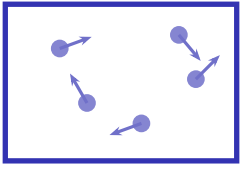
States of Matter

A-Level Chemistry ▪ Topic 4

A-Level Chemistry

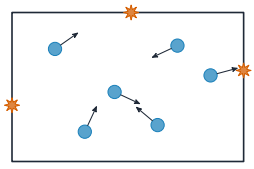


What we will cover

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

boiling changes state

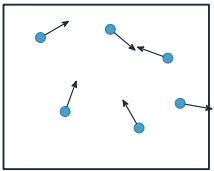
Gas pressure



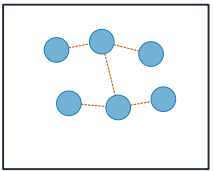
fast particles collide with the walls; the many pushes make the **pressure**

copper metal

Ideal gases



ideal gas (model)
point particles, *no* forces



real gas: high p, low T
real size + attractions (dashed)

diamond crystal

The ideal gas equation

$$pV = nRT$$

Worked example

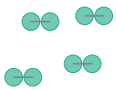
$0.50\,\text{mol}$ at $27\,^\circ\text{C}$, $100\,\text{kPa}$: $V = \dfrac{nRT}{p} = \dfrac{0.50 \times 8.31 \times 300}{1.00 \times 10^5} = 0.0125\,\text{m}^3$

Convert first: $^\circ\text{C} \to \text{K}$ $(+273)$, volume $\to \text{m}^3$. From $n = m/M$: $M = \dfrac{mRT}{pV}$ gives the **molar mass** 摩尔质量.

quartz

The four structures

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



simple molecular
I_2, ice: low m.p.,
weak forces between

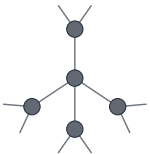
giant covalent
diamond, SiO_2: very
high m.p., insulating

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

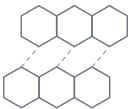
Four structures of a crystalline solid:

- **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

Diamond and graphite



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



graphite
layers slide; spare
electrons let it conduct

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

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.

Topic 4 – key takeaways

1 Gas pressure

collisions with the walls add up

2 Ideal gas

$pV = nRT$; zero volume, no forces

3 Structures

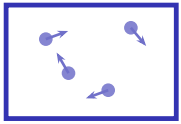
ionic, molecular, covalent, metallic

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