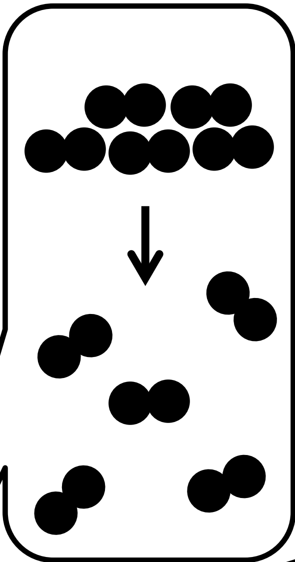
MOLECULAR

Non-polar molecules are usually soluble in **non-polar solvents** such as cyclohexane. Since both molecules have similar weak intermolecular forces between them, then weak forces can also exist between the two different molecules. (Like dissolves like).

Particles are MOLECULES

Molecules may be polar or non-polar.



Molecular solids are made of molecules. There are **weak intermolecular forces** or van der Waals forces (forces BETWEEN molecules) holding the molecules together, and they require a small amount of energy to be overcome. This means the substances have low melting and boiling points.

Since the weak van der Waals forces allow the molecules to be easily separated this makes them soft or brittle - easy to break the solid.

Polar molecules are usually soluble in **polar solvents** such as water. Since both types of molecules have similar weak intermolecular forces between them, then weak forces can also exist between the two different molecules. (Like dissolves like).

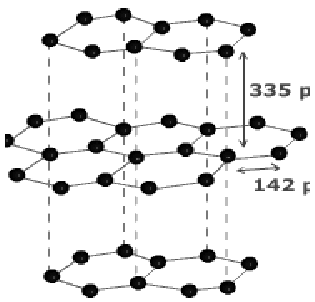
IMPORTANT

There are strong covalent bonds between the atoms in the molecules (**intramolecular forces**) but it is NOT these that are being broken when the solids melts or the liquid boils.

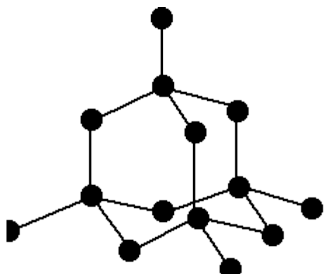
Molecular solids are made of **molecules** in which the atoms are covalently bonded to each other. They **do not contain mobile charged particles** (no free electrons or mobile ions). Therefore molecular substances cannot conduct in the solid or liquid state.

COVALENT NETWORK

Graphite consists of C atoms each covalently bonded to 3 other C atoms (in a trigonal planar shape) in a 2D arrangement, forming layers with weak van der Waals forces between them. The weak attractions between the layers of atoms in graphite are easily broken. Therefore, graphite is soft and slippery and the layers can slide over each other. This makes it useful as a lubricant.



Particles are ATOMS

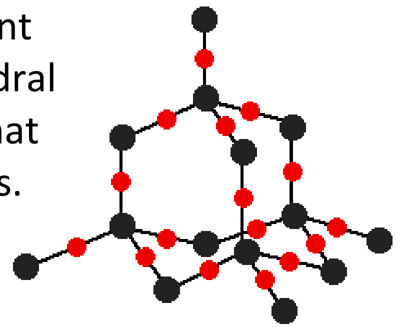


Diamond is made of carbon atoms. Each carbon atom is covalently bonded to 4 other C atoms in a tetrahedral arrangement, which forms a covalent network solid. The covalent bonds between the carbon atoms are very strong and require a large amount of energy – explaining diamonds strength and high melting point.

In order to melt covalent network substances strong covalent bonds between atoms must be broken. Because of their strength, a lot of energy is required to break these bonds and separate atoms. Therefore diamond, graphite and SiO_2 all have high melting points.

In graphite (solid) each carbon atom is covalently bonded to 3 others. This leaves one electron that is delocalised and is free to move. Because this electron is free to move, it carries charge and so graphite conducts electricity.

Silicon dioxide, SiO_2, consists of silicon and oxygen atoms held together by covalent bonds in a tetrahedral arrangement, so that a 3D network exists.



IONIC

Ionic solids are made of positive ions and negative ions, held together by strong **electrostatic attractions** in a 3–D lattice structure. As these electrostatic attractions (ionic bonds) are strong, they require a large amount of energy to overcome them so their melting and boiling points are high.

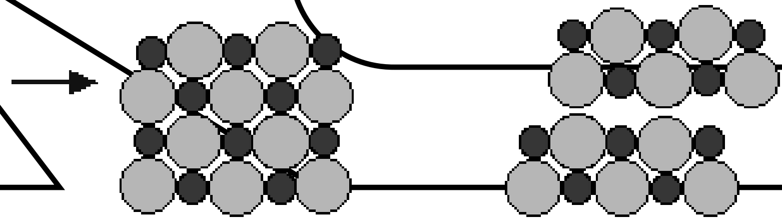
Particles in ionic solids are **IONS**

Bonding in ionic solids is **IONIC**

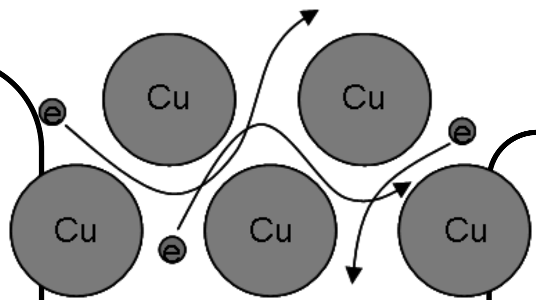
Solid ionic substances are a 3D lattice of ions held together by strong ionic bonds. These forces hold the ions in a fixed position.
As the ions cannot move, the solid will not conduct electricity.
When melted (or dissolved in water) the ions become free to move, and this allows the liquid to conduct electricity.

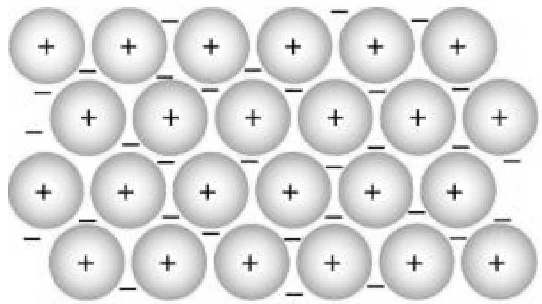
Ionic solids are soluble in water as the ions are separated from the lattice due to attraction towards the polar water molecules which is sufficient to pull the ions from the lattice.

Molecules of a non–polar solvent like cyclohexane are not attracted towards the ions and so ionic solids are insoluble in this.



The bonds within ionic solids are directional so they are not malleable or ductile. Instead they are brittle. If oppositely charged ions are forced to shift position then like charges are lined up and repel, causing the crystal to shatter.





METALS

Particles in metals

ATOMS

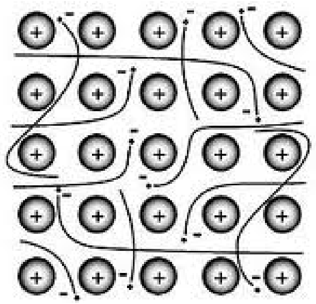
Bonding in metals

METALLIC

Many metals are hard and strong, and have high melting and boiling points as there is a strong attraction to overcome between the valence electrons and the nuclei of neighbouring atoms.

Metal atoms are held together in a 3–D lattice by metallic bonding, in which loosely held valence electrons are attracted to the neighbouring ions. (Metal cations in a sea of delocalised electrons). The valence electrons are free to move throughout the structure in both the solid and liquid state. This is why metals are good conductors of electricity (and heat).

Metals are not soluble in water, as the metallic bonds are too strong to be broken by the attraction to the water molecules.



The attraction of the metal atoms for the valence electrons is not in any particular direction (a non-directional force), therefore metal atoms can move past one another (without breaking the metallic bond and disrupting the structure and breaking the metal), and so metals are both malleable and ductile.