Polar and Non-Polar Molecules

- Molecules often contain more than one bond
    - Each bond may or may not be polar. It depends on the atoms involved

- Bonds dipoles within a molecule add together in the same way that ordinary push/pull forces add together
    - Sometimes forces will be balanced
    - Sometimes the forces combine to produce a net force in one direction

- If dipoles balance (cancel each other out) there will be no net dipole.
    - The bonds may be polar but because the individual dipoles cancel, the molecule will actually be **non-polar**.

- Individual dipoles may add together to produce a net dipole in one direction.
    - The bonds will be polar and the molecule will be polar.

Predicting Polarity

HINT: DRAW A LEWIS DIAGRAM

Once you know the shape of a molecule and the direction of each bond and dipole, you can work out whether a molecule is polar or not (i.e. does the molecule have 'poles' of charge?)

1. **Individual bonds: Are they polar or not?**
   This will be due to **electronegativity differences between atoms** in the bond

   Remember, electron clouds repel to be as far apart as possible – this causes shape

2. **The shape (3-D arrangement of atoms) of a molecule.**
   Lone electron pairs must be accounted for

   - Tetrahedral (4 bonding clouds only)
   - Trigonal pyramid (3 bonding clouds + 1 lone pair)
   - Triangular planar (3 bonding clouds only)
   - Bent (2 bonding clouds + 1 or 2 lone pairs)
   - Linear (1 or 2 bonding clouds only)

3. Whether or not the arrangement of polar bonds in the molecule is **symmetrical**

   - If it is **symmetrical**, polar bonds can cancel making molecule **non-polar**

     If it is **not symmetrical** the effect of polar bonds is not cancelled and molecule is **polar**

   - This is due to…

     - lone pairs of electrons on central atom **or**
     - different atoms bonded to central atom

Non Polar molecules

These are molecules with
- identical atoms
- molecules containing only non-polar bonds
- molecules with polar bonds but have a symmetry and even distribution of charge (the centre of negative charge = centre of positive charge)

Examples with explanations (Excellence Level)

1. **CO_2**

The 2 C-O bond in CO_2 are polar due to **difference in electronegativity** of C and O.

There are 2 regions of negative charge about the central C atom (both bonding regions). These repel into a **linear shape.**

The arrangement of polar bonds in CO_2 molecule is **symmetrical**.

The polar bonds **cancel due to symmetry.** Molecule is **non-polar**.

2. **NH_3**

The 3 N-H bonds in NH_3 are polar due to **difference in electronegativity** of N and H.

There are 4 regions of negative charge about the central C atom (3 bonding regions, 1 non-bonding).

These **repel** into a tetrahedral arrangement, but a **trigonal pyramid shape.**

The arrangement of polar bonds in NH_3 molecule is a**symmetrical**.

The polar bonds **do not cancel** out, therefore molecule is **polar**.

3. **CH_4**

The 4 C-H bonds in CH_4 are polar due to **difference in electronegativity** of C and H.

There are 4 regions of negative charge about the central C atom (all bonding regions)

These **repel** into a tetrahedral arrangement and **shape.**

The arrangement of polar bonds in CH_4 molecule is **symmetrical**.

The polar bonds **cancel** out, therefore molecule is **non-polar**

4. H_2O

The 2 O-H bonds in H_2O are polar due to **difference in electronegativity** of O and H.

There are 4 regions of negative charge about the central O atom (2 bonding regions, 2 non-bonding).

These **repel** into a tetrahedral arrangement, but a **bent/angular/V shape.**

The arrangement of polar bonds in H_2O molecule is a**symmetrical**.

The polar bonds **do not cancel** out, therefore molecule is **polar**.