Notes - Polarity

- Forces of attraction that exist between molecules that are the same are very important in helping chemists (us) establish physical traits like melting/boiling points and viscosity (the ability to resist flowing). It is these **relatively weak** forces that attract and hold substances together. The stronger these forces are the higher the viscosity (ex. Molasses) and boiling/melting point.

- These same forces also explain why "like dissolves like". This means that if you want to dissolve a substance you use a solvent that is "like" (more about this below).

- There are three of these important forces and you already know one.

- Remember that _____ are weak attractive forces between atoms when the atoms have a temporary charge separation occurring due to repulsion of electrons as electrons are all the same charge and repel like charges.

- A second molecular force is a dipole-dipole force. Dipole-dipole forces are when the atoms have a charge separation occurring due to different electronegativities of the atoms causing a force of attraction between opposite charges, however they differ from London forces in that dipole-dipole forces occur when there is a _____ charge separation resulting in a permanent dipole attraction.

- For dipole-dipole forces to exist there must be two occurrences;

  1.) Differing electronegativities between the atoms

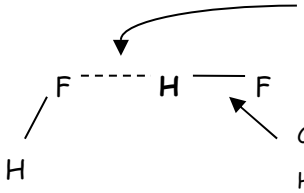
  2.) The shape of the molecule must be _____. To be asymmetrical one end of the molecule must be different than the other.

- The following have at least one dipole and are asymmetrical, meaning they are also **polar molecules**.

- The following have at least one dipole but are **NOT** asymmetrical, meaning they are **NOT** polar molecules.

- The third force is still related to polarity, in what is called <u>hydrogen bonding</u>. This exists when hydrogen atoms are bonded to F, O or N. Because these atoms are so electronegative they set up a very strong dipole that the hydrogen of each molecule in that substance is mutually attracted to the other F, O, N.

<u>Ex.</u> -



Hydrogen bond, in which the more electropositive H attracts the more electronegative F.

Covalent bonds holding H and F together to make the Hydrogen Fluoride molecule are much stronger.

<u>The Nature of Snow – A hydrogen bonding story</u>

- How do snowflakes form? High in the cold atmosphere, water molecules in the gas phase lose kinetic energy until the energy is less than the deposition hydrogen-bond energy into the solid phase. However, deposition requires the existence of tiny solid particles (that is, dust) as nuclei. Some of those particles are silicates, containing the tetrahedral silicate ion. The surface oxygen atoms of the silicate particles possess a partial negative charge (hello polarity!); thus, the partially positive hydrogen atoms of water molecules are attracted to an oxygen atom in the silicate ion, forming <u>hydrogen bonds</u> (Fig. 5).

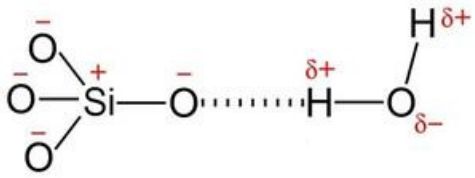


FIGURE 5: Attraction between a silicate ion and a water molecule by means of hydrogen bonding.

Once this layer is deposited, subsequent low-kinetic-energy water molecules will <u>hydrogen bond</u> to the molecules already on the surface. Layer after layer will form. Almost uniquely among solids, water molecules crystallize to form very open structures, which we call **snowflakes**.

FIGURE 6: A colourless transparent snowflake.

- Snowflakes are colourless and transparent, as Fig. 6 shows. It is <u>internal light reflection</u> which causes them to <u>appear white</u>.

- The following table sums up the importance of bonds or forces holding substances together.

Ionic Bond – the substance is an ionic crystal (made of metal and non-metal atoms or recognizable ions)

Ex. – NaCl (s) or NH_4NO_3 (s)

Covalent Bond – the bond in question is intramolecular (bond holds two atoms together IN a molecule)

Ex. – C-H in CH_4

Hydrogen Bonds – look for HF or any molecule having OH or NH in its formula.

IF NOT PRESENT THEN

Dipole-Dipole Force – look for an asymmetric molecule.

IF NOT PRESENT THEN

London Forces – is all that is present.

- Because "like dissolves like" to dissolve a polar substance use a polar solvent. Or if the substance is nonpolar then use a nonpolar solvent.