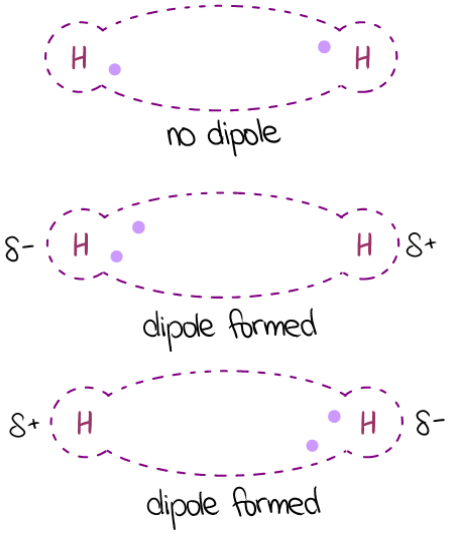
4.3 - Intermolecular Forces

4.3.1 - Describe the types of intermolecular forces (attractions between molecules that have temporary dipoles or hydrogen bonding) and explain how they arise from the structural features of molecules

Intermolecular forces are the bonds that form between molecules, its strength determined by the electrostatic attraction between them. This is dependent on the **size of the molecules** and their **polarity**. Intermolecular forces determine the melting and boiling points of the substance.

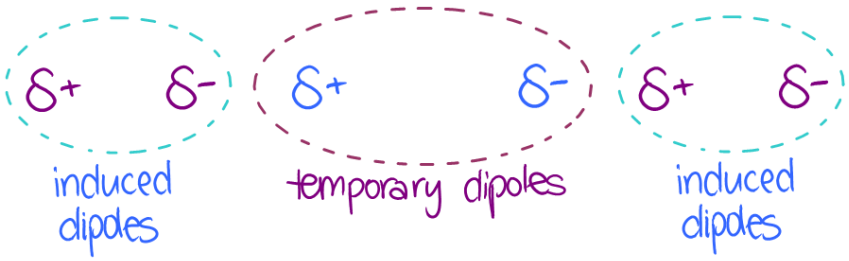
Van der Waals' Forces

These are weak forces between **all molecules** when temporary dipoles form.



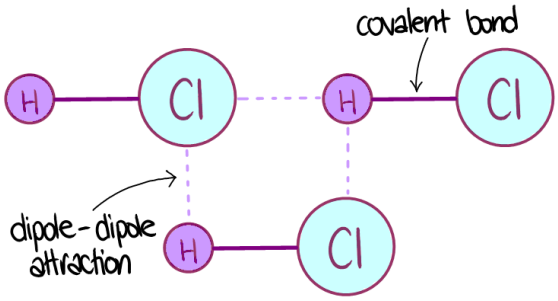
Electrons are not always symmetrically arranged, creating the instantaneous dipoles which in turn can induce a charge in surrounding molecules. This causes a weak overall attractive force. All molecules have Van der Waals' forces, regardless of the other intermolecular forces between them.

Lager molecules have more pronounced forces because there are more electrons. The magnitude of the dipoles increases, causing higher boiling and melting points.

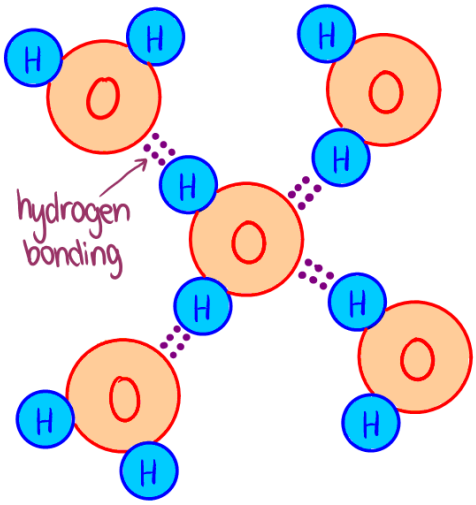


Permanent Dipoles

All **polar molecules** have permanent dipoles; with same ends have either a positive or negative charge. This slight charge creates <u>electrostatic attraction</u> between the molecules which is stronger than temporary dipoles, as the **dipoles are larger**.



Therefore, polar molecules will have <u>higher melting and boiling points</u> than non-polar molecules because their intermolecular forces are stronger.



Hydrogen Bonding

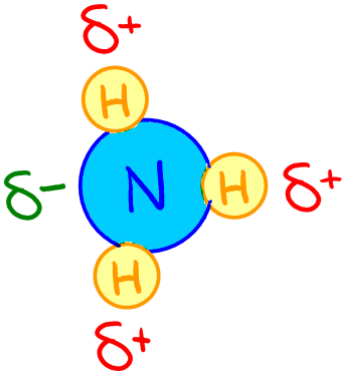
Hydrogen bonding is a **stronger dipole-dipole attraction**. It is the result of the exposure of the hydrogen nucleus, since its electrons are pulled towards the other atom. This results in a strong, permanent <u>positive dipole</u> on the hydrogen end of the molecule.

Molecules with hydrogen bonding are highly polar and have strong dipoles. This only occurs between molecules with **H-F**, **H-O** and **H-N** bonds.

The strong positive end is attracted to the negative end of another molecule.

Hydrogen bonding in **water** explains its unusual properties:

- High melting point and boiling point
- High surface tension



Ammonia also has a high melting point

- Weaker bond than in water due to smaller electronegativity of nitrogen

4.3.2 - Describe and explain how intermolecular forces affect the boiling points of substances

Hydrogen bonds are very strong, meaning that more energy is required to break them. This raises the melting and boiling point.

Van der Waals forces (temporary dipoles) are present in all molecules, but larger molecule with more electrons will have larger dipoles. The increased attraction means that larger molecules have a higher boiling point. In addition, more linear molecules have larger temporary dipoles, giving them a higher boiling point.

Permanent dipoles in polar molecules are stronger, requiring more energy to overcome and giving them a higher boiling point.

Boiling point essentially increases by: