HIGHER

3.3 Particle Model of Matter: 1-hour Pack

AQA 8463 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A pure solid substance is heated at a constant rate, from below its melting point until it becomes a gas well above its boiling point. A graph of temperature against time for this process shows two flat (horizontal) sections.

(a) State what each of the two flat sections of the graph represents. **(2)**

(b) The substance has a greater specific latent heat of vaporisation than specific latent heat of fusion. State which of the two flat sections would last for the greater length of time, assuming the heater transfers energy at a constant rate throughout. **(1)**

(c) Explain, in terms of energy, why this flat section lasts for longer than the other. **(2)**

(Total for Question 1 is 5 marks)

2 The density of mercury is 13.6 g/cm^3.

(a) Show that this is equal to 13600 kg/m^3. **(2)**

(b) A steel ship has an overall (average) density less than that of water (1000 kg/m^3), even though steel itself has a density of 7850 kg/m^3, which is much greater than water. Suggest how the ship is able to float. **(2)**

(Total for Question 2 is 4 marks)

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3 A sealed, rigid container holds a fixed mass of gas at a constant volume.

(a) Explain, in terms of the particle model, what happens to the pressure of the gas as its temperature increases. **(4)**

(b) State what is meant by absolute zero. **(1)**

(Total for Question 3 is 5 marks)

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4 A 0.20 kg block of ice at -10°C is heated until it becomes steam at 100°C. Specific heat capacity of ice = 2100 J/(kg °C). Specific latent heat of fusion of ice = 334000 J/kg. Specific heat capacity of water = 4200 J/(kg °C). Use: change in thermal energy = mass x specific heat capacity x change in temperature, and thermal energy for a change of state = mass x specific latent heat

(a) Calculate the energy needed to raise the temperature of the ice from -10°C to 0°C. **(2)**

.....

(b) Calculate the energy needed to melt the ice completely at 0°C. **(2)**

.....

(c) Calculate the energy needed to raise the temperature of the water (from the melted ice) from 0°C to 100°C. **(2)**

.....

(d) Using your answers to parts (a) to (c), calculate the total energy required to change the ice at -10°C into water at 100°C (just before it starts to boil). **(1)**

.....

(e) State one reason why the energy actually supplied by a real heater for this process would need to be greater than your answer to part (d). **(1)**

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(Total for Question 4 is 8 marks)

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5 A weather balloon contains gas at a pressure of 101 kPa and a volume of 2.50 m^3 at ground level. As the balloon rises, the temperature of the gas stays constant, but the pressure falls to 25 kPa. Use the Physics Equations Sheet: pressure x volume = constant (for a fixed mass of gas at constant temperature)

(a) Calculate the new volume of the gas in the balloon. **(3)**

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(b) The balloon material can stretch to a maximum volume of 8.0 m^3 before it bursts. Calculate the pressure of the gas when the volume reaches 8.0 m^3. **(3)**

.....

(Total for Question 5 is 6 marks)

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6 The particle model represents all substances as being made up of small particles (atoms or molecules).

(a) State the term used to describe the total energy of all the particles in a system (their kinetic energy plus their potential energy). **(1)**

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(b) Describe how the arrangement and the movement of particles differ between a solid and a gas. **(4)**

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.....

(c) State two ways in which the internal energy of a substance can increase when it is heated. **(2)**

(Total for Question 6 is 7 marks)

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7 Which row correctly lists the three states of matter in order of increasing density (lowest to highest), for a typical substance?

- ☐ A) solid, liquid, gas
- ☐ B) gas, liquid, solid
- ☐ C) liquid, solid, gas
- ☐ D) gas, solid, liquid

(Total for Question 7 is 1 mark)

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8 Four liquids, labelled A, B, C and D, do not mix together. Their densities are: A = 0.92 g/cm^3, B = 1.00 g/cm^3, C = 1.26 g/cm^3, D = 13.6 g/cm^3.

(a) State the order in which the four liquids would settle into layers in a tall glass cylinder, from top (least dense) to bottom (most dense). **(1)**

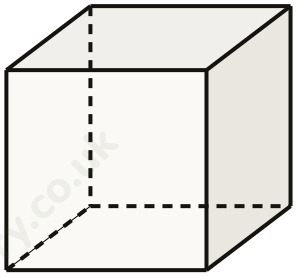
(b) Give a reason for your answer to part (a). **(1)**

(Total for Question 8 is 2 marks)

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9 A metal cube has sides of length 4.0 cm. The mass of the cube is 500 g.

(a) Calculate the volume of the cube, in cm^3. **(1)**



4.0 cm

(b) Calculate the density of the cube. Use: density = mass / volume **(2)**

(c) The density of aluminium is 2.7 g/cm^3. Determine whether the cube could be made from aluminium, giving a reason for your answer using your answer to part (b). **(2)**

(d) State the SI unit of density. **(1)**

(Total for Question 9 is 6 marks)

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10 A student measures the density of a salt solution. Mass of empty measuring cylinder = 45.2 g. Mass of measuring cylinder plus 40 cm^3 of salt solution = 89.2 g.

(a) Calculate the mass of the salt solution. **(1)**

.....

(b) Calculate the density of the salt solution, in g/cm^3. Use: density = mass / volume **(2)**

.....

(c) The student repeats the measurement three times and calculates a mean value. Suggest why taking repeat readings improves the reliability of the result. **(1)**

(Total for Question 10 is 4 marks)

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Mark scheme · 3.3 Particle Model of Matter: 1-hour Pack

Question 1

(a) melting (change from solid to liquid) **B1**

(a) boiling/evaporating (change from liquid to gas) **B1**

(a) Answer: Melting, and boiling.

(b) the boiling section (liquid to gas) ft **B1**

(b) Answer: The boiling (liquid to gas) section.

(c) more energy is required to overcome the forces of attraction between particles when changing from liquid to gas than from solid to liquid **B1**

(c) since the heater transfers energy at a constant rate (constant power), transferring more energy takes more time **B1**

(c) Answer: More energy is needed to separate particles fully (liquid to gas), so at constant power this takes longer.

Question 2

(a) correct conversion factor used: 1 g/cm^3 = 1000 kg/m^3 (since 1 kg = 1000 g and 1 m^3 = 1000000 cm^3) **M1**

(a) 13.6 x 1000 = 13600 kg/m^3 (answer given) cso **A1**

(a) Answer: 13600 kg/m^3 (given)

(b) the ship's hull encloses a large volume of air (hollow space), which reduces the average density of the ship as a whole **B1**

(b) because the ship's overall average density is less than the density of water, the ship floats **B1**

(b) Answer: The hollow hull gives the ship an average density lower than water, so it floats.

Question 3

(a) as temperature increases, the average kinetic energy of the gas particles increases **B1**

(a) the particles move faster, so they collide with the walls of the container more frequently **B1**

(a) the particles collide with the walls with greater force (each collision transfers more momentum) **B1**

(a) since pressure is caused by the force of these collisions acting on a fixed wall area, the pressure increases **B1**

(a) Answer: Pressure increases with temperature: particles move faster, hitting the walls more often and with greater force.

(b) the theoretical minimum possible temperature (0 K, or -273°C), at which particles have minimum kinetic energy oe **B1**

(b) Answer: 0 K (-273°C), the minimum possible temperature.

Question 4

(a) 0.20 x 2100 x 10 substituted **M1**

(a) 4200 J cao **A1**

(a) Answer: 4200 J

(b) 0.20 x 334000 substituted **M1**

(b) 66800 J cao **A1**

(b) Answer: 66800 J

(c) 0.20 x 4200 x 100 substituted **M1**

(c) 84000 J cao **A1**

(c) Answer: 84000 J

(d) 155000 J ft (sum of parts a, b and c) **A1**

(d) Answer: 155000 J

(e) some energy transferred by the heater is lost to the surroundings and does not go into heating the ice/water oe **B1**

(e) Answer: Some energy is lost to the surroundings rather than heating the ice/water.

Question 5

(a) 101 x 2.50 = p2 x V2 written **M1**

(a) rearranges to V2 = (101 x 2.50) / 25 **dM1**

(a) 10.1 m^3 cao **A1**

(a) Answer: 10.1 m^3

(b) 101 x 2.50 = P x 8.0 written **M1**

(b) rearranges to P = (101 x 2.50) / 8.0 **dM1**

(b) awrt 31.6 kPa cao **A1**

(b) Answer: 31.6 kPa (31.5625 kPa)

Question 6

(a) internal energy oe **B1**

(a) Answer: Internal energy

(b) solid particles are closely packed / touching, in a regular arrangement **B1**

(b) solid particles vibrate about fixed positions and do not move from place to place **B1**

(b) gas particles are far apart, in a random arrangement, with negligible forces between them **B1**

(b) gas particles move quickly, in random directions, throughout their container **B1**

(b) Answer: Solid: closely packed, regular arrangement, particles vibrate in fixed positions. Gas: far apart, random arrangement, particles move quickly in random directions.

(c) the kinetic energy of the particles increases (they move or vibrate faster) **B1**

(c) the potential energy of the particles increases (e.g. bonds between particles are stretched or broken during a change of state) **B1**

(c) Answer: Kinetic energy of particles increases; potential energy of particles increases.

Question 7

B cao **B1**

Answer: B (gas, liquid, solid)

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Question 8

(a) A, B, C, D (top to bottom) cao **B1**

(a) Answer: A (top), B, C, D (bottom)

(b) a liquid with a lower density floats on top of a liquid with a higher density oe **B1**

(b) Answer: A less dense liquid floats on top of a more dense liquid.

Question 9

(a) 64 cm^3 cao **A1**

(a) Answer: 64 cm^3

(b) 500 / 64 substituted **M1**

(b) awrt 7.8 g/cm^3 cao **A1**

(b) Answer: 7.8 g/cm^3 (7.8125)

(c) no ft (from part b) **B1**

(c) reason: calculated density (awrt 7.8 g/cm^3) is much greater than the density of aluminium (2.7 g/cm^3) ft **B1**

(c) Answer: No; 7.8 g/cm^3 is much greater than 2.7 g/cm^3.

(d) kg/m^3 **B1**

(d) Answer: kg/m^3

Question 10

(a) 44.0 g cao **A1**

(a) Answer: 44.0 g

(b) 44.0 / 40 substituted **M1**

(b) 1.1 g/cm^3 cao **A1**

(b) Answer: 1.1 g/cm^3

(c) repeating readings and taking a mean reduces the effect of random errors / anomalous results oe **B1**

(c) Answer: Reduces the effect of random error / anomalies on the result.

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