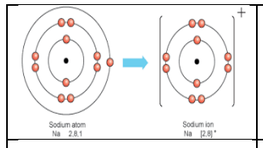
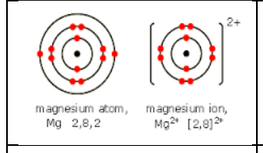
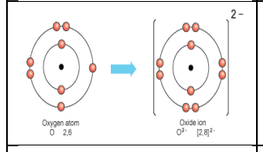
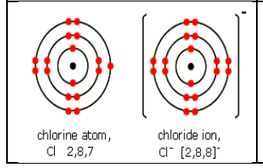
Chemistry Knowledge Organiser – Unit 2 Bonding

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

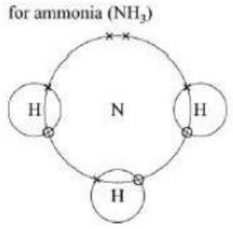
All atoms do this to gain a full outer shell. Just like the electronic configuration of the noble gases (group 0) because they are the most stable.

Covalent Bonding

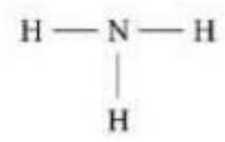
Formed when 2 or more **non-metals share pairs** of **electrons** on their outer shells.

The covalent bonds in molecules and giant structures can be represented in the following forms

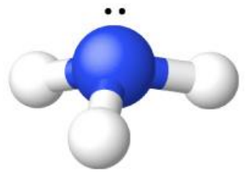
Outer electrons, with electron shells:



Bond lines – to show a pair of shared electrons



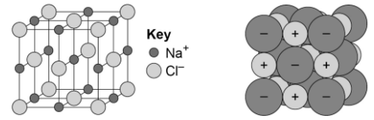
Or as a stick and ball model:



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.**

Calculating the empirical formula of ionic compounds

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)

Metals will have the same positive charge as their group.

Non metals will have the same negative charge of their group – 8.

Write out the formula with enough positive ions and negative ions to cancel each other out.

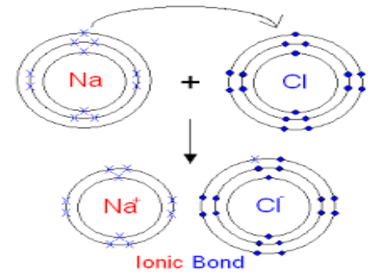
Ionic Bond

Positive and negative ions bonded together with strong **electrostatic attraction**.

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

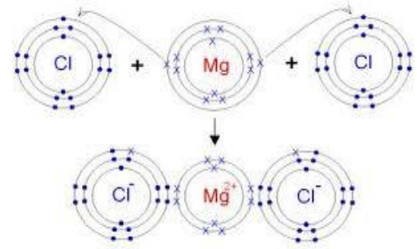
When a metal atom reacts with a non-metal atom electrons in the outer shell of the metal atom are **transferred.**

Making sodium chloride



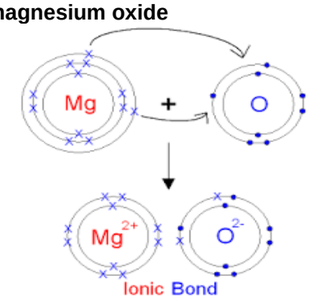
Formula - NaCl

Making magnesium chloride



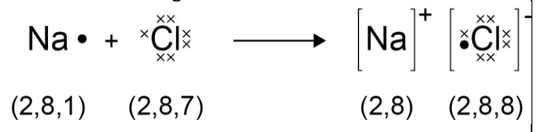
Magnesium needs to lose 2 outer electrons. Each chlorine receives an outer electron to give the Formula $MgCl_2$

Making magnesium oxide

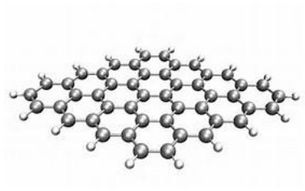


Formula = MgO

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



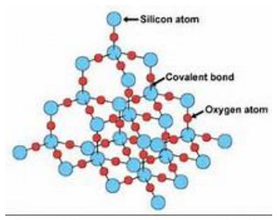
Graphene (giant covalent)



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 carbon atoms (structure of graphite).

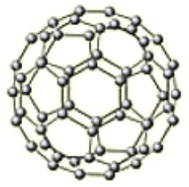
Graphene fibres are strong.
Graphene is highly resistant to attack by strong acids or strong alkalis and so can be used to give surfaces an ultra-thin protective layer which is transparent

Silicon dioxide – Giant covalent (comparison to diamond)



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.

Buckminster Fullerene

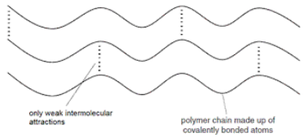


It is actually not a giant covalent structure, but a giant molecule in which the carbon atoms form pentagons and hexagons - in a similar way to a leather football. It is used in lubricants

Polymers

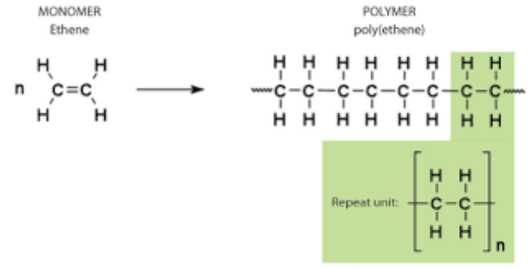
Polymers are large molecules. They are formed from repeating units called monomers. They have strong covalent bonds between the atoms in the chain.

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.



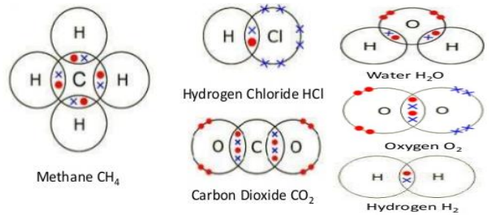
As many of these intermolecular forces exist the substance are **solid** at room temperature.

The weaker the intermolecular forces the lower the melting point.



Simple Covalent compounds

These are the structures of the common simple covalent compounds.



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.

Properties of simple covalent compounds

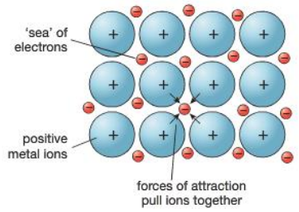
Low melting and boiling points - This is because the weak intermolecular forces break down easily. Simple molecular substances are gases, liquids or solids with low melting and boiling points.

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.

Metallic bonding

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

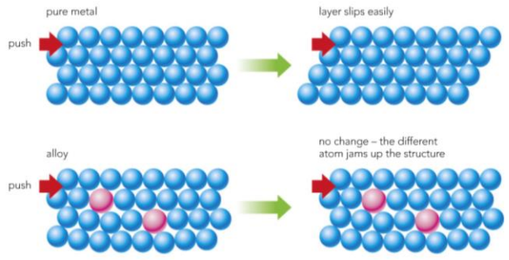


Metals conduct electricity as the electrical current is the movement of the delocalised electrons through the lattice of ions.

Alloys

An alloy is a mixture of fused metals.

Comparing the properties of metals and alloys



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).

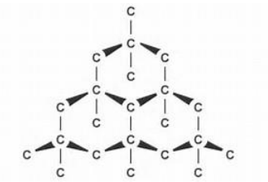
In an alloy, the **different sized** metal atoms **distort** the layers making it difficult to slide over each other. Alloys are **harder** than pure metals.

Giant covalent compounds and the properties

Allotropes of carbon

Allotropes are made of the same element but with different structures.

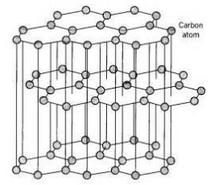
Diamond



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.

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.

1. Why do atoms form bonds?
2. How do positive ions form?
3. How do negative ions form?
4. What is an electrostatic force?
5. What sort of atoms does an ionic bond form between?
6. What type of force makes up an ionic bond?
7. Draw a lithium ion
8. Draw a chlorine ion
9. How do you work out the charge of a metal ion?
10. How do you work out the charge of a non metal ion?
11. Describe the structure of an ionic substance
12. What is the ratio of Magnesium to Chloride ions in magnesium chloride?
13. What is the ratio of Sodium to oxide ions in sodium oxide?
14. Why do ionic compounds have high melting and boiling points?
15. When can ionic compounds conduct electricity?
16. What types of atoms do covalent bonds form between?
17. What is a single covalent bond made of?
18. Why do small covalent molecules have low melting and boiling points?
19. Describe a metallic bond
20. Why can metallic substances conduct electricity?
21. **What are addition polymers made of?**
22. **Why would a cross linked polymer have a high melting point?**
23. **What chemical makes up (poly)tetrafluoroethene?**
24. **Which type of bond is found in a polymer chain?**
25. **What type of bond is found between polymer chains that are not cross linked?**
26. **What are allotropes?**
27. **What sort of bond forms between carbon atoms?**
28. **Why are diamonds hard with high melting points?**
29. **Why is graphite slippery?**
30. **Why is carbon 60 described as a molecular cage?**