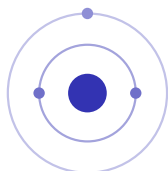


Atoms, Elements & Compounds

IGCSE Chemistry ■ Topic 2

IGCSE Chemistry



Atoms, Elements & Compounds

What we will cover

- 1 Elements, compounds & mixtures
- 2 Inside the atom
- 3 Electron shells & isotopes
- 4 Ionic bonding
- 5 Covalent & giant structures
- 6 Metallic bonding

1

Classifying matter

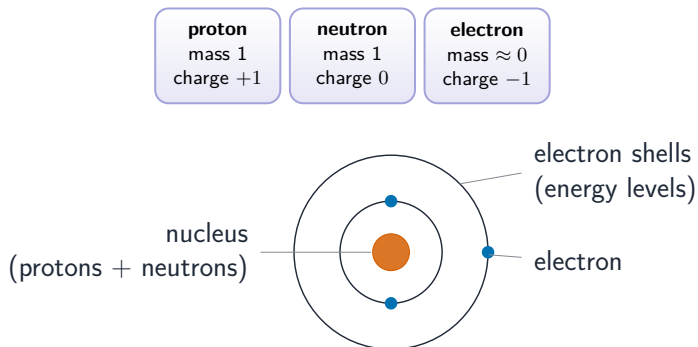
Elements, compounds and mixtures

An **element** 元素 is one type of atom. A **compound** 化合物 is two or more elements chemically bonded, in a fixed ratio. A **mixture** 混合物 is not bonded – it can be separated physically.

2 The atom

Inside the atom

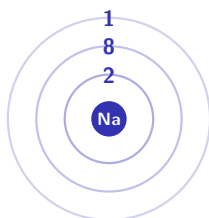
A tiny **nucleus** 原子核 of **protons** 质子 & **neutrons** 中子; **electrons** 电子 in **shells** 电子层 around it.



Two numbers, and electron shells

- **proton number** 质子数 = protons = which element
- **mass number** 质量数 = protons + neutrons
- neutrons = mass number – proton number

Shells fill from the inside: 2, then 8, then 8...



outer = 1 → Group I

3 shells → Period 3

Isotopes and relative atomic mass

Isotopes 同位素: same protons, different neutrons – same element, same chemistry.

$^{35}_{17}\text{Cl}$
18 neutrons

$^{37}_{17}\text{Cl}$
20 neutrons

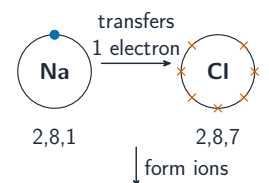
A_r is the weighted average mass.

$$A_r = \frac{(35 \times 75) + (37 \times 25)}{100} = 35.5$$

3

Bonding

Ionic bonding

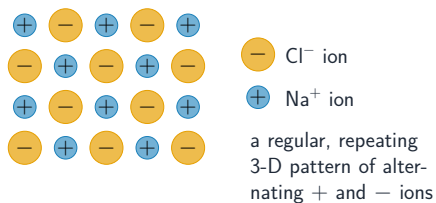


A metal **gives** electrons to a non-metal; both reach full shells.

- metal → positive **cation** 阳离子
- non-metal → negative **anion** 阴离子

An **ionic bond** 离子键 is the pull between + and - ions.

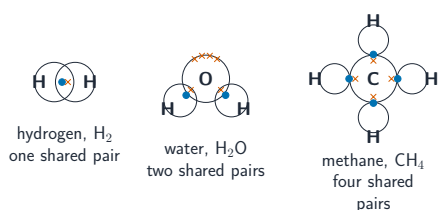
Ionic lattices and their properties



Ions pack into a giant **lattice** 晶格 of alternating + and -.

- **high** melting & boiling points
- solid: does **not** conduct (ions fixed)
- molten / aqueous: **does** conduct (ions free)

Covalent bonding

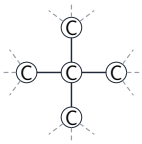


Non-metals **share** 共用 pairs of electrons in a **covalent bond** 共价键.

Simple molecules (H_2O , CH_4): **low** melting points (weak **intermolecular forces** 分子间作用力) & poor conductors.

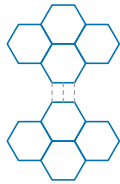
Giant covalent structures

diamond



each carbon bonded to **4** others: a hard 3-D network

graphite



flat layers of hexagonal rings (each C bonded to **3**); weak forces let the layers slide

Millions of atoms bonded into one network:

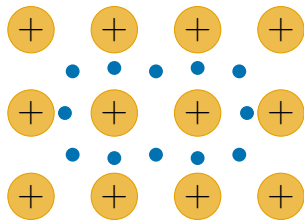
- **diamond** 金刚石 – 4 bonds each; very **hard**
- **graphite** 石墨 – 3 bonds, sliding **layers** 层; soft, conducts

Graphite's free electrons let it conduct.

Metallic bonding

Positive ions in a **sea of delocalised electrons** 离域电子海.

- **conducts** – free electrons carry charge
- **malleable** 有展性 & **ductile** 有延性 – layers slide



'sea' of **delocalised electrons**, free to move and carry charge

positive metal ions in a fixed lattice

4

Recap

Worked example – relative atomic mass

Chlorine is 75% ^{35}Cl and 25% ^{37}Cl . Find its relative atomic mass.

- Isotopes are atoms of the same element with different numbers of neutrons.
- A_r is the weighted average of the isotopes:
- $$A_r = \frac{(75 \times 35) + (25 \times 37)}{100} = \frac{2625 + 925}{100} = 35.5$$
- = 35.5 – which is why the value is not a whole number.

Isotopes have identical chemistry (same electrons), only different mass. Weight by abundance – never take a plain average of 35 and 37.

Topic 2 – key takeaways

1 Atom

nucleus of protons & neutrons;
electrons in shells

2 Isotopes

same protons, different neutrons;
 A_r averages

3 Ionic

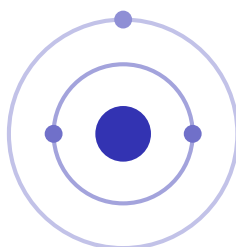
metal gives electrons; giant lattice

4 Covalent & metallic

shared pairs; ions in an electron sea

Check yourself

- How many neutrons are in $^{35}_{17}\text{Cl}$?
- What is the electronic configuration of sodium?
- Why does molten NaCl conduct but solid NaCl not?
- Why can metals be hammered into sheets?



Answers 1. 18 ($35 - 17$) 2. 2, 8, 1 3. molten ions are free to move 4. layers of ions slide over each other