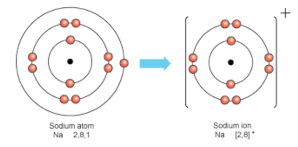
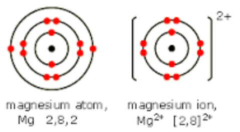
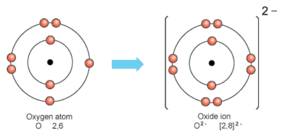
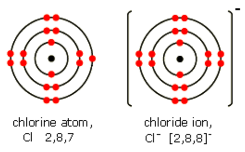
C2 Bonding Structure

1. Formation of ions based on the periodic table

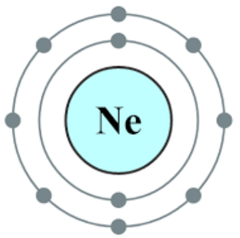
Ions – are charged particles formed from the gaining or losing of outer electrons.

Metal atoms LOSE outer electrons they become POSITIVELY charged

Non- metal atoms GAIN outer electrons they become NEGATIVELY charged.

	Group 1 metals LOSE 1 electron BECOME 1+ ion
	Group 2 metals LOSE 2 electrons BECOME 2+ ion
	Group 6 non-metals GAIN 2 electrons Become 2- ions
	Group 7 non-metals GAIN 1 electron Become 1- ions

All atoms do this to gain the electronic configuration of the noble gas (group 0) of:



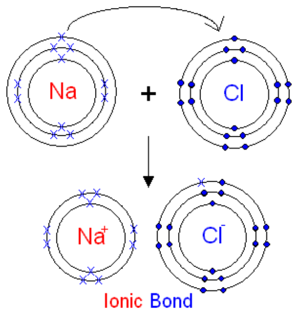
2. Ionic Bond

Metal – donates outer electrons

Non-metal – receives outer electrons **to gain a full outer sell.**

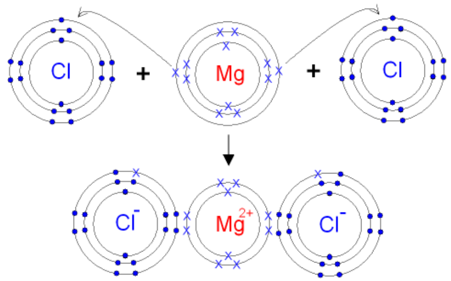
When a metal atom reacts with a non-metal atom electrons in the outer shell of the metal atom are **transferred.**

Making sodium chloride



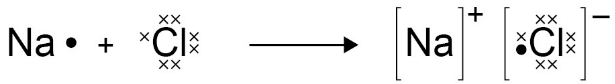
Formula - NaCl

Making magnesium chloride



Magnesium needs to lose 2 outer electrons. Each chlorine receives an outer electron to give the Formula $MgCl_2$

The electron transfer can be represented by simple dot and cross diagrams.

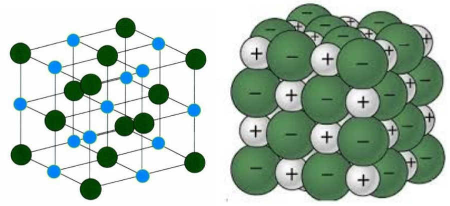


(2,8,1) (2,8,7) (2,8) (2,8,8)

3. Properties of ionic compounds

Remember **to gain higher marks you need to link the property of the compound to its bonding and structure.**

The structure of sodium chloride can be shown as:



Regular structure (giant ionic) produced by strong electrostatic forces of attraction between oppositely charged ions.

- **They have high melting and boiling points because a high amount of energy is needed to break the many strong ionic bonds.**
- **They dissolve in water because water has polarity and attracts the oppositely charged ions.**
- **When dissolved in water or molten they conduct electricity because the ions are free to move – allowing charge to flow.**

Working out the empirical formula of ionic compounds from a given model

Empirical formula is the simplest ration of ions in the compound.

Sodium chloride is NaCl (1:1)

Magnesium chloride is $MgCl_2$ (1:2)

Magnesium oxide MgO (1:1)

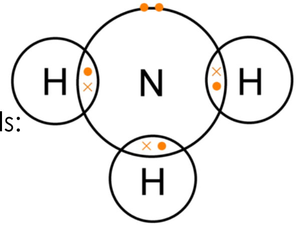
Sodium oxide is Na_2O (2:1)

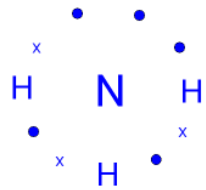
C2 Bonding Structure

4. Covalent Bonding

Formed when 2 or more **non-metals share pairs of electrons** on their outer shells.
The covalent bonds in molecules and giant structures can be represented in the following forms

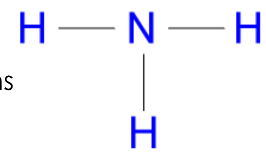
Outer electrons, with electron shells:



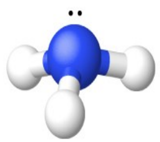


Dot and cross – outer electrons only

Bond lines – to show a pair of shared electrons

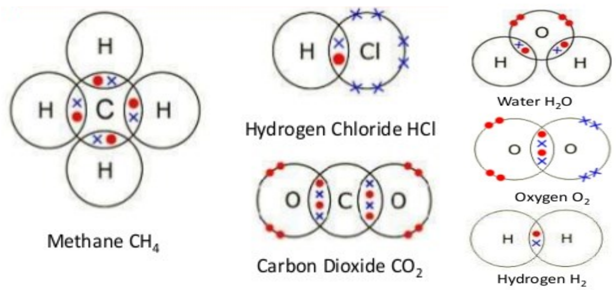


Or as a stick and ball model:



5a. Simple Covalent compounds

These are the structures of the common simple covalent compounds.



5a. The examiner may ask you to draw different ones.

Remember
use the periodic table to find out how many outer electrons each atom has; All electrons need to be paired and shared.

5b. Properties of simple covalent compounds

Low melting and boiling points - This is because the weak intermolecular forces break down easily. Simple molecular substances are gases, liquids or solids with low melting and boiling points.

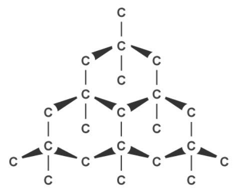
Non-conductive - Substances with a simple molecular structure do not conduct electricity. This is because they **do not** have any free electrons or an overall electric charge (ions).

Hydrogen, ammonia, methane and water are also simple molecules with covalent bonds. All have **very strong bonds between the atoms**, but much **weaker forces holding the molecules** together. When one of these substances melts or boils, it is these weak 'intermolecular forces' that break, not the strong covalent bonds.

6a. Giant covalent compounds and the properties

Allotropes of carbon

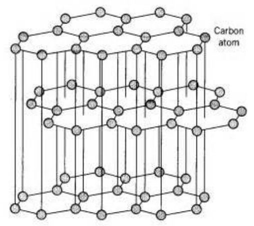
Diamond



Properties

- **High melting and boiling point –** all carbons have 4 strong covalent bonds which required extremely high temperatures to break. (NO intermolecular forces)
- **Non-conductive** as it does not have free electrons or ions.
- **Extremely hard** due to covalent bonds.

6b. Graphite

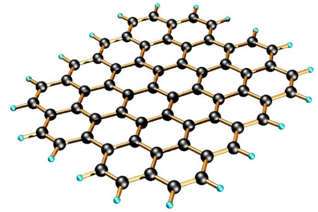


Properties

- **High melting and boiling point –** all carbons have 3 strong covalent bonds which required extremely high temperatures to break.
- **Conducts electricity –** it has delocalised electrons.
- **Layers** are weakly attracted meaning they can slide over each other useful as a lubricant.

7a. Graphene

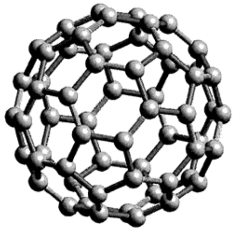
Graphene is a smart material, because it is only one atom thick. Graphene is essentially a single layer of carbon in the form of graphite, with its layered structure of hexagonal rings of



Graphene fibres are strong.
Graphene is highly resistant to attack by strong acids or strong alkalis and so can be used to give surfaces an ultra-thin protective layer which is transparent

C2 Bonding Structure

7b. <u>Buckminster Fullerene</u>



It is actually not a giant covalent structure, but a giant molecule in which the carbon atoms form pentagons and hexagons - in a similar way to a leather football. It is used in lubricants

8. <u>Exam questions on bonding:</u>

By reference to the detailed structure of sodium chloride explain fully why:

(i) sodium chloride has a quite high melting point**(1)**

(ii) solid sodium chloride melts when it is heated strongly, **(2)**

(iii) molten sodium chloride will conduct electricity**(1)**

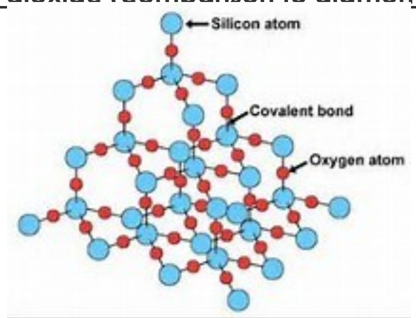
Use your knowledge of structure and bonding to explain why:

(i) graphite is very soft **(2)**

(ii) diamond is very hard **(2)**

(iii) graphite conducts electricity. **(2)**

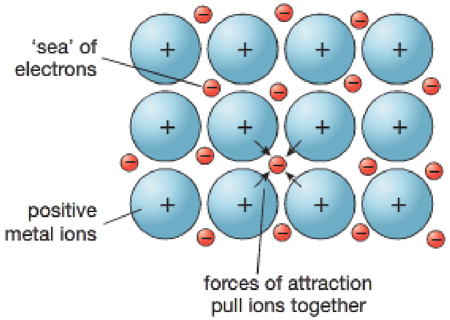
9. <u>Silicon dioxide (comparison to diamond)</u>



Silica, which is found in sand, has a similar structure to diamond. It is also hard and has a high melting point, but contains silicon and oxygen atoms, instead of carbon atoms. The fact that is a **SEMI-CONDUCTOR** makes it useful in the electronic industry.

10. <u>Metallic bonding</u>

Metals have giant structures of atoms with strong metallic bonding. The giant structure of metal cations with a 'sea of electrons' moving.

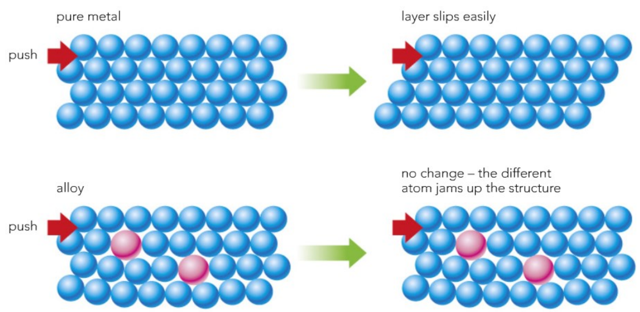


Metals conduct electricity as the electrical current is the movement of the delocalised electrons through the lattice of ions.

11. <u>Alloys</u>

An alloy is a mixture of fused metals.

<u>Comparing the properties of metals and alloys</u>



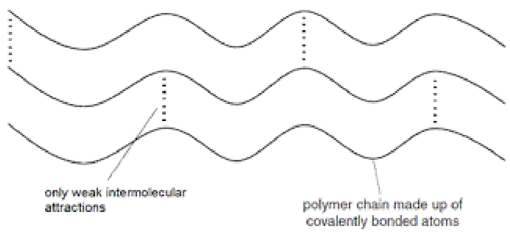
In a pure metal the atoms are in layers which can easily slide over each other. This means metals can be shaped and bent. They are **malleable** (can be hammered into shape) and are **ductile** (drawn into wires).

In an alloy, the **different sized** metal atoms **distort** the layers making it difficult to slide over each other. Alloys are **harder** than pure metals.

12. <u>Polymer structure</u>

Polymers are large molecules. They are formed from repeating units called monomers. They have strong covalent bonds between the atoms in the chain.

Between the polymers weak **intermolecular forces** keep the molecules together. These forces can be broken so polymer chains move over each other. This allows the polymer to be stretched.



As many of these intermolecular forces exist the substance are **solid** at room temperature.

The weaker the intermolecular forces the lower the melting point.

<u>Types of polymer (HT only)</u>

<u>Addition polymerisation</u>

Monomers are identical

Monomers have at least one carbon – carbon double bond

Examples poly(ethene), PVC, PTFE