

Question 18

- (a) **M1** add times: 28+31+29+32+30 = 150
- (a) **M1** divide by 5 to find mean
- (a) **A1** 30 s cao
- (a) Answer: **30 s**
- (b) **M1** identify a value that differs from the rest (eg: 32 or 28)
- (b) **A1** give reason such as it is more than 1 or 2 s away from the mean or others cluster near 29-31 indicating possible timing error
- (b) Answer: **32 s could be considered an anomaly because most values are 28-31 s and 32 is furthest from the mean**