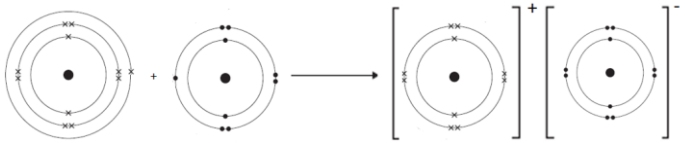
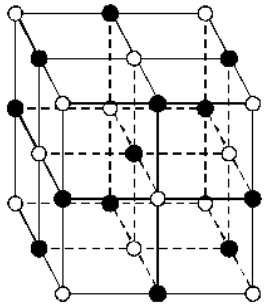
When a metal and a non-metal react together, the metal atom loses electrons and becomes a positive ion. The non-metal atom gains electrons and becomes a negative ion.

Ionic compounds are held together by strong electrostatic forces of attraction between oppositely charged ions. This is called **ionic bonding**.



Dot and cross diagrams show how ionic bonds form but they don't show the structure, size or arrangement of the ions.

Ionic compounds arrange themselves in a giant **lattice**.



A lattice diagram shows the 3D structure of the ions and bonds, but doesn't show the distance between the ions or the relative sizes of the ions.

Ionic compounds have **high melting and boiling points** because it takes a lot of energy to overcome the many strong ionic bonds in the lattice.

Ionic compounds **cant conduct electricity when solid** because the ions are fixed and cannot move.
Ionic compounds **can conduct electricity when molten or dissolved in water** because the ions can move and carry an electric current.

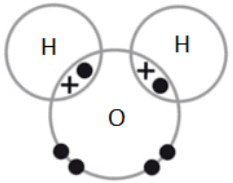
The higher the charge on the ions, the **stronger** the ionic bond. $MgCl_2$ has a higher melting point than NaCl because it contains an Mg^{2+} ion (whereas NaCl contains an Na^+ ion) hence $MgCl_2$ has a stronger ionic bond.

When non-metals bond together, they share electrons forming **covalent bonds**.

A **covalent bond** is the electrostatic attraction between the positively charged nuclei of the bonded atoms and the electrons shared between them.

Atoms only share electrons in their outermost shells. Atoms share electrons to gain a full outermost shell, by doing so they have the configuration of a noble gas which gives them stability.

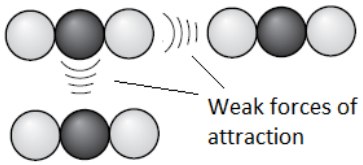
Simple covalent molecules are made up of a few atoms covalently bonded together. For e.g., H_2, F_2, H_2O, CH_4, CO_2, NH_3 etc.



Covalent dot and cross diagrams show which atoms the electrons have come from but don't show relative size of atoms or their arrangement in space.

A single covalent bond contains one shared pair of electrons. A double covalent bond contains four electrons (2 shared pairs of electrons.)

Simple covalent molecules have **low melting points and boiling points** and are gases or liquids at room temperature. This is because there are only **weak intermolecular forces of attraction** between molecules which don't need much energy to overcome.



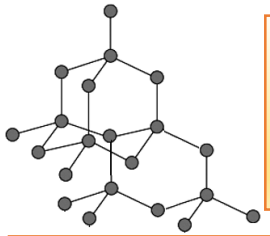
Structure and bonding – Knowledge organiser

The **bigger the molecule** the more electrons there are, hence **the greater the weak forces of attraction**. Hence melting and boiling points increase as more energy is required to overcome the weak forces of attraction.

Simple covalent molecules cannot conduct electricity because the electrons are fixed in strong covalent bonds.

In Giant covalent compounds, all the atoms are bonded via strong covalent bonds in a giant lattice structure.

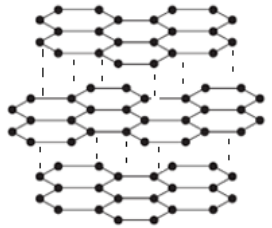
Giant covalent compounds have very high melting and boiling points because it takes a lot of energy to break the millions of strong covalent bonds.



In Diamond, each **C is bonded to 4 other carbons** in a tetrahedral arrangement. This makes it **very hard**.

Diamond cannot conduct electricity as it's electrons are fixed in strong covalent bonds.

Graphite contains layers of hexagons with each carbon having 3 bonds. The extra electrons become delocalised between the layers.



Graphite can conduct electricity because the **delocalised electrons can move** and carry an electric current.

Graphite's layers of hexagons are held in place by weak forces of attraction.

Graphite has a **high melting and boiling point** because the covalent bonds within the layers require a lot of energy to break.

Graphite is soft and slippery because the layers can slide.

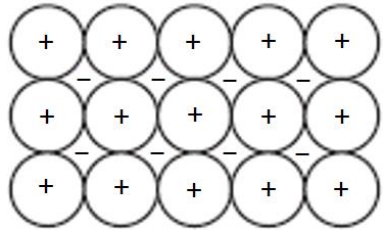
Graphene is one layer of graphite that is one atom thick.

Graphene is strong, light and can conduct electricity because it contains delocalised electrons.

Fullerenes are cage like structures and tubes which also contain hexagonal rings.

Fullerenes form incredibly thin cylinders with a high tensile strength. Can be used for drug delivery in the body, lubricants, catalysts (large surface to volume ratio) and in electronics.

Metals consist of a giant metallic structure.



Metals consist of a lattice of **positive ions** surrounded by a **sea of delocalised electrons**.

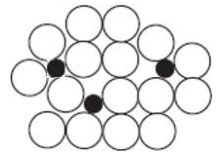
The metallic bond is the attraction between the positive ions and sea of delocalised electrons.

Metals **conduct** electricity because the delocalised electrons are free to move and carry a charge.

Metals **have high melting and boiling points** because it takes a lot of energy to break the strong metallic bonds.

Metals are **malleable** and **ductile** because the layers of ions can slide over each other.

Alloys are a mixture of two or more metals or a non-metal and a metal. Steel is an alloy of iron and carbon.



Alloys are harder than pure metals because the different sized atoms distort the layers making it harder for them to slide.