Chemical bonds

There are three types of strong chemical bonds: ionic, covalent and metallic.

IONIC	COVALENT	METALLIC
For ionic bonding the particles are oppositely charged ions. Ionic bonding occurs between metals and non-metals.	For covalent bonding the particles are atoms which share pairs of electrons. Covalent bonding occurs in non-metals.	For metallic bonding the particles are atoms which share delocalised electrons. Metallic bonding occurs in metallic elements and alloys.

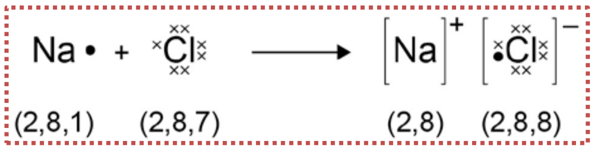
Ionic bonding

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.

The ions produced by metals in Groups 1 and 2 and by non-metals in Groups 6 and 7 have the electronic structure of a noble gas (Group 0).



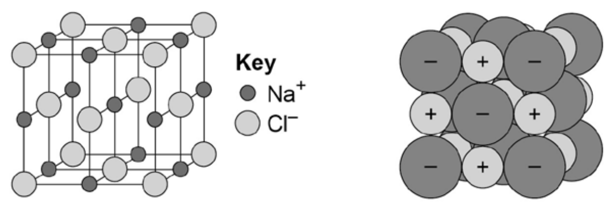
Ionic compounds

Ionic compounds are held together by strong electrostatic forces of attraction between oppositely charged ions.

These forces act in all directions in the lattice and this is called ionic bonding.

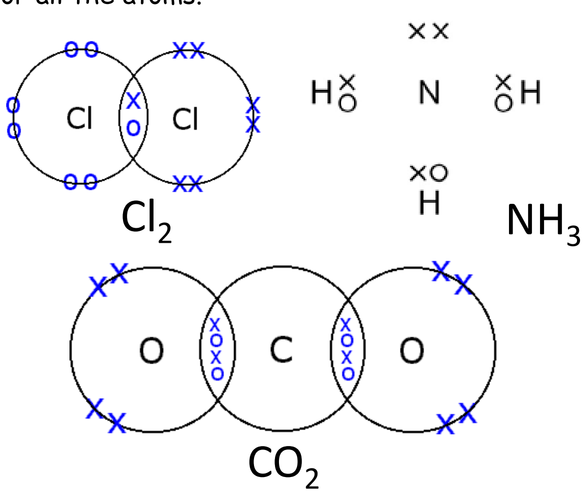
They have high melting and boiling points due to the strong forces of attraction in all directions holding the ions together.

They also conduct electricity when molten or dissolved in water as the ions are free to move so the charge can flow.

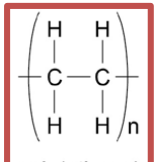


Covalent Bonding

Covalent bonds happen where two or more non-metal elements make a bond. These bonds share electrons, therefore completing the outer shell for all the atoms.



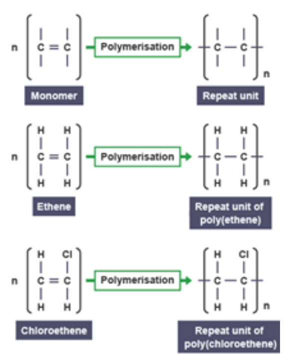
Polymers



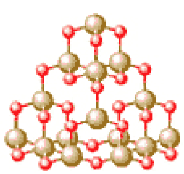
poly(ethene)

Polymers have very large molecules, with the atoms in polymer molecules linked to other atoms by strong covalent bonds. They are ,made by joining thousands of small identical molecules together (monomers). The monomers are often alkene molecules (e.g. ethene). The intermolecular forces between polymer molecules are relatively strong so they are solid at room temperature

By changing the monomer used, we can change the properties of the polymer formed.



Giant Covalent Structures 1



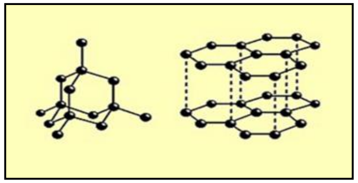
Silicon dioxide (silica)

Each silicon atom is covalently bonded to four oxygen atoms. Each oxygen atom is covalently bonded to two silicon atoms. This means that, overall, the ratio is two oxygen atoms to each silicon atom, giving the formula SiO_2.

Silicon dioxide is very **hard**. It has a very **high melting point** (1,610 °C) and **boiling point** (2,230 °C), is insoluble in water, and does not conduct electricity. These properties result from the very strong covalent bonds that hold the silicon and oxygen atoms in the giant covalent structure.

AQA Science A: Bonding, structure and the properties of matter

Giant Covalent Structures 2



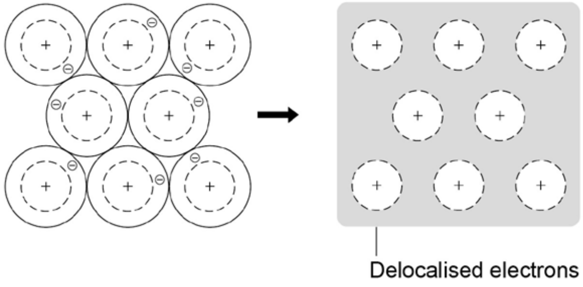
Diamond and graphite are both allotropes of carbon.

In Diamond each carbon atom is bonded to four other carbon atoms by very strong covalent bonds and therefore has no free electrons. The four strong covalent bonds give diamond a very high melting point.

In Graphite each carbon is bonded to 3 carbon atoms with weak intermolecular forces between the layers, which allows the layers to easily slide over each other. They also have a delocalised electron which allows graphite to conduct electricity. Graphite is used in lubricants as the layers can slide.

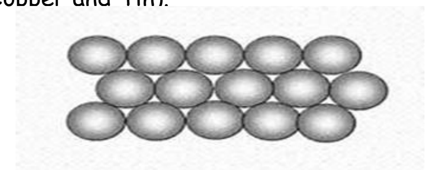
Metallic Bonding

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. The sharing of delocalised electrons gives rise to strong metallic bonds.



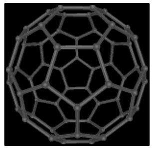
Giant Metallic Structures

Metals also form alloys. In alloys they contain at least two different types of atom which distorts the rigid regimented structure of the metal. As the layers are unable to slide over each other this causes metal alloys to be much stronger than the pure metals. Examples of alloys include Bronze (Copper and tin), Steel (Iron and Carbon) and Bronze (Copper and Tin).



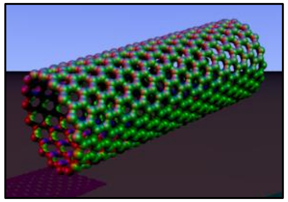
Giant Covalent Structures 3

Fullerenes are molecules of carbon atoms with hollow shapes, based on hexagonal rings of carbon atoms but they may also contain five or seven carbon atoms. Buckminsterfullerene C_{60} was the first to be discovered.



Carbon nanotubes are cylindrical fullerenes with high length to diameter ratios, this makes them useful for nanotechnology, electronics and materials.

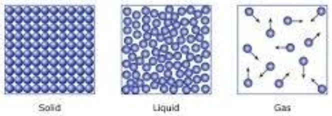
Fullerenes are often good lubricants due to their ability to roll.



Particle Model

The particles in a solid are tightly packed together and can only vibrate. They cannot be pushed any closer together.

The particles in a liquid are in contact with each other, but are arranged randomly. They can roll over each other, that is why a liquid can be poured.



The particles in a gas can move around freely. There are large spaces between the particles, so they can be pushed closer. This is why a gas can be compressed

In melting and boiling the strength of the forces between particles becomes less due to the increased kinetic energy, resulting in more space between the particles and more random arrangement

Nanoparticles (TRIPLE)

Unit name	Unit symbol	Meaning
gigametre	Gm	one billion metres
megametre	Mm	one million metres
kilometre	km	one thousand metres
metre	m	one metre
millimetre	mm	one thousandth of a metre
micrometre	μm	one millionth of a metre
nanometre	nm	one billionth of a metre

Nanoscience refers to structures that are 1^{-100} nm in size, of the order of a few hundred atoms.

Nanoparticles, are smaller than fine particles (PM2.5), which have diameters between 100 and 2500 nm (1×10^{-7} m and 2.5×10^{-6} m).

Coarse particles (PM10) have diameters between 1×10^{-5} m and 2.5×10^{-6} m. Coarse particles are often referred to as dust.

Nanoparticles may have properties different from those for the same materials in bulk because of their high surface area to volume ratio. It may also mean that smaller quantities are needed to be effective than for materials with normal particle sizes.

As the side of cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of 10.