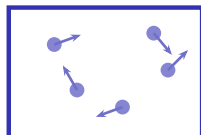


States of Matter

A-Level Chemistry ■ Topic 4

A-Level Chemistry



States of Matter

What we will cover

- 1 Gas pressure
- 2 Ideal gases
- 3 The ideal gas equation
- 4 The four structures
- 5 Diamond & graphite
- 6 Physical properties



boiling changes state

1 The gaseous state

Gas pressure

Pressure is the force from molecules hitting the walls.

more molecules

more hits per
second $\Rightarrow$ higher p

higher T

faster molecules
 $\Rightarrow$ harder hits

smaller V

hits more of-
ten $\Rightarrow$ higher p

Ideal gases

An **ideal gas** 理想气体 is a model: point particles, no attractions, elastic collisions.
Real gases approach it at **low pressure** and **high temperature** (far apart, moving fast).

The model fails when molecules take up a real volume (high p) or attract each other (low T).

The ideal gas equation

$$pV = nRT$$

Worked example

$$0.50 \text{ mol at } 27^\circ\text{C, } 100 \text{ kPa: } V = \frac{nRT}{p} = \frac{0.50 \times 8.31 \times 300}{1.00 \times 10^5} = 0.0125 \text{ m}^3$$

Convert first: $^\circ\text{C} \rightarrow \text{K}$ (+273), volume $\rightarrow \text{m}^3$. From

$$n = m/M: M = \frac{mRT}{pV} \text{ gives the molar mass 摩尔质量.}$$



Quartz

2 Structure

States of Matter
└ Structure

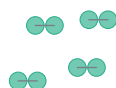
The four structures



giant ionic
NaCl: high m.p.,
conducts when molten



giant covalent
diamond, SiO₂: very
high m.p., insulating



simple molecular
I₂, ice: low m.p.,
weak forces between



giant metallic
copper: high m.p.,
conducts (solid + molten)

Four structures of a crystalline solid:

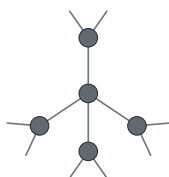
- **giant ionic** 离子晶体 – lattice of ions
- **simple molecular** 分子晶体 – small molecules
- **giant molecular** 原子晶体 – covalent network
- **giant metallic** 金属晶体 – ions in an electron sea

States of Matter
└ Structure

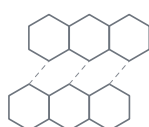
Diamond and graphite

Two giant covalent forms of carbon:

- **diamond** 金刚石 – a rigid 3-D network (very hard)
- **graphite** 石墨 – sliding layers & spare electrons that **conduct**



diamond
every C bonded to 4:
rigid 3D network, very hard



weak forces

graphite
layers slide; spare
electrons let it conduct

Physical properties

giant ionic 离子晶体 – high m.p.; conducts when molten/dissolved; soluble

simple molecular – low m.p.; does not conduct; low solubility

giant molecular – very high m.p.; no conduction (except graphite); insoluble

giant metallic – high m.p.; conducts (solid & molten); insoluble

Strong forces → high **melting point** 熔点; **conductivity** 导电性 needs mobile ions or delocalised electrons.

3

Recap

Topic 4 – key takeaways

1 Gas pressure

collisions with the walls add up

2 Ideal gas

$pV = nRT$; zero volume, no forces

3 Structures

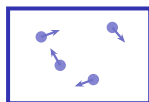
ionic, molecular, covalent, metallic

4 Properties

structure sets m.p., conductivity, solubility

Check yourself

- 1 Write the ideal gas equation.
- 2 When does a real gas behave least ideally?
- 3 Which giant covalent form of carbon conducts?
- 4 When does a giant ionic solid conduct electricity?



Answers 1. $pV = nRT$ 2. high pressure, low temperature 3. graphite 4. when molten or dissolved