1.1 Solids, liquids and gases

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

0 Vocabulary

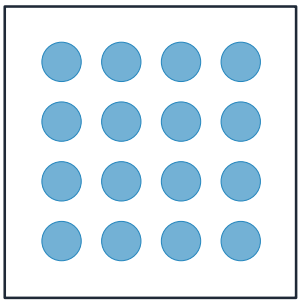
Word	Example
ions /'aɪɒnz/ 离子	Water molecules surround the **ions** as they dissolve. **离子**溶解时，水分子包围着它们。
kinetic particle theory 粒子动理论 /kɪ'netɪk 'pɑ:tɪkl 'θɪəri/	**Kinetic particle theory** says matter is made of moving particles. **粒子动理论**认为物质由运动的粒子组成。
volume /'vɒlju:m/ 体积	The **volume** of the box is 2 m × 1 m × 1 m = 2 m^3. 箱子的**体积**是 2 m × 1 m × 1 m = 2 m^3。
compress /kəm'pres/ 压缩	You can **compress** a gas by pushing it into a smaller space. 可以通过将气体压入更小的空间来**压缩**气体。
density /'densɪti/ 密度	Iron has a higher **density** than wood, so it sinks in water. 铁的**密度**比木头大，所以铁会沉入水中。
separation /ˌsepə'reɪʃn/ 间距	Increase the **separation** of the plates. 增大极板之间的**间距**。
arrangement /ə'reɪndʒmənt/ 排列	The particle **arrangement** in a solid is regular and close. 固体中粒子的**排列**紧密而规则。
regular /'regjʊlə/ 规则	The particles in a crystal are in a **regular** pattern. 晶体中的粒子按**规则**的方式排列。
forces of attraction 引力 /'fɔ:sɪz ɒv ə'trækʃn/	**Forces of attraction** hold the particles together. **引力**将粒子聚集在一起。
melting /'meltɪŋ/ 熔化	**Melting** turns ice into water. **熔化**使冰变成水。
freezing /'fri:zɪŋ/ 凝固	**Freezing** turns water into ice. **凝固**使水变成冰。
evaporating /ɪ'væpəreɪtɪŋ/ 蒸发	Water is **evaporating** from the puddle in the sun. 阳光下，水正从水坑中**蒸发**。

Word	Example
boiling /ˈbɔɪlɪŋ/ 沸腾	During **boiling**, bubbles form all through the water. **沸腾**时，水中各处都会形成气泡。
condensing /kənˈdensɪŋ/ 凝结	Steam **condensing** on a cold window forms drops of water. 水蒸气在冷窗户上**凝结**形成水滴。
melting point /ˈmeltɪŋ pɔɪnt/ 熔点	The **melting point** of ice is 0 °C. 冰的**熔点**是 0 °C。
boiling point /ˈbɔɪlɪŋ pɔɪnt/ 沸点	The **boiling point** of water is 100 °C. 水的**沸点**是 100 °C。
sublimation /ˌsʌblɪˈmeɪʃn/ 升华	Dry ice undergoes **sublimation** from solid to gas. 干冰通过**升华**从固态变成气态。
heating curve /ˈhiːtɪŋ kɜːv/ 加热曲线	A **heating curve** shows temperature rising as a solid is heated. **加热曲线**显示固体受热时温度的上升情况。
cooling curve /ˈkuːlɪŋ kɜːv/ 冷却曲线	A **cooling curve** shows temperature falling as a liquid cools. **冷却曲线**显示液体冷却时温度的下降情况。
thermal energy 热能 /ˈθɜːml ˈenədʒi/	Rubbing your hands turns work into **thermal energy**. 搓手把功转化为**热能**。
pressure /ˈpreʃə/ 压强	A sharp knife puts a large **pressure** on the bread. 锋利的刀对面包产生很大的**压强**。
collide /kəˈlaɪd/ 碰撞	Particles must **collide** to react. 粒子必须发生**碰撞**才能反应。

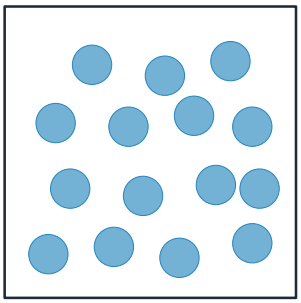
1 Key knowledge and worked examples

■ The three states

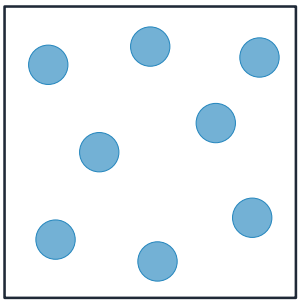
state	separation	arrangement	motion	shape and volume
solid 固体	touching	regular	vibrate about fixed positions	fixed shape, fixed volume
liquid 液体	touching	random	move around each other	takes the container's shape, fixed volume
gas 气体	far apart	random	fast, in all directions	fills the container; easily **compressed** 压缩



solid
regular, touching
vibrate in place



liquid
close, random
slide past each other



gas
far apart, random
move fast

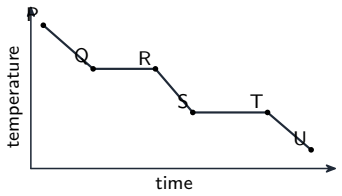
change	from → to	energy
melting 熔化 / **boiling** 沸腾 or **evaporation** 蒸发	solid → liquid / liquid → gas	taken **in**
freezing 凝固 / **condensation** 冷凝	liquid → solid / gas → liquid	given **out**
sublimation 升华	solid → gas	taken **in**

- A pure substance melts and boils at **fixed temperatures**. Evaporation happens below the boiling point, at the surface only.
- **State at a temperature:** below the melting point it is a solid; between the melting and boiling points a liquid; above the boiling point a gas.

Heating and cooling curves

A **flat section** means a change of state. The temperature stays constant because the energy taken in (or given out) changes the forces of attraction between particles, not the particles' kinetic energy.

Worked example 1: reading a cooling curve



1. Known: the substance starts as a gas at P and is cooled.
2. Rule: the first flat section is condensation, the second is freezing.
3. Q to R: the gas **condenses**; particles move closer together. S to T: the liquid **freezes**; the particles move into fixed positions.
4. Result: between R and S the substance is a **liquid**: particles touching, random, moving around each other.

Gas pressure and volume

change to a fixed mass of gas	effect	reason in terms of particles
heated, volume fixed	pressure **rises**	particles move faster, hit the walls harder and more often
heated, pressure fixed	volume **increases**	faster particles push the walls further out
pressure increased, temperature fixed	volume **decreases**	particles pushed closer together

Worked example 2: a balloon left in the sun

1. Known: a fixed mass of air at constant pressure is warmed.
2. Rule: higher temperature means more kinetic energy.
3. The particles move faster and collide with the inside of the balloon harder and more often.
4. Result: the balloon **expands** until the pressure inside again equals the pressure outside. The particles themselves do not get bigger.

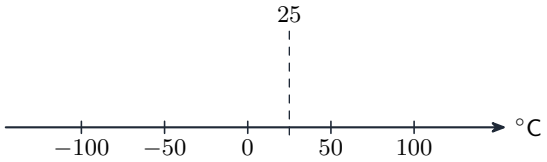
Answer shapes: one mark per property in a table (separation, arrangement, motion); in "explain" answers, name the particles **and** what they do (move faster, collide more often).

2 Practice

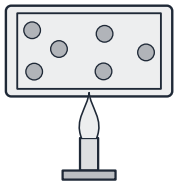
2.1 Name the change of state from gas to liquid and from solid to liquid. [2]

gas ⟶ liquid solid ⟶ liquid

2.2 Substance J melts at −39 °C and boils at 357 °C. State the physical state of J at 25 °C. Give a reason. [2]



2.3 A sealed metal container of gas has a fixed volume. The container is heated. State what happens to the pressure of the gas and explain why, in terms of particles. [3]



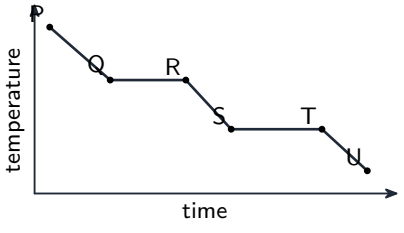
2.4 The plunger of a sealed gas syringe is pushed in. The temperature does not change. State what happens to the volume of the gas and explain why, in terms of particles. [2]



3 Exam-style questions

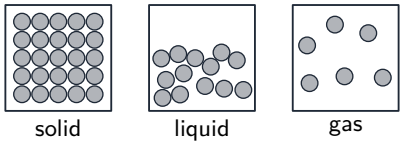
3.1 The graph is a cooling curve for a pure substance. Between which two points do the particles change from being able to move around each other to vibrating about fixed positions? [1]

☐ **A** P and Q
B Q and R
C R and S
D S and T



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3.2 The diagrams show the particles in the three states of matter.



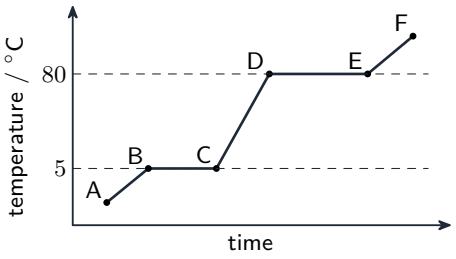
(a) Complete the table. [3]

state	particle separation	particle arrangement	particle motion
solid	touching		
liquid		random	
gas			random, fast

(b) Name each physical change. [3]

- liquid to solid
- gas to liquid
- a soluble solid to an aqueous solution

3.3 Substance X is heated at a steady rate from −20 °C. The graph shows its heating curve.



(a) Explain, in terms of particles and energy, why the temperature does not change between B and C. [2]

(b) Describe how the separation and the motion of the particles change between D and E. [2]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- gas to liquid: **condensation**
- solid to liquid: **melting**

2.2

- 25 °C is above the melting point and below the boiling point
- so J is a **liquid**

2.3

- the pressure **increases**
- the particles gain kinetic energy and **move faster**
- they **collide with the walls** harder and **more often**

2.4

- the volume **decreases**
- the particles are **pushed closer together**: there is a lot of space between gas particles

3.1

D

- S to T is the second flat section: the liquid **freezes**, so its particles move into fixed positions
- Q to R is condensation (gas to liquid), not freezing

3.2

(a) one mark for each correct row:

- solid: regular; vibrate about fixed positions
- liquid: touching; move around each other (slide past each other)
- gas: far apart; random

(b)

- liquid to solid: **freezing**
- gas to liquid: **condensation**
- soluble solid to aqueous solution: **dissolving**; dissolving is not melting

3.3

(a)

- X is **melting**

- the energy taken in is used to **overcome the forces of attraction** between particles, not to increase their kinetic energy

(b)

- separation: the particles go from **touching** to **far apart**
- motion: from moving around each other to moving **fast in all directions**