P3F Particle Model of Matter: Foundation Tier Practice

AQA 8463 · Calculator allowed · about 90 minutes

Total Marks

Name: ______________________________ Date: ____ / ____ / ______

Answer ALL questions. Show all your working.

1 The particle model describes solids, liquids and gases in terms of how their particles are arranged and how they move.

(a) Describe the arrangement of particles in a solid. **(1)**

(b) Describe the movement of particles in a liquid. **(1)**

(c) Describe the arrangement and movement of particles in a gas. **(2)**

(Total for Question 1 is 4 marks)

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2 Density is a property of a material that links its mass to the volume it takes up.

(a) State what is meant by the density of a material. **(1)**

(b) Write down the equation that links density, mass and volume. **(1)**

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(c) State the standard SI unit used for density. **(1)**

(Total for Question 2 is 3 marks)

3 A metal block is a cuboid. It has a mass of 316 g. Its dimensions are: length 4.0 cm, width 2.0 cm, height 10.0 cm.

(a) Calculate the volume of the block. **(2)**

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(b) Calculate the density of the block. Use your answer to part (a). **(2)**

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(Total for Question 3 is 4 marks)

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4 A student wants to measure the density of a small irregularly shaped stone, using the equipment: a balance, a measuring cylinder, water and a piece of string.

(a) Describe how the student could measure the volume of the stone. **(3)**

(b) The initial volume of water was 40 cm^3. After the stone was added, the volume reading was 58 cm^3. The mass of the stone was 45 g. Calculate the density of the stone. **(3)**

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(Total for Question 4 is 6 marks)

5 Substances change state when they are heated or cooled. Give the correct name for each change of state described below.

(a) A solid changing into a liquid. **(1)**

(b) A liquid changing into a gas throughout the liquid, at its boiling point. **(1)**

(c) A gas changing directly into a liquid. **(1)**

(d) A solid changing directly into a gas, without becoming a liquid. **(1)**

(Total for Question 5 is 4 marks)

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6 A 50 g ice cube is left in a sealed, airtight container until it has completely melted into water.

(a) State the mass of the water in the container once the ice has completely melted. **(1)**

(b) Explain why the mass does not change when the ice melts. **(2)**

(c) State whether melting is a physical change or a chemical change. **(1)**

(Total for Question 6 is 4 marks)

7 Internal energy is the energy stored inside a system by the particles that make it up.

(a) State what internal energy is the sum of. **(1)**

(b) A beaker of water is heated but does not change state. Explain what happens to the internal energy of the water, and why its temperature rises. **(2)**

(Total for Question 7 is 3 marks)

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8 A pure solid is heated at a constant rate from room temperature until it has completely melted and the resulting liquid is warming up. A graph of its temperature against time shows the temperature rising steadily, then staying constant for a period of time, then rising steadily again.

(a) State what is happening to the substance during the part of the graph where the temperature stays constant. **(1)**

(b) Explain why the temperature does not rise during this part of the graph, even though the substance is still being heated. **(2)**

(Total for Question 8 is 3 marks)

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9 Specific latent heat is the energy needed to change the state of 1 kg of a substance, without changing its temperature. Use the equation: energy for a change of state = mass x specific latent heat (E = m x L).

(a) State the two types of specific latent heat, and the change of state that each one applies to. **(2)**

(b) The specific latent heat of fusion of ice is 334000 J/kg. Calculate the energy needed to completely melt 0.20 kg of ice at 0 degrees C. **(2)**

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(Total for Question 9 is 4 marks)

10 A gas is trapped inside a sealed, rigid container.

(a) Explain, in terms of particles, why the gas exerts a pressure on the walls of the container. **(2)**

(b) The container is heated, so the temperature of the gas increases, while its volume stays the same. Explain, in terms of particles, why the pressure of the gas increases. **(2)**

(Total for Question 10 is 4 marks)

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11 An aerosol can carries a warning label that says: 'Do not puncture or place near a heat source, even after use.'

(a) Use ideas about the particle model to suggest why heating a sealed aerosol can could be dangerous. **(2)**

(Total for Question 11 is 2 marks)

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12 The table shows the density of four materials. Water has a density of 1.0 g/cm^3.

Material -- Density (g/cm^3)
Cork -- 0.24
Ice -- 0.92
Glass -- 2.5
Oak wood -- 0.75

(a) List the four materials in order of density, starting with the least dense. **(1)**

(b) State which of the four materials would float when placed in water, and give a reason for your answer. **(2)**

(Total for Question 12 is 3 marks)

13 A fixed mass of ice, starting at a temperature of -10 degrees C, is heated steadily until it has become steam at a temperature of 110 degrees C. Using the particle model, explain what happens to the ice/water as it is heated through this whole range of temperatures, including what happens to its temperature and its internal energy at each stage.

(Total for Question 13 is 6 marks)

Mark scheme · P3F Particle Model of Matter: Foundation Tier Practice

Question 1

- (a) **B1** particles are held in fixed positions, close together, in a regular arrangement, oe
- **(a) Answer: The particles are held in fixed positions, close together, in a regular arrangement.**
- (b) **B1** particles are close together but can move around/slide past each other, oe
- **(b) Answer: The particles are close together but can move around and slide past each other.**
- (c) **B1** particles are far apart (spread out), oe
- (c) **B1** particles move quickly, in random directions, oe
- **(c) Answer: The particles are far apart (spread out) and move quickly in random directions.**

Question 2

- (a) **B1** the mass per unit volume of a material, oe
- **(a) Answer: Density is the mass per unit volume of a material.**
- (b) **B1** density = mass / volume, oe
- **(b) Answer: density = mass / volume**
- (c) **B1** kg/m^3 (accept g/cm^3)
- **(c) Answer: kg/m^3 (or g/cm^3).**

Question 3

- (a) **M1** 4.0 x 2.0 x 10.0
- (a) **A1** 80 cm^3 cao
- **(a) Answer: 80 cm^3**
- (b) **M1** 316 / 80, ft from (a)
- (b) **A1** 3.95 g/cm^3 cao
- **(b) Answer: 3.95 g/cm^3**

Question 4

- (a) **B1** partly fill the measuring cylinder with water and record the volume, oe
- (a) **B1** lower the stone into the water (using the string) so it is fully submerged, and record the new volume, oe
- (a) **B1** calculate the volume of the stone as the difference between the two readings, oe
- **(a) Answer: Partly fill the measuring cylinder with water and record the volume. Lower the stone fully into the water using the string and record the new volume. The volume of the stone is the difference between the two readings.**
- (b) **M1** volume of stone = 58 - 40 = 18 cm^3
- (b) **M1** 45 / 18
- (b) **A1** 2.5 g/cm^3 cao
- **(b) Answer: 2.5 g/cm^3**

Question 5

- (a) **B1** melting
- **(a) Answer: Melting.**
- (b) **B1** boiling
- **(b) Answer: Boiling.**
- (c) **B1** condensing (condensation)
- **(c) Answer: Condensing.**
- (d) **B1** sublimation
- **(d) Answer: Sublimation.**

Question 6

- (a) **B1** 50 g cao
- **(a) Answer: 50 g.**
- (b) **B1** no particles enter or leave the sealed container, oe
- (b) **B1** melting only changes the arrangement and movement of the particles, it does not change the number or type of particles present (no new substance is made), oe
- **(b) Answer: No particles enter or leave the sealed container, and melting only changes how the particles are arranged and how they move; it does not change the number or type of particles present.**
- (c) **B1** physical change
- **(c) Answer: A physical change.**

Question 7

- (a) **B1** the kinetic energy and the potential energy of the particles in the system, oe
- **(a) Answer: The kinetic energy and the potential energy of all the particles in the system.**
- (b) **B1** the internal energy of the water increases, oe
- (b) **B1** the kinetic energy of the particles increases, so they move faster, which is what causes the temperature to rise, oe
- **(b) Answer: The internal energy of the water increases, because the kinetic energy of its particles increases and they move faster; this increase in particle kinetic energy is what causes the temperature to rise.**

Question 8

- (a) **B1** the substance is melting (changing from a solid to a liquid), oe
- **(a) Answer: The substance is melting, changing from a solid into a liquid.**
- (b) **B1** the energy supplied is being used to break the bonds/forces holding the particles in fixed positions (to overcome the forces between particles), oe
- (b) **B1** instead of increasing the kinetic energy of the particles, so the temperature does not rise while the state is changing, oe
- **(b) Answer: The energy supplied is being used to break the bonds holding the particles in fixed positions (to overcome the forces between particles), rather than to increase their kinetic energy, so the temperature does not rise while the substance is changing state.**

Question 9

- (a) **B1** specific latent heat of fusion, for melting/freezing, oe
- (a) **B1** specific latent heat of vaporisation, for boiling/condensing, oe
- **(a) Answer: Specific latent heat of fusion applies to melting (or freezing); specific latent heat of vaporisation applies to boiling (or condensing).**
- (b) **M1** quotes E = m x L and substitutes: E = 0.20 x 334000
- (b) **A1** 66800 J cao
- **(b) Answer: 66800 J**

Question 10

- (a) **B1** the particles of the gas are moving quickly, in random directions, oe
- (a) **B1** the particles collide with the walls of the container, and these collisions exert a force on the walls, which causes pressure, oe
- **(a) Answer: The gas particles are moving quickly in random directions, and they collide with the walls of the container. These collisions exert a force on the walls, which is what causes the gas pressure.**
- (b) **B1** the particles have more kinetic energy and move faster, oe
- (b) **B1** this causes more frequent and more forceful collisions with the walls of the container, increasing the pressure, oe
- **(b) Answer: The particles have more kinetic energy and move faster, so they collide with the walls of the container more frequently and more forcefully, which increases the pressure.**

Question 11

- (a) **B1** heating the gas inside increases the pressure of the gas (as particles move faster and collide with the walls more often/forcefully), oe
- (a) **B1** if the pressure becomes too high, the can could burst/explode, oe
- **(a) Answer: Heating the sealed can increases the pressure of the gas inside, because the particles move faster and collide with the walls of the can more often and more forcefully. If the pressure becomes too high, the can could burst or explode.**

Question 12

- (a) **B1** cork, oak wood, ice, glass cao
- **(a) Answer: Cork, oak wood, ice, glass.**
- (b) **B1** cork, ice and oak wood would float
- (b) **B1** because they are all less dense than water (their density is less than 1.0 g/cm^3), oe
- **(b) Answer: Cork, ice and oak wood would all float, because their density is less than the density of water (1.0 g/cm^3).**

Question 13

- **Level 3** (5-6): A clear, detailed and correctly ordered explanation covering all stages: heating the ice, melting at a constant temperature, heating the water, boiling at a constant temperature, and heating the steam, with correct reference to particle kinetic energy and to the breaking of bonds/forces between particles during the two changes of state.
- **Level 2** (3-4): A mostly correct explanation covering several of the stages, with some reference to particle kinetic energy and/or breaking of bonds, but one stage may be missing, muddled or only partly explained.
- **Level 1** (1-2): A simple, partial description of what happens, for example naming melting and/or boiling, with little or no reference to particle kinetic energy or internal energy.
- **Indicative content:**
  - As the solid ice is heated from -10 degrees C, its temperature rises steadily, because the particles gain kinetic energy and vibrate/move faster about their fixed positions.
  - At 0 degrees C, the ice melts: the temperature stays constant while all the energy supplied is used to break the bonds/forces holding the particles in their fixed positions, increasing the particles' potential energy (and the internal energy of the substance) without increasing their kinetic energy.
  - Once melting is complete, the liquid water heats up and its temperature rises steadily again, because the particles' kinetic energy increases further.
  - At 100 degrees C, the water boils: the temperature stays constant again while the energy supplied is used to overcome the forces of attraction between the particles completely, so they can separate and move freely as a gas (increasing potential energy/internal energy, not kinetic energy).
  - Once boiling is complete, the steam continues to heat up from 100 degrees C to 110 degrees C, and its temperature rises again as the particles' kinetic energy increases.
  - Throughout the whole process the internal energy of the substance keeps increasing, both during the temperature rises (kinetic energy increasing) and during the two constant-temperature plateaus (potential energy increasing as bonds break).