

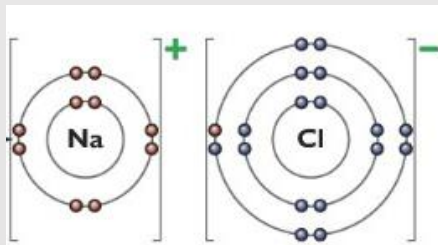


### 1) What is an ion?

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

### 2) Ionic Bonding

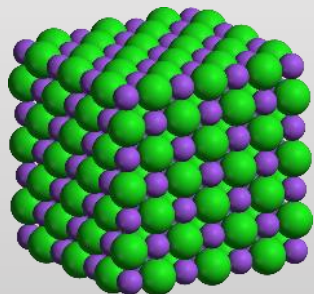
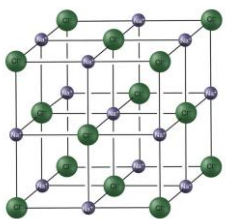
- An ionic bond is an electrostatic force of attraction between 2 or more oppositely charged ions.
- Forms between metals and non-metals.
- Metals give their outer electrons to the non-metal.



### 3) Ionic Structures

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

Sodium Chloride Crystal Lattice



### 4) Properties of ionic substances:

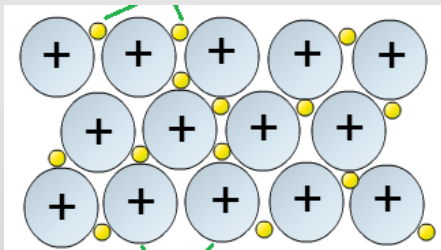
- High melting points - lots of energy needed to break all the strong electrostatic forces between ions.
- Do not conduct electricity when solid (ions can not move freely).
- Conduct when liquid (molten or aqueous) as the ions are free to move and carry the charge.

### 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 or impure liquid)

### 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

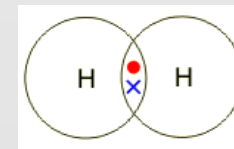
- Pure metals are too soft for many uses and so are **mixed** with other metals to make alloys which are harder.
- Different sized atoms in the alloy prevent layers from sliding.

### 9) What is a molecule?

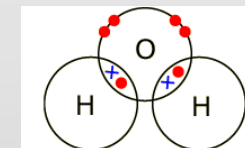
Two or more atoms joined together by covalent bonding (sharing electrons)

### 10) Covalent Bonding

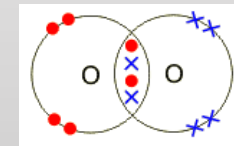
- A covalent bond is a pair of electrons shared between two atoms.
- Forms between two or more non-metals.
- Forms either simple molecules (see below) or giant molecules (see overleaf).
- A simple hydrogen molecule ( $H_2$ )



- A simple water molecule ( $H_2O$ )



- A simple oxygen molecule ( $O_2$ )



This is a double bond

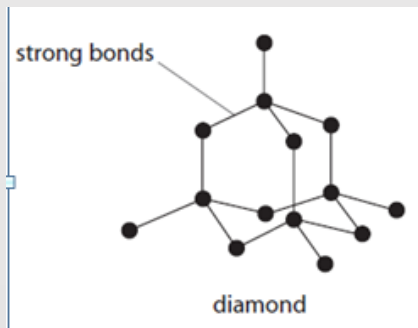
### 11) Properties of simple molecules

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

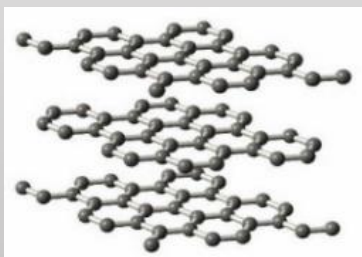


### 12) Giant Covalent Structures (diamond and graphite)

- 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).



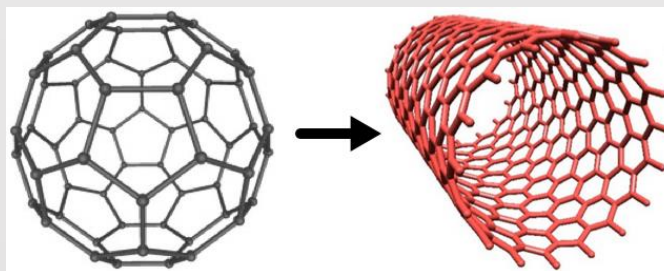
- Graphite has a **giant covalent** structure with every carbon joined to 3 others by strong covalent bonds.
- It forms layers of hexagons which can slide over each other as the layers are held together by weak forces of attraction (intermolecular forces).
- This makes graphite soft & slippery (pencils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



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

### 13) Graphene & fullerenes

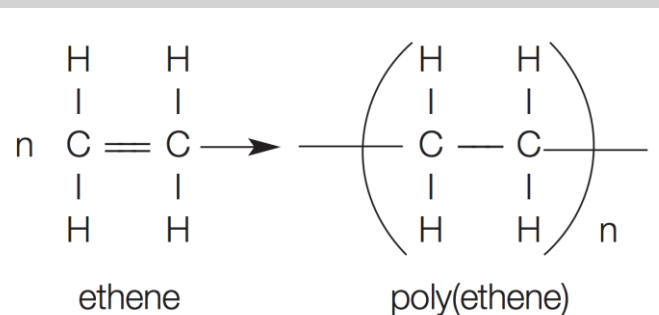
- Graphene is a single layer of graphite and only one atom thick (often called a 2D material).
- Carbon atoms can also form hollow balls or ring structures called fullerenes. Buckminsterfullerene ( $C_{60}$ ) has a spherical shape like a football (used as a lubricant as it can roll).



- Carbon nanotubes can also form which are used in medicine.

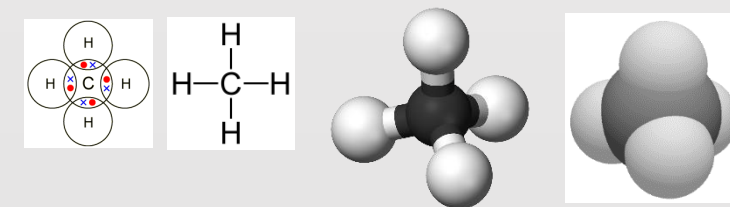
### 14) Polymers

- Polymers have very large molecules. The atoms in the polymer molecules 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 =  $1 \times 10^{-9}$ m)
- Nanoparticles, are smaller than fine particles, which have diameters between 100 and 2500 nm ( $1 \times 10^{-7}$  m and  $2.5 \times 10^{-6}$  m). Coarse particles (PM10) have diameters between  $1 \times 10^{-5}$  m and  $2.5 \times 10^{-6}$  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.