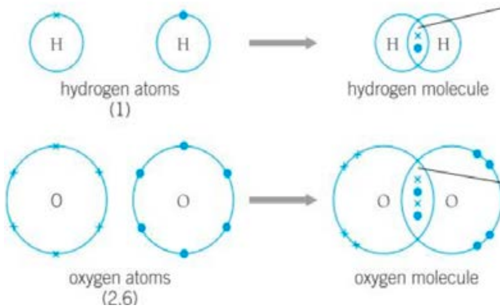
Chemistry C2_3 – Covalent Bonding

Covalent bonding

covalent bond: *a strong bond formed by attraction between atoms that* ***share a pair of electrons.***

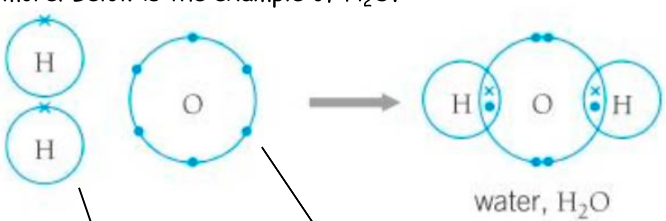
When **non-metal atoms** react with other **non-metal atoms**, electrons are **shared** to form **a covalent bond**.



A shared pair of electrons give both atoms a full outer shell.

This shows 2 pairs of electrons being shared in a **double bond**.

To gain a full outer shell, atoms may need 1 electron or more! Below is the example of H_2O.



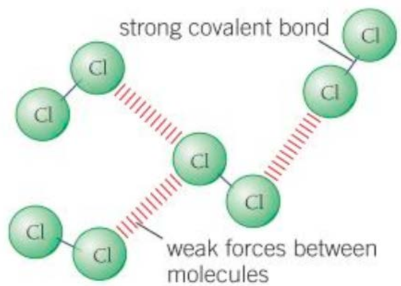
2 hydrogen atoms need to share 1 electron each to gain a full outer shell.

Oxygen has 6 electrons in its outer shell – it needs to gain 2 electrons to gain a full outer shell.

Simple covalent molecules

These are usually gases or liquids that have **low melting points and boiling points**.

Eg: Cl_2 CO_2 H_2O N_2 O_2



They have **strong covalent bonds** between **atoms** but only **weak** forces **between the molecules** (intermolecular forces).

Intermolecular forces are *weak*, so not much energy is needed to break them. Therefore, they have **low melting and boiling points**.

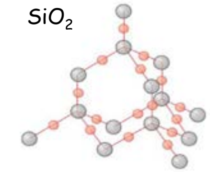
The intermolecular forces **increase** with the size of the molecules, so **larger** molecules have **higher** melting and boiling points. e.g. large polymers

Giant covalent structures

These are solids with **very high melting points**. All of the atoms in these structures are joined by **strong covalent bonds**.

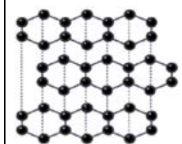
E.g. Carbon can form giant covalent structures as diamond or graphite and silicon dioxide (silica) are examples of giant covalent structures.

SiO_2



The structure of silicon dioxide (silica).

Graphite

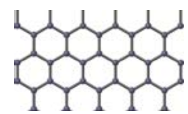


- made of **carbon atoms** forming layers of hexagonal rings.
- Each carbon atom has **3 strong covalent bonds** and one ***delocalised electron.***
- has a **high melting point** because strong covalent bonds take a lot of energy to break.
- can conduct electricity because the delocalised electrons are free to move and carry charge **through** the structure.
- soft because weak forces between layers allow the layers to slide over one another.

Diamond

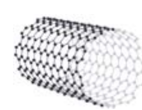
- Like graphite, diamond is also made of **carbon atoms**.
- Each carbon atom has **4 strong covalent bonds**.
- has a **high melting point** because strong covalent bonds take a lot of energy to break.
- **can't conduct electricity** because there are no delocalised electrons free to move and carry a charge.
- **very hard** because each carbon atoms is held strongly in place by 4 covalent bonds.

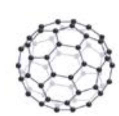
Graphene



- a single layer of graphite.
- can conduct electricity as delocalised electrons are free to move and carry a charge.
- useful for electronics and composites.
- **very hard** as there are no layers to slide.

Fullerenes



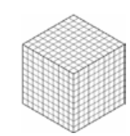


- Graphene can made into hollow shapes called **fullerenes**.
- Buckminster fullerene C_{60} has a spherical shape.
- Carbon nanotubes are cylindrical shapes.
- Their properties make them uses for nanotechnology, electronics and materials.

Nanoscience: study of 1–100 nm structures, of the order of a few hundred atoms. *Includes uses for medicine, electronics, cosmetics, sun creams and new uses being discovered!*
Nanoparticles: smaller than fine particles (PM2.5), which have diameters between 100 and 2500 nm ($1x10^{-7}$ m and $2.5x10^{-6}$ m).
Coarse particles (PM10) have diameters between $1x10^{-5}$ m and $2.5x10^{-6}$ m (often referred to as dust)

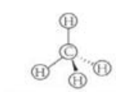
Nanoparticles may have properties different from those for the same materials in bulk because of their high surface area to volume ratio. This may increase their effectiveness.

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

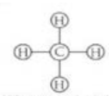


Limitations of models

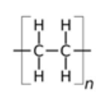
- 2D models show which atoms are bonded but not the **shape** of the molecule.
- Dot and cross diagrams show **electrons** in bonds where ball and stick doesn't.
- Giant structures won't show true number of atoms present.



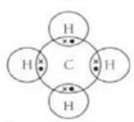
3D ball and stick model



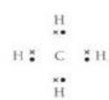
2D ball and stick model



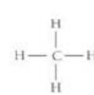
Polymers (e.g. polyethene)



dot and cross diagram (showing outer shells as circles)



dot and cross diagram showing outer shell electrons



displayed formula showing bonds