2 Structure and Bonding

Covalent bonding

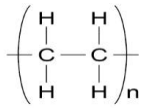
•Formed between and **metal** and a **non metal**.

Simple molecules

•These are usually gases or liquids that have relatively **low** melting points and boiling points.
•They have only **weak** forces between the molecules (intermolecular forces). It is these intermolecular forces that are overcome, not the covalent bonds, when the substance melts or boils.
•The intermolecular forces increase with the size of the molecules, so larger molecules have **higher** melting and boiling points.
•These substances **do not** conduct electricity because the molecules do not have an overall electric charge.

Polymers

•Polymers can be represented in the form: where n is a large number.



poly(ethene)

•Polymers have very large molecules. The atoms in the polymer molecules are linked to other atoms by strong **covalent bonds**. The intermolecular forces between polymer molecules are relatively strong and so these substances are **solids** at room temperature.

Giant covalent

•Giant covalent structures are solids with very **high** melting points.
•All of the atoms in these structures are linked to other atoms by strong covalent bonds.
•These bonds must be overcome to melt or boil these substances. Diamond and graphite (forms of carbon) and silicon dioxide (silica) are examples of giant covalent structures.

Carbon

•In diamond, each carbon atom forms **four** covalent bonds with other carbon atoms in a giant covalent structure, so diamond is very **hard**, has a **very high melting point** and **does not conduct** electricity.
•In graphite, each carbon atom forms **three** covalent bonds with three other carbon atoms, forming layers of hexagonal rings which have no covalent bonds between the layers.
In graphite, one electron from each carbon atom is delocalised so it CAN conduct electricity.
•Graphene is a **single layer** of graphite and has properties that make it useful in electronics and composites.
• Fullerenes are molecules of carbon atoms with hollow shapes. The structure of fullerenes is based on hexagonal rings of carbon atoms.
•Carbon nanotubes are cylindrical fullerenes with very **high length to diameter ratios**. Their properties make them useful for nanotechnology, electronics and materials.

Definitions

Ion - Elements that have lost or gained electrons.
Cation – positively charged ion.
Anion – negatively charged ion.
Covalent bond – a shared pair of electrons.
Ionic bond – The electrostatic attraction between a positive and negative ion.
Metallic bond – the electrostatic attraction between the positive atom and the delocalised electrons.

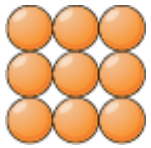
Ionic bonding

•Formed from metals combined with non-metals.
•When a metal atom reacts with a non-metal atom, 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.

Giant ionic

•Ionic compounds have regular structures (giant ionic lattices) in which there are strong electrostatic forces of attraction in all directions between oppositely charged ions.
•They have high melting points and high boiling points because of the large amounts of energy needed to break the many strong bonds.
•When melted or dissolved in water, ionic compounds conduct electricity because the **ions** are free to move and so charge can flow.

Solid

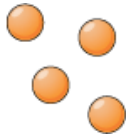


Particles can only **vibrate** around a **fixed position**. Particles are closely packed in a regular arrangement.

Liquid

Particles are **closely packed** in an **irregular arrangement**. Particles are able to move relative to each other.

Gas



Particles are widely spread in **a irregular arrangement**. They move in **random directions** with a **range of speeds**.

Metallic bonding

•Occurs in metallic elements and alloys.
•Metals consist of giant structures of atoms arranged in a regular pattern.
•The electrons in the outer shell of metal atoms are **delocalised** and so are free to move through the whole structure.
•Metals have giant structures of atoms with strong metallic bonding.
•This means that most metals have **high** melting and boiling points.
•In pure metals, atoms are arranged in layers, which allows metals to be bent and shaped.
•Pure metals are too soft for many uses and so are mixed with other metals to make alloys which are harder..
•Metals are **good conductors of electricity** because the delocalised electrons in the metal carry electrical charge through the metal.
•Metals are **good conductors of thermal energy** because energy is transferred by the delocalised electrons.

•Melting and freezing take place at the **melting point**, boiling and condensing take place at the **boiling point**.
•The **stronger** the forces between the particles, the **higher** the melting point and boiling point of the substance.
•In equations solid is (s), liquid is (l), gas is (g) and aqueous solution is (aq).
•**(HT)** Limitations of the simple model include:
•that there are no forces between the spheres,
•that all particles are represented as spheres
•that the spheres are solid.