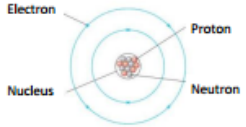
Chemistry: Atoms, Compounds and States of Matter

States of Matter

1. Solid to liquid state change is melting. Liquid to solid state change is freezing. Happens at the melting point.
2. Liquid to gas state change is boiling. Gas to liquid state change is condensing. Happens at the boiling point.
3. The amount of energy needed to change state from solid to liquid and liquid to gas depends on the strength of the forces between the particles of the substance.
4. The nature of the particles involved depends on the type of bonding and the structure of the substance.
5. The stronger the forces between the particles the higher the melting point and boiling point of the substance.
6. Particle model limited by the fact there are no forces, all particles are represented as spheres and that the spheres are solid.
7. States are represented by state symbols in chemical equations, (s), (l) and (g). (aq) for aqueous solutions.

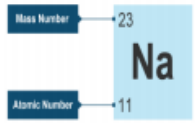
Atomic Structure

Atoms Atoms are tiny, too small to see. They have a radius of 0.1 nanometres (1×10^{-10} m)
Atoms have no charge because they have the same number of **protons** and **electrons**.



Type of sub-atomic particle	Relative charge	Relative mass
proton	+1	1
neutron	0	1
electron	−1	very small (it would take almost 2000 electrons to have the same mass as one proton or neutron)

Electron
Orbit around nucleus in shells
Proton
Found in the nucleus
Neutron
Found in the nucleus



Mass Number : protons + neutrons
Atomic number: Protons

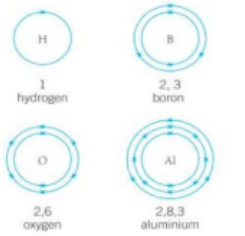
Ions

Ions An **ion** is an atom that has lost or gained electrons.
In an **ion** the number of protons is not equal to the number of **electrons** so the atom has an overall charge.

Electron Configuration

Electronic Structure

- 1st **shell**– Lowest energy level and can hold 2 **electrons**
- 2nd **shell**– Energy level can hold up to 8 **electrons**
- 3rd **shell** onwards– Can hold up to 8 **electrons**.



Electron structure and the **periodic table**
Elements in the same **group** have the same number of **electrons** on their outer **shell.**

Proton number = **Electron** Number
Number of **neutrons**=
Mass number—Atomic number

Electron Configuration

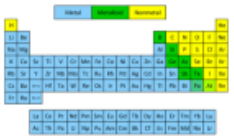
The arrangement of the periodic table has changed.

Early 1800s
- Arranged by **relative atomic mass**.
- Scientists had not yet discovered protons, neutrons or electrons.
- There were gaps for missing elements that had not been found yet.

Dmitri Mendeleev
- Ordered mainly by **atomic mass**.
- Elements with similar properties in the same **group**.
- Gaps left for **elements** that hadn't been found yet.

Modern Day
- In order of increasing **atomic mass**.
- Repeating patterns in the properties of the **elements**.
- **Metals** are on the left and **non– metals** are on the right.

You will need to know the first 20 **element** names and their **symbols**

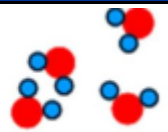


Properties of **metals** - **Ductile** - **Malleable**
- High **melting** and **boiling** point
- **Conduct** heat - **Conduct** electricity

Properties of **non- metals** - **Brittle**
- **Insulators** of heat and electricity
- **Not** always **solids** - lower **density**

Compounds

- Have a fixed composition
- Can be separated by a **chemical reaction**
- Chemical **bonds** between **atoms**



Key Vocabulary

Ionic bond – the electrostatic force of attraction between positively and negatively charged ions.
Dot and cross diagram – a drawing to show only the arrangement of the outer shell electrons of the atoms or ions in a substance.
Covalent bond – the bond between two atoms that share one or more pairs of electrons.
Metallic bond –
Alloy – a mixture of two or more elements, at least one of which is a metal.
Delocalised electrons – bonding electron that is no longer associated with any one particular atom.
Fullerene – form of the elements carbon that can exist as large cage-like structures, based on hexagonal rings of carbon atoms.
Giant covalent structure – a huge 3D network of covalently bonded atoms.
Giant structure/lattice – a huge 3D network of atoms or ions.
Polymer – a substance made from very large molecules made up of many repeating units.

Equations

Chemical reactions are shown using:
- **Word equations**

Magnesium + Oxygen ⟶ *Magnesium Oxide*
(reactants) *(product)*

- ***Symbol equations***—*Show the **atoms** on both sides*

$2Mg + O_2 \longrightarrow 2MgO$

Balancing equations:
- There must always be the same number of **atoms** on both sides of a **symbol equation**.
- Atoms can't just disappear.
- You **balance** equations by putting numbers **in front** of the number.

$CH_4 + 4Cl_2 \longrightarrow CCl_4 + 4HCl$

C = 1 C = 1
H = 4 H = 4
Cl = 8 Cl = 8

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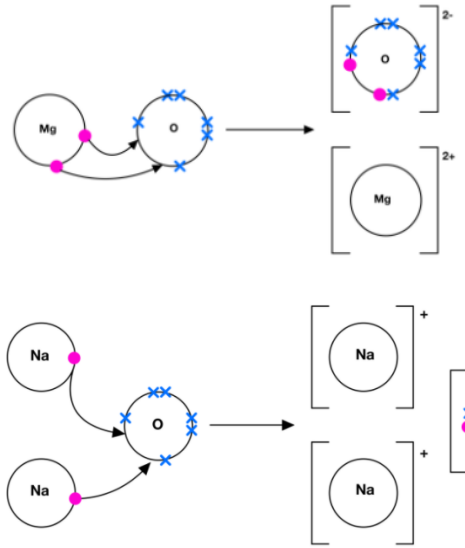
Ionic bonding

Ionic Bonding

Bonds between metal positive ions and non-metal negative ions.
The outer-shell electron of the metal ion transfers to the non-metal ion.
Can be represented with dot and cross diagrams.

Ionic Compounds

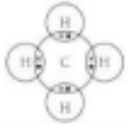
Ionic compounds are held together by strong forces of attraction between their oppositely charged ions.
These forces act in all directions in the compound.
Giant regular structure of ions.
They have high melting and boiling points, due to large amounts of energy being needed to break the strong bonds.
When melted or dissolved in water, ionic compounds conduct electricity due to free moving ions.



Covalent Bonding

Covalent Bonding

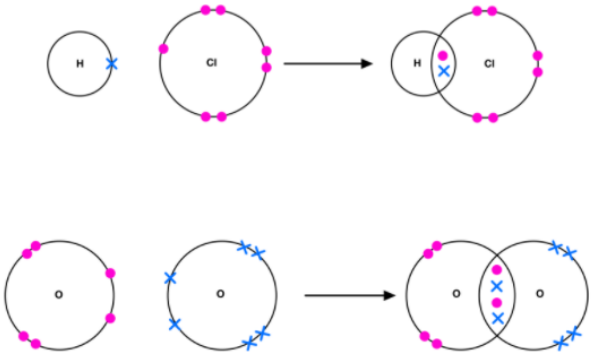
Between non-metal atoms.
Atoms share pairs of electrons.



dot and cross diagram (showing outer shells as circles)

Small Covalent Molecules

Gases or liquids with low melting and boiling points.
Weak intermolecular forces that break when the substance melts or boils.
Intermolecular forces increase with the size of the molecules.
Do not conduct electricity.
Examples – water, ammonia, carbon dioxide



Metallic Bonding

- Metallic Bonding

Giant structures of atoms arranged in a regular pattern.
Delocalised outer shell electrons are free to move through the whole structure.
Sharing of delocalised electrons gives rise to strong metallic bonds.