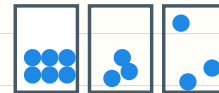


States of Matter



Syllabus topics 1.1 Solids, liquids and gases · 1.2 Diffusion

For the Cambridge IGCSE Chemistry 0620 syllabus, exams in 2026, 2027 and 2028 (Core and Extended)

Syllabus statements covered in this chapter

Syllabus ref.	What you must be able to do	Level
1.1	Properties of solids, liquids and gases; particle separation, arrangement and motion; changes of state; effect of temperature and pressure on the volume of a gas C . Changes of state, heating and cooling curves, and gas volume explained by kinetic particle theory S	C S
1.2	Describe and explain diffusion C . Effect of relative molecular mass on the rate of diffusion of gases S	C S

What is inside

1. Concept notes, particle diagrams, computed heating and cooling curves, 8 worked examples
2. Practical skills (Paper 5 / 6); common mistakes
3. 20 MCQs (Paper 1/2 style), explained
4. 4 Extended (Paper 4) + 2 Core (Paper 3) theory questions and 1 Alternative to Practical (Paper 6), all with full mark schemes
5. Quick-reference sheet, "I can" checklist

How to read these notes

C = Core · **S** = Supplement (Extended only)

red = key term green = definition

1 = one mark in the mark scheme

★ **Exam tip:** Particle answers need three separate ideas: **separation** (how far apart), **arrangement** (regular or random) and **motion** (vibrate, slide, move freely).

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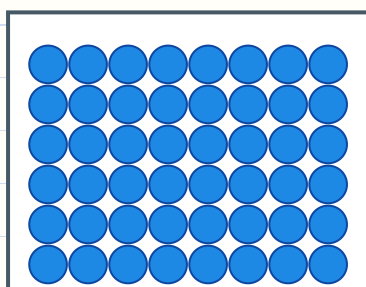
1.1 Solids, liquids and gases

Properties of the three states

Property	Solid	Liquid	Gas
shape	fixed shape	takes the shape of the container (bottom part)	fills the whole container
volume	fixed volume	fixed volume	no fixed volume (fills the container)
flow	does not flow	flows	flows
compression	cannot be compressed (squashed)	almost impossible to compress	easily compressed
density	high	high (usually a little lower than the solid)	very low

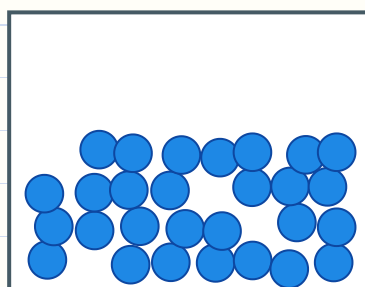
The kinetic particle model

All matter is made of tiny particles (atoms, molecules or ions) that are always moving. The state depends on how strongly the particles attract each other and how much kinetic energy they have.



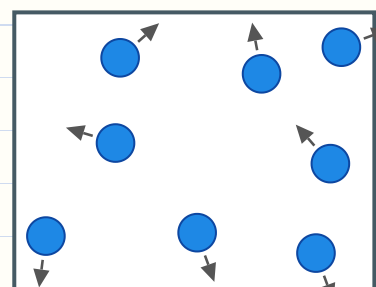
solid

fixed, regular pattern; touching;
vibrate about fixed positions



liquid

random arrangement; touching;
slide past each other



gas

random; far apart;
move fast in all directions

Particles in a solid, a liquid and a gas.

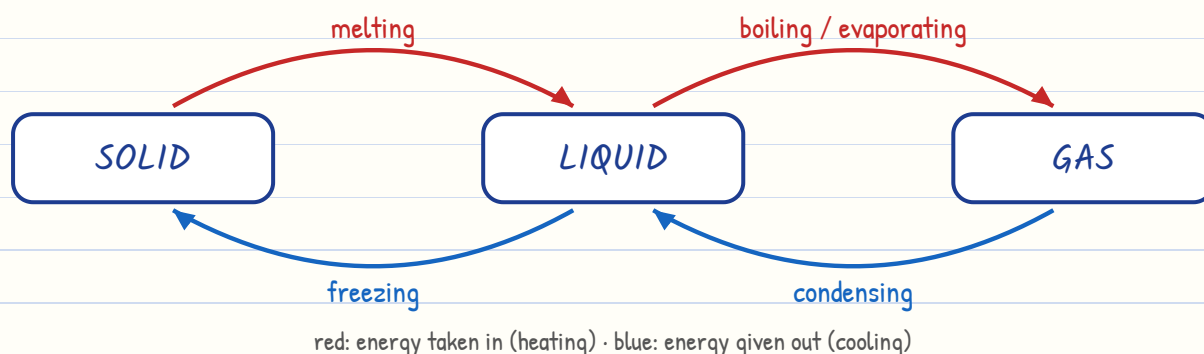
	Separation	Arrangement	Motion
solid	very close together (touching)	regular pattern (lattice)	vibrate about fixed positions
liquid	close together (touching)	random, irregular	move around, sliding past each other
gas	far apart	random	move quickly in all directions (random motion)

This explains the properties: a gas can be compressed because there is a lot of space between its particles; solids and liquids cannot, because the particles are already touching. Liquids and gases flow because their particles can move past each other.

Changes of state

- **Melting:** solid $\rightarrow$ liquid, at the **melting point**. **Freezing:** liquid $\rightarrow$ solid, at the same temperature (melting point = freezing point).

- **Boiling:** liquid $\rightarrow$ gas, throughout the liquid (bubbles form inside it), at the **boiling point**. **Evaporating:** liquid $\rightarrow$ gas, only at the **surface**, at temperatures **below** the boiling point.
- **Condensing:** gas $\rightarrow$ liquid (at the boiling point, or below it).
- To find the state at a temperature: below the melting point, **solid**; between the melting point and the boiling point, **liquid**; above the boiling point, **gas**.



The changes of state.

Worked example 1: state from melting and boiling points

Bromine melts at -7°C and boils at 59°C . State its physical state at (a) -20°C , (b) 25°C , (c) 100°C .

(a) below the melting point: **solid**; (b) between -7 and 59°C : **liquid**; (c) above the boiling point: **gas**.

Worked example 2: evaporation and boiling

A puddle of water dries up on a day when the temperature is 20°C . Explain how this happens although water boils at 100°C .

The water **evaporates**: particles at the surface with enough energy escape into the air. Evaporation takes place at any temperature below the boiling point; boiling happens only at 100°C .

Effect of temperature and pressure on the volume of a gas

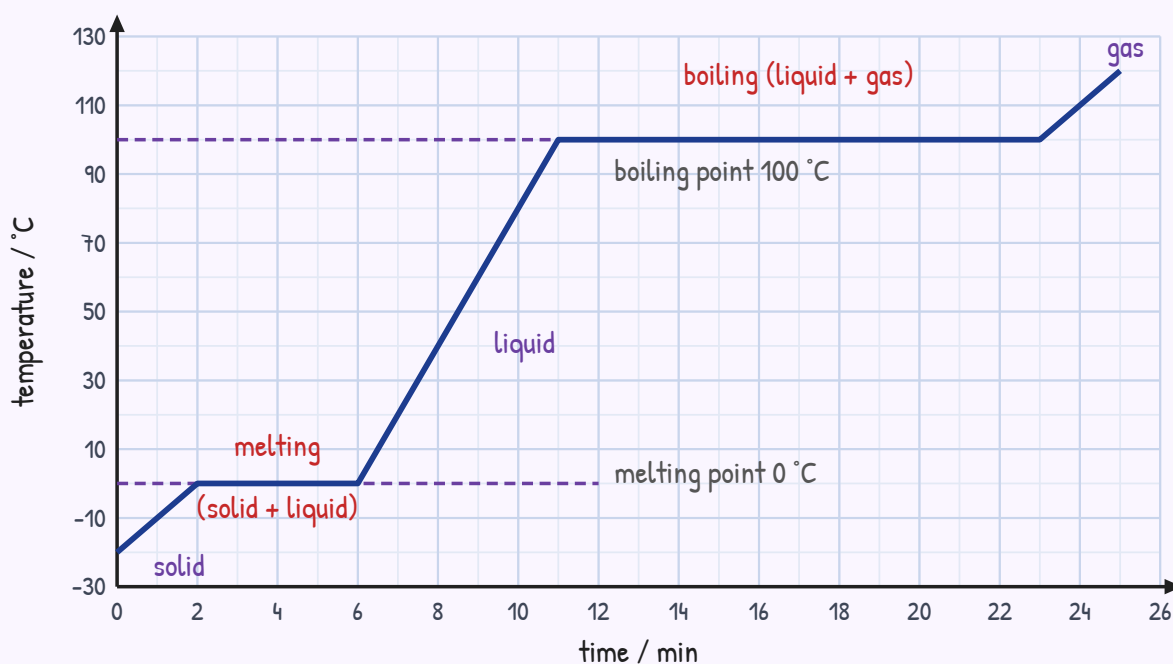
- At constant pressure, increasing the **temperature** of a gas **increases** its volume (the gas expands).
- At constant temperature, increasing the **pressure** on a gas **decreases** its volume (the gas is compressed).

Extended (Supplement) only

Explaining changes of state with the kinetic particle theory

- **Melting:** heating gives the particles more kinetic energy; they vibrate more until they have enough energy to overcome some of the forces of attraction and leave their fixed positions.
- **Boiling:** the particles gain enough energy to overcome the remaining forces of attraction completely and move far apart.
- **Freezing and condensing:** the particles lose energy, move more slowly and the forces of attraction pull them closer together; energy is **given out**.
- Melting, boiling and evaporating **take in** energy (endothermic); freezing and condensing **give out** energy (exothermic).

Heating and cooling curves



Heating curve for water, heated at a constant rate from -20 °C.

- **Sloping sections:** the energy supplied increases the kinetic energy of the particles, so the temperature rises.
- **Flat sections** (melting and boiling): the temperature stays constant although heating continues, because the energy is used to **overcome the forces of attraction** between the particles, not to increase their kinetic energy.
- The boiling section is **longer** than the melting section: more energy is needed to separate the particles completely than to let them slide past each other.
- A **cooling curve** is the reverse: the temperature falls, then stays constant while the substance condenses (at the boiling point) and while it freezes (at the melting point), because energy is released as attractions form. The flat section for condensing is at the same temperature as the flat section for boiling.

Explaining gas volume

- **Higher temperature:** the particles gain kinetic energy and move faster; they hit the walls of the container more often and with more force; if the pressure is to stay the same, the gas expands, so the volume increases.
- **Higher pressure:** the particles are pushed closer together into a smaller space (there is plenty of space between gas particles), so the volume decreases.

Worked example 3: a flat section

Explain why the temperature of boiling water stays at 100 °C although it is still being heated.

The energy supplied is used to overcome the forces of attraction between the water molecules (so they can separate into a gas), not to increase their kinetic energy, so the temperature does not rise until all the water has boiled.

Worked example 4: a heated syringe S

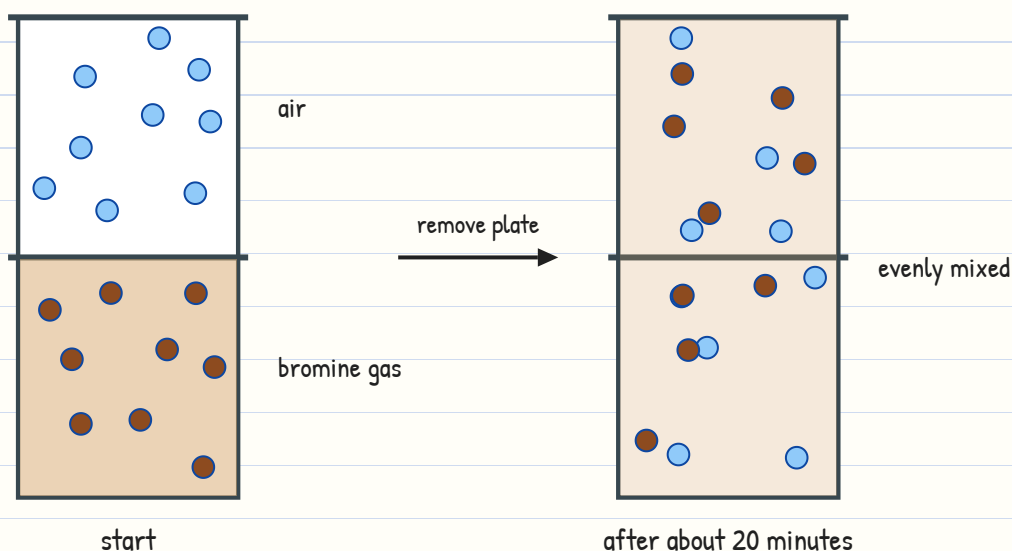
A gas syringe containing 50 cm³ of air is warmed from 20 °C to 60 °C. The plunger is free to move. Describe and explain what happens.

The volume increases (the plunger moves out). The particles move faster and hit the plunger more often and harder; the plunger moves out until the pressure inside again equals the pressure outside.

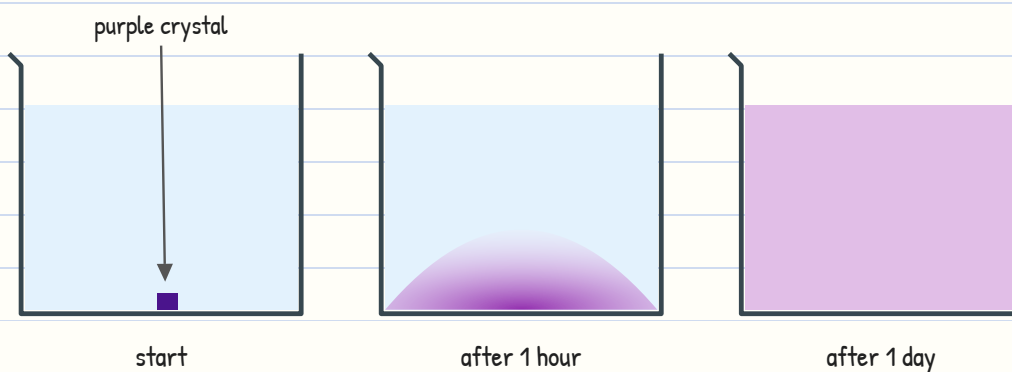
1.2 Diffusion

Definition  **Diffusion** is the net movement of particles from a region of **higher concentration** to a region of **lower concentration**, as a result of their **random motion**, until they are evenly mixed.

- Diffusion happens in gases and liquids (the particles can move around). It is fast in gases and slow in liquids, because liquid particles are close together and collide with each other very often.
- Diffusion needs no stirring: the random motion of the particles is enough.
- Diffusion is faster at higher temperature, because the particles move faster.



Bromine gas diffusing into air: the brown colour spreads until it is even in both jars.



A crystal of potassium manganate(VII) dissolving in water: the purple colour spreads by diffusion.

Worked example 5: explaining a colour change

Explain why the whole of the water turns purple in the potassium manganate(VII) experiment, although the water is not stirred.

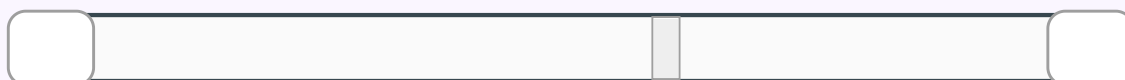
The crystal dissolves and the particles move randomly. There is a net movement of particles from where they are concentrated (near the crystal) to where they are less concentrated, until they are evenly spread: diffusion.

Extended (Supplement) only**Effect of relative molecular mass on the rate of diffusion**

- At the same temperature, gas particles with a **lower relative molecular mass (Mr)** move **faster**, so they **diffuse faster**. Heavier particles diffuse more slowly.
- Example: ammonia, NH_3 (Mr = 17), diffuses faster than hydrogen chloride, HCl (Mr = 36.5).

cotton wool soaked in
concentrated ammonia

cotton wool soaked in
concentrated hydrochloric acid



white ring of ammonium chloride (59 cm from the ammonia end)

Ammonia and hydrogen chloride diffusing along a tube. The white ring forms nearer the hydrochloric acid end.

The gases meet and react: $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \longrightarrow \text{NH}_4\text{Cl}(\text{s})$ (white solid). The ring forms nearer the HCl end because ammonia, with the lower Mr, travels further in the same time.

Worked example 6: the white ring S

In the tube experiment, explain why the white ring is not formed in the middle of the tube.

Ammonia (Mr 17) has a lower relative molecular mass than hydrogen chloride (Mr 36.5), so its molecules move faster and diffuse faster. The ammonia travels further before the gases meet, so the ring forms closer to the hydrochloric acid end.

Worked example 7: comparing gases S

Put these gases in order of rate of diffusion, fastest first: carbon dioxide (Mr 44), methane (Mr 16), oxygen (Mr 32).

Lowest Mr diffuses fastest: **methane, oxygen, carbon dioxide**.

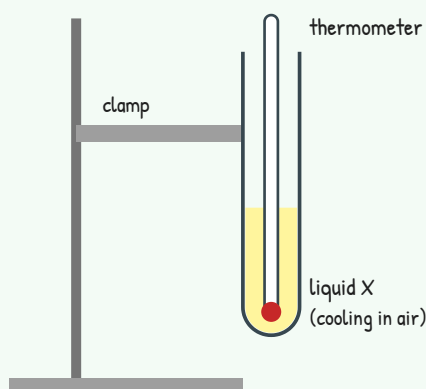
Worked example 8: why the ring takes minutes S

Gas molecules move at hundreds of metres per second, yet the ring takes several minutes to form. Explain why.

The ammonia and hydrogen chloride molecules collide many times with air particles in the tube, so they keep changing direction (random motion); their net progress along the tube is slow.

Practical skills for Paper 5 and Paper 6

Plotting a cooling curve



Apparatus for a cooling curve.

- Melt the solid in a boiling tube placed in a beaker of hot water (a water bath): many organic solids are flammable, so they are not heated directly over a flame.
- Put a thermometer in the liquid and clamp the tube in the air; start the stop-watch.
- Record the temperature at regular intervals (e.g. every 30 s or 1 min) until the substance has solidified and cooled further. Stir gently with the thermometer while it is still liquid.
- Plot temperature (y-axis) against time (x-axis) and draw a smooth curve with a horizontal section; the temperature of the flat section is the freezing point (= melting point).

Diffusion experiments

- Ammonia and hydrogen chloride tube: use concentrated solutions in a **fume cupboard** (both gases are toxic and corrosive); insert both bungs of cotton wool at the same time; wear eye protection and gloves; measure the distance of the ring from each end with a ruler.
- Potassium manganate(VII) in water: do not stir or move the beaker; observe at intervals.

Common mistakes that lose marks

- **Mixing up separation, arrangement and motion.** "Regular" is arrangement; "close together" is separation; "vibrate" is motion. Answer the one that is asked.
- **Bulk properties instead of particles.** "A gas fills its container" is a property; the question may want "particles are far apart and move randomly".
- **Particles in a solid "do not move".** They vibrate about fixed positions.
- **Particles expanding.** When a gas expands the particles move further apart; the particles themselves do not get bigger.
- **Flat sections (S).** Energy overcomes the forces of attraction **between** the particles; it does not break bonds inside molecules.
- **Cooling curves.** The flat section for condensing is at the boiling point: the same temperature as boiling.
- **Diffusion definition.** Give the direction (high to low concentration) and the cause (random motion of particles).
- **Mr and rate (S).** Lower Mr → faster diffusion. Say "relative molecular mass", not "the gas is lighter" alone.

Exam-style multiple-choice questions (Paper 1/2 style)

20 questions, 1 mark each. Choose one answer, A, B, C or D. Questions marked **S** are Extended only. Answers with full explanations follow the questions.

1. Which describes the particles in a solid?
 - A close together, in a regular pattern, vibrating about fixed positions
 - B far apart, random, moving quickly
 - C close together, random, sliding past each other
 - D far apart, regular, not moving
2. Which state has a fixed volume but no fixed shape?
 - A solid
 - B gas
 - C liquid
 - D solid and gas
3. What is condensing?
 - A solid $\rightarrow$ liquid
 - B gas $\rightarrow$ liquid
 - C liquid $\rightarrow$ gas
 - D liquid $\rightarrow$ solid
4. A substance melts at $-39\text{ }^{\circ}\text{C}$ and boils at $357\text{ }^{\circ}\text{C}$. What is its state at $25\text{ }^{\circ}\text{C}$?
 - A solid
 - B gas
 - C a mixture of solid and liquid
 - D liquid
5. Which process can take place at temperatures below the boiling point of a liquid?
 - A boiling
 - B evaporation
 - C melting
 - D sublimation of the liquid
6. A gas in a syringe is heated. The plunger is free to move, so the pressure stays the same. What happens to the volume of the gas?
 - A it increases
 - B it decreases
 - C it stays the same
 - D it becomes zero
7. The pressure on a gas is increased at constant temperature. What happens to its volume?
 - A it increases
 - B it stays the same
 - C it doubles
 - D it decreases
8. What is diffusion?
 - A the movement of particles only when a liquid is stirred
 - B the movement of particles from low to high concentration
 - C the net movement of particles from high to low concentration due to their random motion
 - D the expansion of particles when heated
9. A purple crystal is placed in water. After a day, all the water is purple. Why?
 - A the particles move randomly and spread out by diffusion
 - B the water was stirred
 - C the crystal particles expanded
 - D the water particles turned purple

10. Why can a gas be compressed easily?
- A its particles are very small
 - B its particles are far apart
 - C its particles are touching
 - D its particles do not move
11. Which is a property of a liquid?
- A it has a fixed shape
 - B it fills the whole of its container
 - C it takes the shape of its container
 - D it is easily compressed
12. An ice cube melts in a warm room. Which statement is correct?
- A energy is given out by the ice
 - B no energy change takes place
 - C the particles lose kinetic energy
 - D energy is taken in by the ice
13. **S** On a heating curve the temperature stays constant during melting. What is the energy used for?
- A overcoming forces of attraction between the particles
 - B increasing the kinetic energy of the particles
 - C breaking the atoms apart
 - D making the particles bigger
14. **S** In the tube experiment, the white ring of ammonium chloride forms nearer the hydrochloric acid end. Why?
- A HCl has a lower Mr and diffuses faster
 - B NH₃ has a lower Mr and diffuses faster
 - C HCl is a liquid
 - D NH₃ is denser than air
15. **S** Which gas diffuses fastest at the same temperature? (A_r : H = 1, He = 4, C = 12, N = 14, O = 16)
- | | |
|-------------------|------------------|
| A CO ₂ | B O ₂ |
| C N ₂ | D He |
16. **S** Why does the volume of a gas increase when it is heated at constant pressure?
- A the particles get bigger
 - B more particles are made
 - C the particles move faster and hit the walls more often and harder, so the gas expands
 - D the forces of attraction increase

17. **S** Why does the volume of a gas decrease when the pressure is increased at constant temperature?
- A the particles are pushed closer together into the space between them
 - B the particles get smaller
 - C the particles slow down
 - D some particles are destroyed
18. **S** A liquid is cooling. Its temperature stays constant while it freezes. Why?
- A no energy is being lost
 - B the particles stop moving
 - C the thermometer is broken
 - D energy is released as forces of attraction form, balancing the energy lost to the surroundings
19. **S** Which two gases diffuse at the same rate at the same temperature? (A_r : H = 1, He = 4, C = 12, N = 14, O = 16)
- | | |
|--------------------------------------|-------------------------|
| A O ₂ and N ₂ | B N ₂ and CO |
| C CO ₂ and O ₂ | D H ₂ and He |
20. **S** Ethanol is heated steadily. Its heating curve has a flat section at 78 °C. What is happening during this flat section?
- | | |
|-----------|--------------|
| A melting | B freezing |
| C boiling | D condensing |

Answers and explanations

1 A · 2 C · 3 B · 4 D · 5 B · 6 A · 7 D · 8 C · 9 A · 10 B · 11 C · 12 D · 13 A · 14 B · 15 D · 16 C · 17 A · 18 D · 19 B · 20 C

1. **A.** Solid particles touch, are in a regular pattern and vibrate about fixed positions.
2. **C.** A liquid has a fixed volume but takes the shape of its container.
3. **B.** Condensing is gas → liquid.
4. **D.** 25 °C lies between -39 °C and 357 °C: liquid (this is mercury).
5. **B.** Evaporation takes place at the surface below the boiling point.
6. **A.** Heating at constant pressure makes a gas expand.
7. **D.** Higher pressure compresses the gas.
8. **C.** Net movement from high to low concentration caused by random motion.
9. **A.** Diffusion: random motion spreads the particles evenly.
10. **B.** There are large spaces between gas particles.
11. **C.** Liquids take the shape of the container but keep their volume.
12. **D.** Melting takes in energy from the surroundings.
13. **A.** The energy overcomes the attractions between particles; kinetic energy does not change, so temperature is constant.
14. **B.** NH₃ (17) has a lower Mr than HCl (36.5), so it travels further.
15. **D.** He (Mr 4) is the lightest.
16. **C.** Faster particles hit the walls more often and harder; the gas expands to keep the pressure constant.
17. **A.** There is space between gas particles, so they can be pushed closer.
18. **D.** Forming attractions releases energy, which balances the loss to the surroundings.

19. **B.** $N_2 = 28$ and $CO = 12 + 16 = 28$.

20. **C.** A flat section on heating above room temperature for a liquid is boiling (78°C is ethanol's boiling point).

Exam-style Extended theory questions (Paper 4 style)

Answer all parts. Total: 38 marks. Full mark schemes follow each question.

Question 1 [10 marks]

(a) Complete the descriptions of the particles in a solid and in a gas: separation, arrangement and motion. [4]

(b) Use the kinetic particle model to explain why a gas can be compressed but a solid cannot. [2]

(c) The table gives the melting and boiling points of three substances. Give the physical state of each at 20°C . [3]

substance	melting point / $^\circ\text{C}$	boiling point / $^\circ\text{C}$
P	-219	-183
Q	17	118
R	44	280

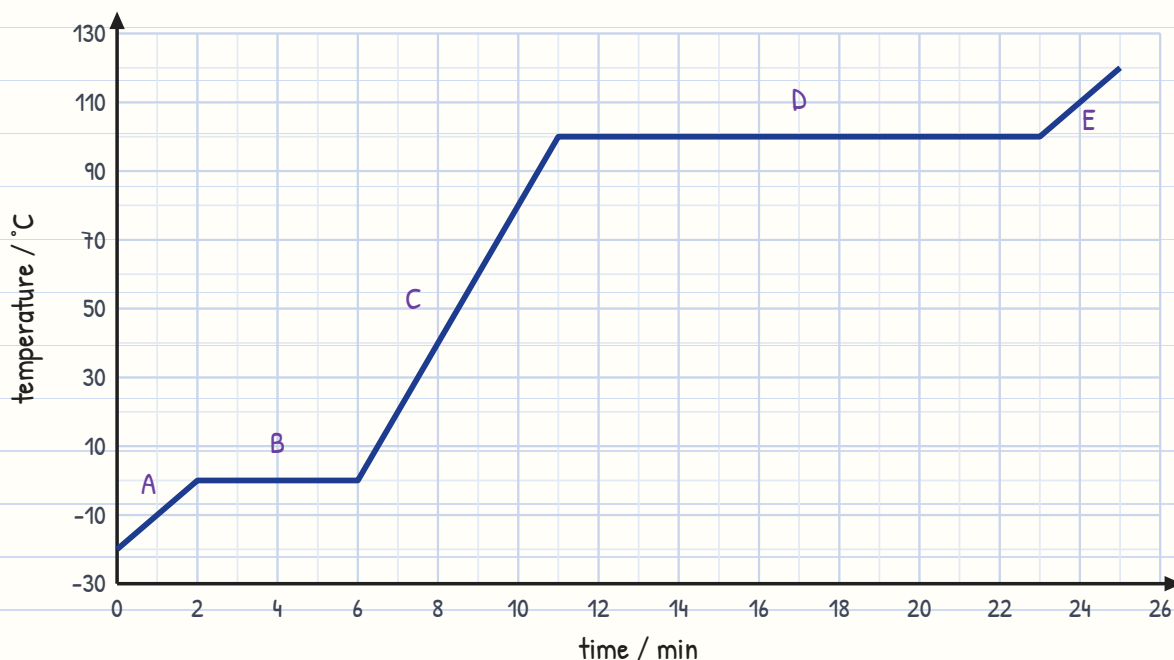
(d) Explain why a liquid can evaporate at a temperature below its boiling point. [1]

Mark scheme

- (a) solid: close together / touching **and** regular arrangement 1; vibrate about fixed positions 1;
gas: far apart **and** random arrangement 1; move quickly / randomly in all directions 1
- (b) gas particles are far apart, so there is space to push them closer together 1; solid particles are already touching / have no space between them 1
- (c) P gas 1; Q liquid 1; R solid 1
- (d) some particles at the surface have enough energy to overcome the attractions and escape 1

Question 2 [10 marks]

Ice at -20°C is heated at a constant rate until it has all turned to steam at 120°C . The graph shows the heating curve.



Heating curve (Question 2).

- State the physical state(s) of the water in sections A, C and E. [3]
- Name the processes taking place in sections B and D. [2]
- Explain, in terms of particles, why the temperature does not change in section D although heating continues. [2]
- Suggest why section D lasts longer than section B. [1]
- Steam at 120°C is cooled to -20°C . Describe how the temperature changes with time. [2]

Mark scheme

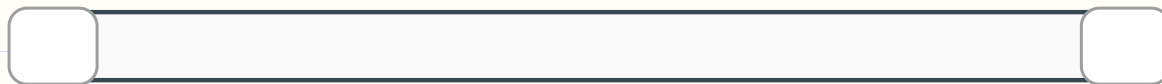
- (a) A: solid 1; C: liquid 1; E: gas 1
- (b) B: melting 1; D: boiling 1
- (c) energy is used to overcome the forces of attraction between the particles 1; not to increase their kinetic energy (so the temperature stays the same) 1
- (d) more energy is needed to separate the particles completely (all attractions overcome) than to melt the solid 1
- (e) temperature falls, then stays constant at 100°C while the steam condenses 1; falls again, then stays constant at 0°C while the water freezes, then falls to -20°C 1

Question 3 [9 marks]

Cotton wool soaked in concentrated ammonia and cotton wool soaked in concentrated hydrochloric acid are placed at the same time at opposite ends of a glass tube 100 cm long.

cotton wool soaked in
concentrated ammonia

cotton wool soaked in
concentrated hydrochloric acid



glass tube, 100 cm long

Diffusion tube (Question 3).

- The two gases react to form a white solid. Name the solid and write a balanced equation, with state symbols, for its formation. [2]
- Predict where in the tube the white solid forms, and explain your answer. (M_r : $\text{NH}_3 = 17$, $\text{HCl} = 36.5$) [4]
- Explain why it takes several minutes for the white solid to form. [2]
- The experiment is repeated in a warmer room. State the effect on the time taken for the white solid to form. [1]

Mark scheme

- (a) ammonium chloride 1; $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$ 1
- (b) nearer the hydrochloric acid end (about 59 cm from the ammonia end) 1; ammonia has the lower M_r 1; so its molecules move faster / diffuse faster 1; so ammonia travels further in the same time 1
- (c) the gas molecules collide with air particles 1; so they move randomly / keep changing direction 1
- (d) shorter time (the particles move faster) 1

Question 4 [9 marks]

- A sealed gas syringe contains 40 cm^3 of nitrogen. The syringe is placed in hot water; the plunger can move freely. Describe and explain the change in volume. [3]
- The plunger is then pushed in while the temperature is kept constant. Describe and explain the change in volume. [3]
- A gas jar of brown bromine gas is placed below a gas jar of air, separated by a glass plate. The plate is removed. Describe what is seen and explain it in terms of particles. [3]

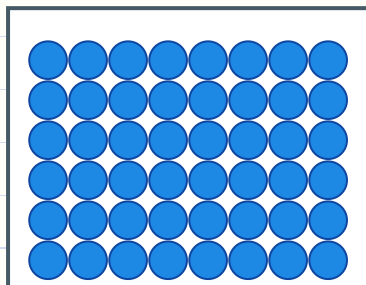
Mark scheme

- (a) volume increases 1; particles gain kinetic energy and move faster 1; they hit the plunger more often / harder, so the gas expands (until the pressures balance) 1
- (b) volume decreases 1; there is space between gas particles 1; the particles are pushed closer together 1
- (c) brown colour spreads into the upper jar until both jars are the same (pale brown) colour 1; the particles move randomly 1; net movement from high to low concentration (diffusion) until

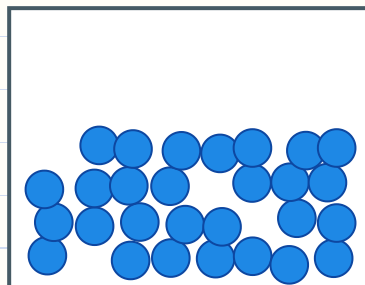
evenly mixed 1

Exam-style Core theory questions (Paper 3 style)

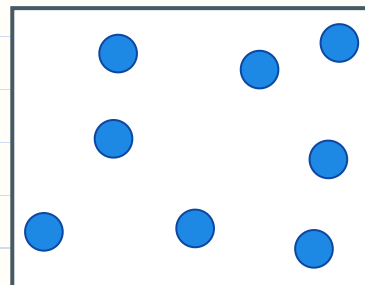
Total: 16 marks. Full mark schemes follow each question.

Question 5 [8 marks]

X



Y



Z

Particles in three states, X, Y and Z (Question 5).

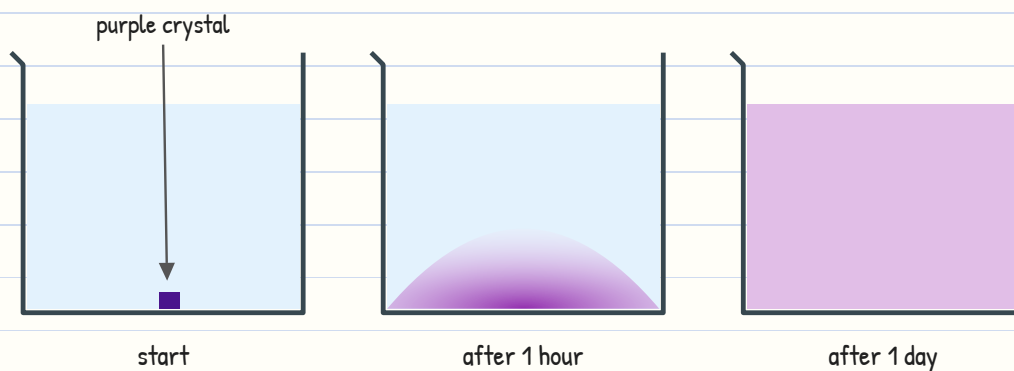
- (a) State which diagram, X, Y or Z, shows a solid, a liquid and a gas. [3]
 (b) Describe the motion of the particles in Z. [1]
 (c) Name the change of state from X to Y and from Z to Y. [2]
 (d) State two properties of a gas. [2]

Mark scheme

- (a) X solid 1; Y liquid 1; Z gas 1
- (b) move quickly and randomly in all directions 1
- (c) X → Y melting 1; Z → Y condensing 1
- (d) any two from: no fixed shape / fills the container; no fixed volume; easily compressed; flows; low density 2

Question 6 [8 marks]

A purple crystal of potassium manganate(VII) is placed at the bottom of a beaker of water. The beaker is left without stirring.

*Potassium manganate(VII) in water (Question 6).*

- (a) Name the process that spreads the purple colour. [1]
 (b) Explain the observations in terms of particles. [2]

- (c) Suggest how the result would differ in warm water, and why. [2]
- (d) Sodium chloride melts at 801 °C and boils at 1413 °C. State its physical state at 25 °C and at 1000 °C. [2]
- (e) Name the change of state in which a liquid becomes a gas at its surface, below its boiling point. [1]

Mark scheme

- (a) diffusion 1
- (b) particles move randomly 1; spread from high to low concentration until evenly mixed 1
- (c) colour spreads faster 1; particles move faster at higher temperature 1
- (d) 25 °C: solid 1; 1000 °C: liquid 1
- (e) evaporation 1

Exam-style Alternative to Practical question (Paper 6 style)

Question 7 [11 marks]

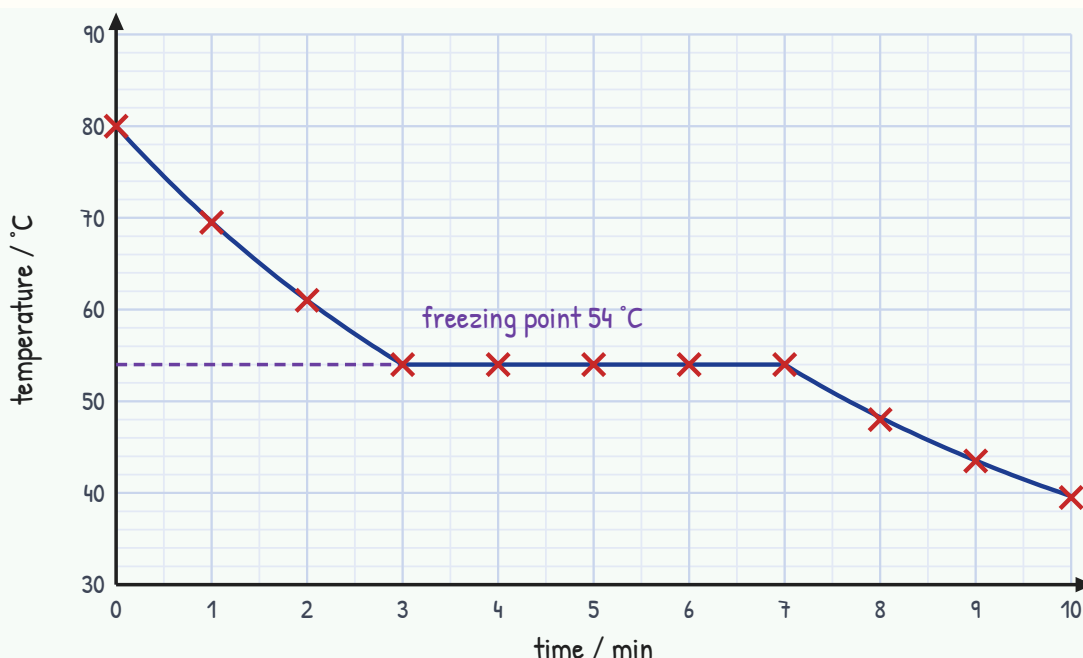
A student melts solid X in a boiling tube in a hot-water bath. The tube is then clamped in the air, as in the practical-skills diagram, and the temperature is recorded every minute.

time / min	0	1	2	3	4	5	6	7	8	9	10
temperature / °C	80	69.5	61	54	54	54	54	54	48	43.5	39.5

- (a) Plot the results on a grid and draw a smooth curve of best fit. [4]
- (b) Use your graph to find the freezing point of X. [1]
- (c) Explain why the temperature stays constant between 3 and 7 minutes. [2]
- (d) State the physical state of X at 2 minutes and at 9 minutes. [2]
- (e) Suggest why X is melted in a hot-water bath and not over a Bunsen flame. [1]
- (f) Suggest one improvement to make the freezing point more accurate. [1]

Mark scheme

- (a) axes labelled with units, temperature on the y-axis 1; suitable scales using more than half the grid 1; all points plotted correctly 1; smooth curve with a horizontal section, not dot-to-dot 1
- (b) 54 °C 1
- (c) X is freezing 1; energy released as the particles are attracted into fixed positions balances the energy lost to the surroundings 1
- (d) 2 min: liquid 1; 9 min: solid 1
- (e) X may be flammable / the water bath heats more gently and evenly 1
- (f) take readings more often (e.g. every 30 s) / stir while liquid / use a thermometer with a finer scale 1



Mark-scheme figure: cooling curve of X with the freezing point marked.

Quick-reference sheet

Item	Statement	Level
solid	fixed shape and volume; particles touching, regular, vibrate	C
liquid	fixed volume, takes container's shape, flows; particles touching, random, slide past each other	C
gas	fills container, compressible; particles far apart, random, move fast	C
changes of state	melting, freezing, boiling, evaporating (surface, below b.p.), condensing	C
gas volume	temperature $\uparrow \rightarrow$ volume $\uparrow$; pressure $\uparrow \rightarrow$ volume $\downarrow$	C
curves	slopes: kinetic energy changes; flat sections: attractions overcome or formed (m.p., b.p.)	S
diffusion	net movement from high to low concentration by random motion	C
Mr and rate	lower Mr $\rightarrow$ faster diffusion (NH_3 faster than HCl)	S

"I can" checklist

- ☐ state the properties of solids, liquids and gases and describe their particles (separation, arrangement, motion)
- ☐ name and describe the changes of state, and use melting and boiling points to find the state
- ☐ describe the effects of temperature and pressure on the volume of a gas
- ☐ **S** explain changes of state, heating and cooling curves, and gas volume using the kinetic particle theory
- ☐ describe and explain diffusion
- ☐ **S** explain the effect of relative molecular mass on the rate of diffusion

★ **Exam tip:** Next chapter: 2.1–2.3 Elements, compounds and mixtures; atomic structure; isotopes.