Topic 2 AQA Chemistry- Bonding, structure, and the properties of matter

- Triple Science Content only in purple
- Triple Science and Higher Content Only in blue

States of matter-

Solid	**Liquid**	**Gas**
Symbol - (s)	Symbol - (l)	Symbol - (g)

Polymers-

- Large molecules
- Contain **strong** covalent bonds
- Strong intermolecular bonds meaning high melting and boiling point

Small Molecules-

- Have **weak intermolecular**
- Therefore **low** boiling and melting points
- Larger the molecule, stronger the intermolecular forces

Giant Covalent Structures-

- Giant structures with **strong covalent** bonds
- Therefore **high** melting and boiling points
- E.g Diamond

Properties of metals, alloys, and metals as conductors-

- Most metals have **high melting and boiling points**
- **Particles in metals are the same size** so they can slide over each other making them bendy
- Alloys are a mixture with 2 or metals
- Particles are **different sizes** so the metal is less bendy/malleable and can't slide over each other.

- Metals are **good conductors of electricity due to their delocalised electrons** so can carry an electrical charge
- Also good heat energy conductors as heat is transferred by delocalised electrons.

Chemical bonds and types of bonding

Chemical bonds

Compounds - substances in which 2 or more elements are chemically combined.

- There are 3 types of chemical bonds: ionic, covalent and metallic.

Ionic	**oppositely charged ions -** forms electrostatic attraction Occurs in **metals(+) combined with non-metals(-)**
Covalent	Atoms which **share pairs of electrons** Occurs in **nonmetals**
Metallic	Atoms which **share delocalised electrons -** forms electrostatic attraction Occurs in metals

Ionic bonding

Metal + Non-metal: electrons in the outer shell of the metal atom are transferred

- Metal atoms lose electrons to become positively charged ions

- Non-metal atoms gain electrons to become negatively charged ions

- Join through an electrostatic force of attraction

- An ion is an atom that has lost or gained electron(s).

Ionic compounds and their properties

-Contain **strong electrostatic forces of attraction**

-between oppositely charged ions

-An example is sodium chloride (salt):
- Na+ (positive charge) and Cl- (negative charge)
- high melting and boiling points
When melted or dissolved in water they can conduct electricity.

Covalent bonding

-atoms share one or more pairs of electrons.
-such as: HCl, has strong covalent bonds
-Giant **covalent structures** (macromolecules) consist of many atoms covalently bonded in a lattice structure e.g. diamond
-Can use Dot and Cross Diagrams to show this.

Metallic bonding

-The bonding in a metal consists of **positive ions** (atoms that have lost electron(s) and delocalised electrons.
-The **delocalised electrons are free** from the atoms to form positive metal ions.
-The delocalised electrons are electrostatically attracted to the positive ions in the metal, making it strong.

Diamond

- In diamond , **each carbon is joined to 4** other carbons covalently bonded together.
- It's **hard and has a high melting point** and does not conduct electricity.

Graphite

- Each carbon is covalently **bonded to 3 other carbons,** forming layers which have weak intermolecular bonds between.
- The layers **can slide over each other**, meaning that graphite is **soft and slippery.**
- One electron from each carbon atom is **delocalised.**
- Therefore it can conduct **electricity**.

***Graphene and fullerenes* - Graphene**

- Single layer of graphite
- this makes it useful in **electronics**

- Very strong because atoms within the layers are very tightly bonded.

- Elastic as atoms can flex **without the atoms breaking apart**.

● Carbon can also form fullerenes -

- They are molecules **made up of carbon atoms** and have hollow shapes

- They are based on hexagonal rings of carbon atoms
- The first fullerene to be discovered was Buckminsterfullerene (C60)

Graphene and fullerenes - Graphene

- **Carbon nanotubes-**

- Cylindrical fullerenes .
- Useful for nanotechnology, electronics and materials

- Examples of uses

- They can be used as lubricants to deliver drugs in the body and catalysts.

- Nanotubes can be used for reinforcing materials, for example tennis rackets.

Bulk and surface properties of matter including nanoparticles

Nanoparticles

- 1-100 nanometers across.

- Coarse particles (dust) have diameters between 1 x 10^-5 m and 2.5 x 10^-6 m.

  - compared to the same material in bulk.

- **Properties of Nanoparticles:**
  - **Large surface area to volume ratio:** Makes them more **reactive** than larger particles.
  - Can have **different optical, electrical, and chemical properties**.
  - Can penetrate cells and materials more easily due to their small size.

Uses of Nanoparticles

1. **Medicine**
   - **Targeted drug delivery:** Nanoparticles can carry drugs directly to **diseased cells**, reducing side effects.
   - **Antibacterial properties:** Silver nanoparticles are added to wound dressings and coatings to **kill bacteria**.
2. **Electronics**
   - Used in **tiny electronic components** for faster, smaller devices (e.g., transistors, sensors).
3. **Cosmetics**
   - Nanoparticles in **sunscreens** absorb or reflect UV light more effectively without leaving a white residue.
4. **Catalysis**
   - Some nanoparticles (like platinum or gold) act as **efficient catalysts** in chemical reactions due to their large surface area.
5. **Clothing and materials**
   - Nanoparticles in fabrics can make clothes **waterproof, stain-resistant, or antibacterial**.

Advantages

- Can improve **effectiveness** and efficiency of products.
- Reduce **waste** and **material usage** due to small size and high surface area.
- Enable **new technologies** (medicine, electronics).

Concerns / Risks

- **Toxicity:** Some nanoparticles may enter cells and **cause harm**.

- **Environmental impact:** Can accumulate in water or soil, affecting wildlife.
- **Unknown long-term effects:** Nanotechnology is still new, so long-term safety is uncertain.