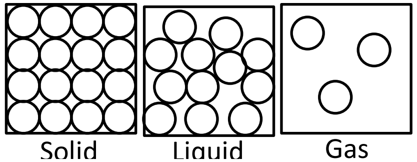
C3: Structure and Bonding



Melting and freezing happen at the **melting point**.
Boiling and condensing happen at the **boiling point**.
The stronger the forces between the particles the higher the melting and boiling point.

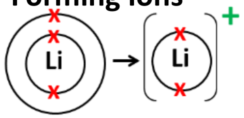
Limitations of the particle model

- No forces between the spheres
- Particles represented as spheres
- Spheres are solid

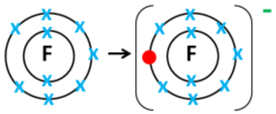
Fundamentals

- Atoms want full outer shells
- Max. configuration is 2,8,8
- Group number is the number of electrons on the outer shell.

Forming Ions

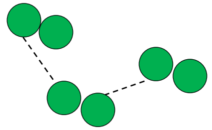


Metals always form **positive** ions (lose electrons).
A group 2 metal forms a 2+ ion (loses two electrons)



Non-metals form **negative** ions (they gain electrons).
Group 6 non-metals forms a 2- ion (gains 2 electrons)

Simple molecular covalent substances

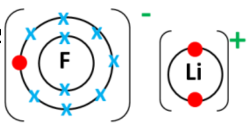


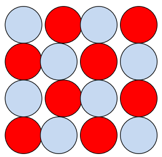
Two atoms of chlorine are held together by a very strong covalent bond.

There are very weak **intermolecular** forces between **molecules** of chlorine. This means they are easy to separate so molecular substances have low melting and boiling points.
There are no free electrons or charged particles so they do not conduct.

Ionic Bonding

Strong **electrostatic** forces hold ions of opposing charges together.
The ions form a giant lattice:

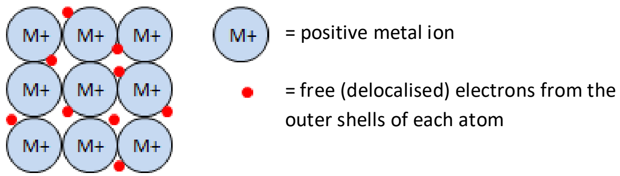




Ionic bonds are very strong so ionic compounds have very high melting points.

Metallic Bonding

Metals are made from **positive ions** held together by a sea of **delocalised electrons**.

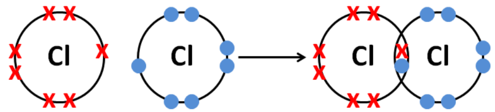


The strong electrostatic forces between the ions and electrons mean metals have very high melting points.

The free electrons are able to move so metals are good conductors of electricity and heat.

Covalent Bonding

Non-metal atoms bond by sharing electrons to form a very strong covalent bond.



Both chlorine atoms have 7 electrons on their outer shell, therefore need one more each.

They both share one electron to form a single covalent bond. Each chlorine now has a full outer shell (8 electrons).

Tips: Draw the shared e^- first. Sharing must be equal – if one atoms shares one e^-, the other atom must share one e^-. Then, count up the remaining e^- for each atom and put these around the outer shell.

Ionic Formula

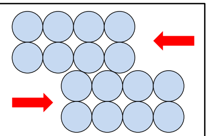
Group 1 form 1+ ions, group 2 form 2+ ions.
Group 7 form 1- ions, group 6 form 2- ions.

An ionic compound must have no overall charge.

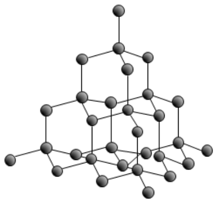
MgO: Mg is 2^+ and O is 2^-, so one of each needed
Li_2O: Li is 1^+ and O is 2^-, so two Li ions needed.

Metals are Malleable

The layers can slide over each other because the free electrons



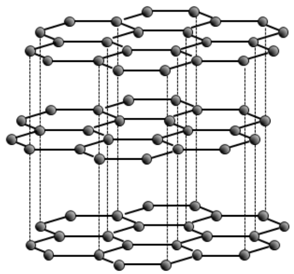
Giant Covalent Structures (Macromolecules)



Diamond

Each carbon atom is covalently bonded to **four** other carbon atoms.

As these bonds are very strong diamond has a very high melting point and is very



Graphite

Each carbon atom is covalently bonded to **three** other carbon atoms.

This means **layers** are formed and held together by intermolecular forces.

These are weak to the layers can slide over each other, making graphite soft and slippery.

Silicon dioxide (Silica)

A giant covalent structure of silicon and oxygen.

Sand is made from silica.

Bonding Overview

	Ionic	Simple Covalent	Giant covalent	Metallic
Formation	Positive and negative ions	Non-metal atoms sharing electrons to form a small molecule	Non-metal atoms sharing electrons to form a giant structure	Positive metal atoms held together by delocalised electrons
Melting/boiling point	High	Low (often gases at room temperature)	High	High
Conduct electricity and heat	Not as a solid Yes when molten	No	No (except graphite)	Yes

Nanoparticles

Have a diameter between 1nm and 100nm

Some of their uses are:

Fullerenes can be used to **carry drugs** into the body as they are easily absorbed due to their small size.

Silver nanoparticles have **antibacterial** properties so are used in surgical masks, wound dressings and deodorants.

Nanoparticles **block UV rays** so can be used in **suncream**.

Disadvantages

The effect on the body isn't fully understood.

The effect on the environment isn't fully understood.

Bulk and Surface Properties

Nanoparticles: 1-100nm

Fine particles: 100-2500nm

Coarse particles: $1x10^{-5}$m to $2.5x\ 10^{-6}$m

Nanoparticles have unique properties due to their large surface area:volume ration.

Each time the side of a cube decreases in size by 10x the SA:Vol ratio increases by 10x