science

chemistry

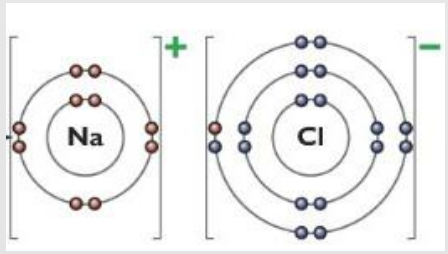
GCSE C2 – Structure & Bonding

1) What is an ion?

An ion is a charged atom. It becomes charged by gaining or losing electrons.

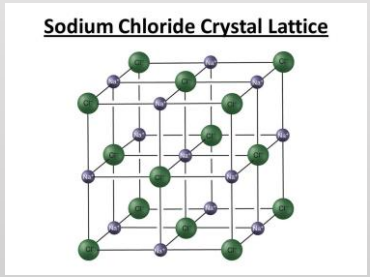
2) Ionic Bonding

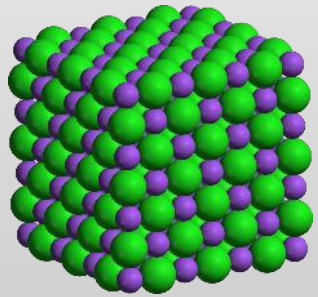
- An ionic bond is an electrostatic force of attraction between 2 or more oppositely charged ions.
- Forms between metals and non-metals.
- Metals give their outer electrons to the non-metal.



3) Ionic Structures

- Ions attract each other to form a regular 3D arrangement of ions (giant lattice).





4) Properties of ionic substances:

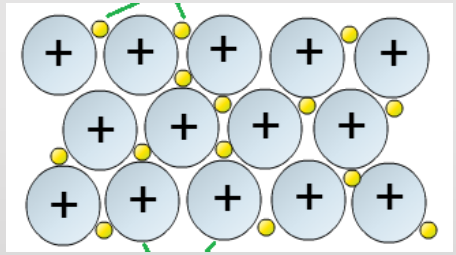
- High melting points - lots of energy needed to break all the strong electrostatic forces between ions.
- Do not conduct electricity when solid (ions can not move freely).
- Only conduct when liquid (molten or aqueous) as the ions are free to move and carry the charge.

5) States of matter & State Symbols

- The three states of matter can be represented by a particle model which helps explain melting, boiling, freezing and condensing.
- The amount of energy needed to change state (solid to liquid etc) depends on the strength of the forces between the particles of the substance.
- The stronger the forces between the particles the higher the melting point and boiling point of the substance.
- There are 4 state symbols (which show the physical state at room temperature)
- s (solid) l (pure liquid) g (gas)
- aq (aqueous meaning a solution / dissolved in water)

6) Metallic bonding

- Metals have a regular 3D arrangement of layers of positive ions held together by a sea of delocalised electrons.



7) Properties of metals:

- Malleable & ductile as the layers of metal ions can slide over each other (malleable = they can be hit with a hammer without cracking, ductile = drawn into wires).
- Good conductors of electricity because the delocalised electrons are free to move **through** the whole structure and carry the charge.
- Good conductors of thermal energy because energy is transferred by the delocalised electrons.

8) Alloys

- Pure metals are too soft for many uses and so are **mixed** with other metals to make alloys which are harder.
- Different sized atoms in the alloy prevent layers from sliding.

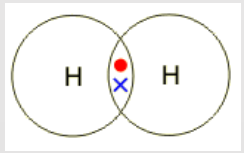
9) What is a molecule?

Two or more atoms joined together by covalent bonding (sharing electrons)

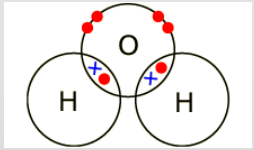
10) Covalent Bonding

- A covalent bond is a pair of electrons shared between two atoms.
- Forms between two or more non-metals.
- Forms either simple molecules (see below) or giant molecules (see box 12&13).

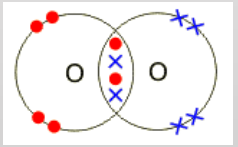
- A simple hydrogen molecule (H_2)



- A simple water molecule (H_2O)



- A simple oxygen molecule (O_2)



This is a double bond

11) Properties of simple molecules such as the ones above:

- Usually gases or liquids
- Low melting points and boiling points because they are held together by weak intermolecular forces of attraction so little energy is needed to break the forces between the molecules.
- They do not conduct electricity because the molecules do not have a charge – there are no ions or free electrons to carry the charge.

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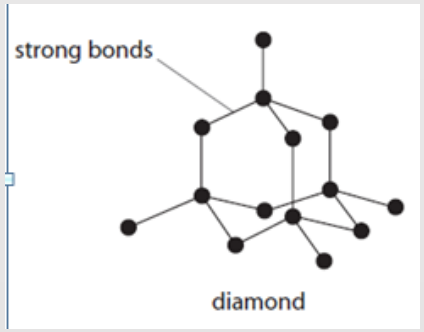
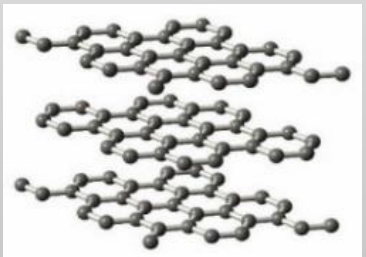
12) Giant Covalent Structures (diamond and graphite)

- Diamond has a **giant covalent** structure with every carbon atom joined to 4 others by strong covalent bonds.
- Lots of energy is needed to break all these strong bonds which make diamonds very hard (useful as drill bits).



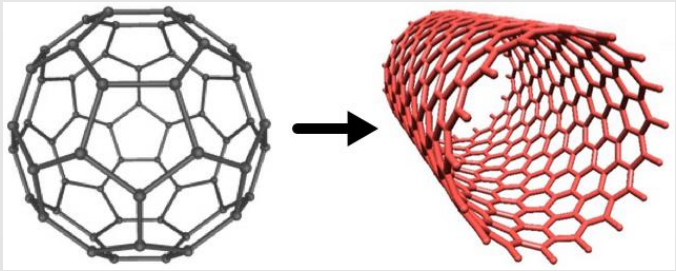
- Graphite has a **giant covalent** structure with every carbon joined to 3 others by strong covalent bonds.
- It forms layers of hexagons which can slide over each other as the layers are held together by weak forces of attraction (intermolecular forces).
- This makes graphite soft & slippery (pencils & lubricants)



- **Graphite conducts electricity because these delocalised electrons are free to move <u>through</u> the structure and <u>carry the charge</u>.**

13) Graphene & fullerenes

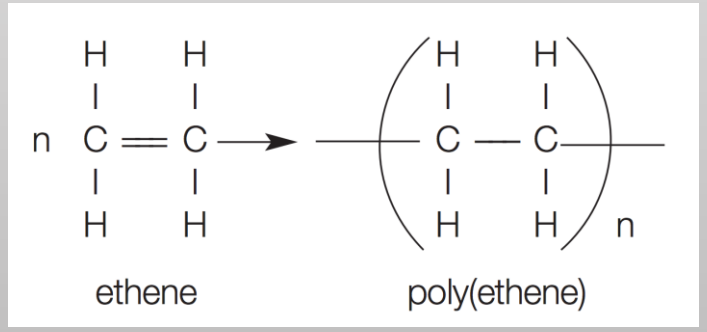
- Graphene is a single layer of graphite and only one atom thick (often called a 2D material).
- Carbon atoms can also form hollow balls or ring structures called fullerenes. Buckminsterfullerene (C_{60}) has a spherical shape like a football (used as a lubricant as it can roll).



- Carbon nanotubes can also form which have very high length to diameter ratios and are used in electronics.

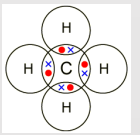
14) Polymers

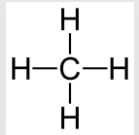
- Polymers are very large molecules. The atoms in the polymer chain are linked to other atoms by strong covalent bonds.
- Since polymers are large molecules the intermolecular forces between polymer molecules are fairly strong and so these substances are solids at room temp.

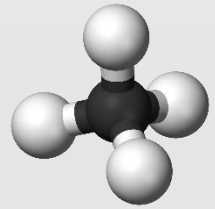


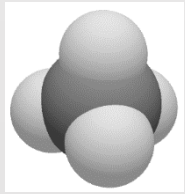
15) Using models to represent structures of compounds (HT)

- **Simple particle model (s,l,g) assumes particle made up of solid spheres and doesn't show the forces between them.**
- **Dot & cross model (shows where electrons come from but doesn't show 3D shape).**
- **Ball & stick model (limited as spheres are shown to be solid, inelastic and does not show true shape).**
- **Close packed model (difficult to see arrangement in 3D).**









16) Nanoparticles (SINGLE CHEMISTRY ONLY):

- Nanoscience refers to structures that are 1–100 nm in size (1nm = $1x10^{-9}$m)
- Nanoparticles, are smaller than fine particles, 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 have a high surface area to volume ratio so smaller quantities are needed to be effective compared to normal particle sizes.
- As the side of cube decreases by a factor of 10 the surface area to volume ratio increases by 10.
- Nanoparticles have many applications in medicine, in electronics, in cosmetics and sun creams, as deodorants, and as catalysts.

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