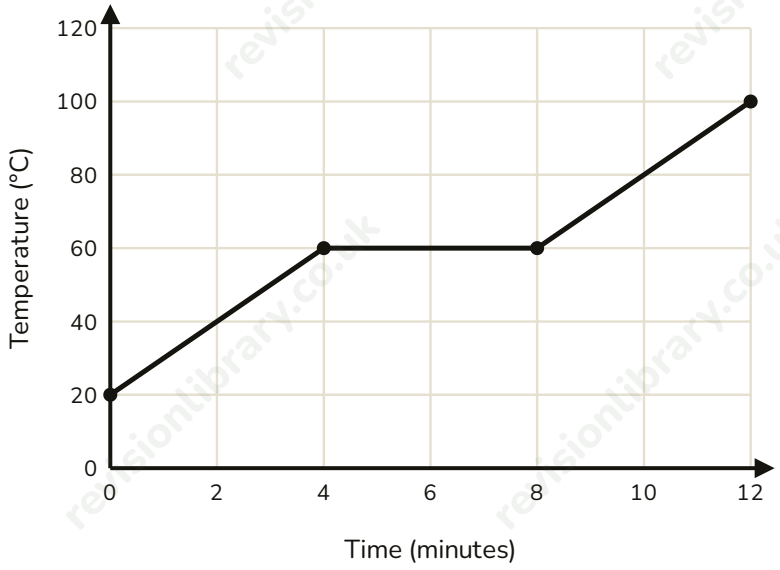
2.1 Particles and their Behaviour: 1-hour Pack

Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The graph shows a heating curve for a pure substance. Temperature (°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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2 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 m³ = 1000 litres).

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

.....

3 A beaker contains 150 cm³ 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)**

4 Extended response: A student investigates how long it takes for different solids to dissolve in 100 cm³ of water. She tests sugar, salt and sand at 25°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)

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5 Data handling: An experiment measures time taken for 1 g of a powdered solid to dissolve in 100 cm³ 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)**

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

(a) First blank **(1)**

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

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7 This question has two parts.

(a) Give the name of the change of state when a gas becomes a liquid. **(1)**

(b) Give one real-life example of this change and explain, using particle ideas, why it happens. **(3)**

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8 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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9 A student measures the time for sugar to dissolve in 200 cm^3 of water at three temperatures. Results:

Temperature (°C)	**Time for sugar to dissolve (s)**
15	180
30	90
60	30

Explain these results using particle ideas.

Temperature (°C)	Time for sugar to dissolve (s)
15	180
30	90
60	30

(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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10 State whether each of the following is a physical change or a chemical change.

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

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

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

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

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11 A thermometer measured the temperature of a sealed container of gas at two times: 20°C and 80°C. The pressure rose from 100 kPa to 120 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)**

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12 A bottle of concentrated orange squash is diluted with water to make a drink. A student makes one glass using a small amount of squash with lots of water (dilute), and another glass using a large amount of squash with only a little water (concentrated).

(a) Explain, in terms of particles, the difference between the dilute and concentrated drinks. **(2)**

(b) The student adds more water to the concentrated drink to dilute it further. Explain what happens to the concentration of squash particles as more water is added, assuming no squash is added or removed. **(2)**

13 A short length of copper pipe has a mass of 178 g and a volume of 20 cm^3. Calculate its density.

(3)

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14 Which of these substances changes directly from a solid to a gas, without melting first, when it is left in a room at normal room temperature and pressure?

- [ ] A) Ice
- [ ] B) Solid carbon dioxide (dry ice)
- [ ] C) Table salt
- [ ] D) Copper

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15 Water boils at 100°C at normal atmospheric pressure (at sea level). On a high mountain, atmospheric pressure is much lower, and water has been observed to boil at only about 85°C.

(a) State what this data suggests about the relationship between atmospheric pressure and the boiling point of water. **(1)**

(b) Suggest, in terms of particles, why a lower atmospheric pressure lowers the boiling point of a liquid. **(2)**

(c) Suggest one practical consequence of this effect for cooking food at high altitude. **(1)**

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Mark scheme · 2.1 Particles and their Behaviour: 1-hour Pack

Question 1

(a) the substance is changing state (melting or boiling) depending on context **B1**

(a) Answer: **The substance is changing state (a phase change) between 4 and 8 minutes**

(b) energy is used to break bonds/overcome forces between particles rather than raise temperature **M1**

(b) so temperature stays constant until the change of state is complete **A1**

(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 2

(a) use volume = mass / density = 0.50 / 1000 = 0.0005 m^3 **M1**

(a) 0.5 litres cao **A1**

(a) Answer: **0.5 litres**

Question 3

(a) state oil is less dense than water or oil particles are less closely packed **M1**

(a) so oil floats on water because less dense materials sit above denser materials cao **A1**

(a) Answer: **Oil is less dense because its particles are less closely packed, so it floats on denser water**

(b) oil and water do not mix because their particles do not form strong attractions with each other **M1**

(b) so oil stays as a separate layer on top rather than dispersing into the water **A1**

(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 4

Level 3 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. **5-6**

Level 2 Some explanation using particle ideas linking results to collision frequency and solubility; at least one limitation and one improvement suggested; answer is generally clear. **3-4**

Level 1 Simple statements, for example that sugar dissolves and sand does not, with little or no explanation and no realistic improvements. **1-2**

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 5

(a) add times: 28+31+29+32+30 = 150 **M1**

(a) divide by 5 to find mean **M1**

(a) 30 s cao **A1**

(a) Answer: **30 s**

(b) identify a value that differs from the rest (eg: 32 or 28); accept: no clear anomaly, because the readings are evenly spread from 28 to 32 s and all are within 2 s of the mean **M1**

(b) gives a valid reason for the choice made: for no anomaly, all readings are close together (within 2 s of the mean); for a named reading (28 or 32), it is the furthest from the mean (2 s) with the others clustered near 29-31, possible timing error **A1**

(b) Answer: **No reading is clearly anomalous: the times are evenly spread and all are within 2 s of the mean. 28 s or 32 s could be named, as each is 2 s from the mean.**

Question 6

(a) energy (accept kinetic energy or thermal energy) cao **B1**

(a) Answer: **energy**

(b) faster or more quickly **B1**

(b) Answer: **faster**

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Question 7

(a) condensing or condensation cao **B1**

(a) Answer: **Condensing**

(b) gives a correct real-life example of condensation (eg: water vapour on a cold window, steam forming droplets on a cold surface, dew forming on grass) **M1**

(b) says the gas cools or loses energy (eg: the window is cold, so the water vapour cools down) **A1**

(b) the gas particles slow down and move closer together or stick together to form a liquid, oe **B1**

(b) Answer: **Water vapour in a room condenses into droplets on a cold window: the vapour cools, so its particles lose energy, slow down and stick together as a liquid.**

Question 8

(a) mass measures amount of matter so particles are the same in number **M1**

(a) particles remain the same number so mass stays the same cao **A1**

(a) Answer: **The amount of matter (the number of particles) stays the same when ice melts**

(b) describe particles gaining energy and moving more but not leaving the sample **M1**

(b) so mass is unchanged because particles are still present in the melted water **A1**

(b) Answer: **When ice melts particles gain energy and move more freely as a liquid but they remain in the sample so mass is unchanged**

Question 9

(a) particles move faster as temperature increases **B1**

(a) Answer: **Particles move faster at higher temperatures**

(b) faster water particles collide with the sugar more often and with more energy, breaking it apart **M1**

(b) so the sugar dissolves faster and the time taken is shorter **A1**

(b) uses the data, e.g. the time falls from 180 s at 15°C to 90 s at 30°C and 30 s at 60°C **B1**

(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 10

(a) physical change **B1**

(a) Answer: **Physical change**

(b) chemical change **B1**

(b) Answer: **Chemical change**

(c) physical change **B1**

(c) Answer: **Physical change**

(d) chemical change **B1**

(d) Answer: **Chemical change**

Question 11

(a) particles gain energy and move faster when heated **M1**

(a) faster motion gives more frequent and harder collisions so pressure increases approximately from 100 to 120 kPa **A1**

(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 120 kPa**

(b) assume volume of container is constant and amount of gas is unchanged **B1**

(b) Answer: **Assume the container volume and amount of gas stayed the same**

Question 12

(a) the concentrated drink has a greater number of squash (solute) particles in the same volume of solution than the dilute drink **M1**

(a) so there are fewer water particles relative to squash particles in the concentrated drink than in the dilute drink, oe **A1**

(a) Answer: **The concentrated drink has more squash particles per unit volume than the dilute drink, which has relatively more water particles.**

(b) the same number of squash particles becomes spread through a larger volume of liquid as water is added **M1**

(b) so the concentration (number of squash particles per unit volume) decreases, oe **A1**

(b) Answer: **The same number of squash particles is spread through more liquid, so the concentration decreases.**

Question 13

density = mass / volume **M1**

178 / 20 **M1**

8.9 g/cm^3 cao **A1**

Answer: **8.9 g/cm^3**

Question 14

B cao **B1**

Answer: **B) Solid carbon dioxide (dry ice)**

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Question 15

(a) as atmospheric pressure decreases, the boiling point of water also decreases, oe **B1**

(a) Answer: **As atmospheric pressure decreases, the boiling point of water decreases.**

(b) at a lower atmospheric pressure, there are fewer air particles pressing down on/colliding with the liquid's surface **M1**

(b) so liquid particles need less kinetic energy (a lower temperature) to overcome this smaller pressure and escape into the gas state, oe **A1**

(b) Answer: **Lower atmospheric pressure means fewer air particles pressing on the liquid's surface, so particles need less energy (a lower temperature) to escape as gas.**

(c) food that is boiled takes longer to cook, because the boiling water is at a lower temperature than at sea level, oe **B1**

(c) Answer: **Boiled food takes longer to cook, because the water boils at a lower temperature.**

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