Honors Pre-AP Chemistry Final Notes for Bonding Ch. 8 and 9 Intermolecular Forces

Intermolecular Forces

"Inter" means **between**. These are forces that are between molecules.

(Do not confuse these forces between molecules with the forces inside molecules (intramolecular) which are actual bonds.) An interstate highway is "between" states, whereas, an intrastate highway is "within" a state or a state highway. The same is true for molecules.

Molecules, depending on whether they are polar or non-polar, will set up forces between themselves. These attractive forces allow the molecules in the substance to have the characteristics they possess.
Polar molecules have a strong attraction for themselves and for other kinds of polar molecules because of their dipole moments. Non-polar molecules do not have strong attractions for themselves or for any other polar or non-polar molecules.

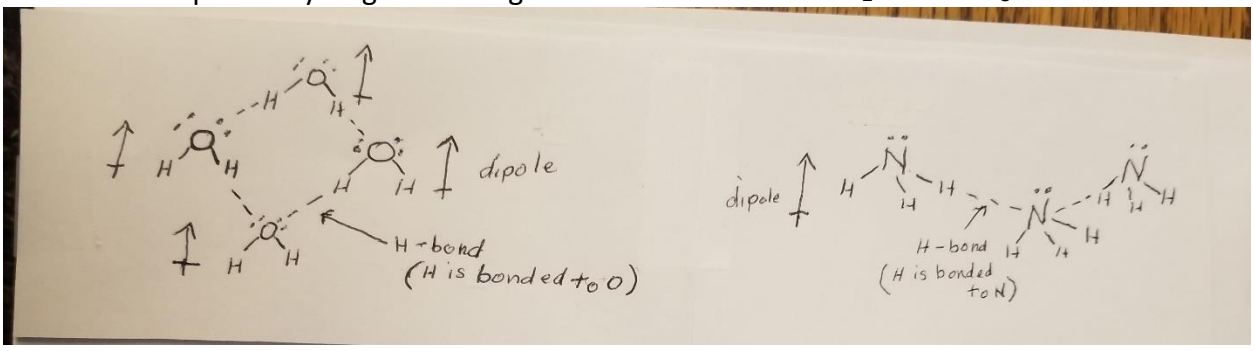
Here is how it works:
In polar molecules, the dipoles "line-up" with their negative (-) and positive (+) ends attracting each other.
Non-polar molecules do not have these strong (-) and (+) ends so they have a very weak attraction to one another called (London dispersions or VanderWaal forces). I will explain them later.

There are three basic Intermolecular Forces.

1) **(Polar) Hydrogen bonding** (or H-bonds)
2) **(Polar) Dipole-Dipole forces**
3) **(Non-Polar) London Forces** (or London dispersions**)**

1) Hydrogen Bonds

These are "bonds" formed between **polar molecules** that have **Hydrogen** bonded to**(N, O,** or **F).**
Both conditions are necessary. The molecule must be "polar" and the hydrogen must be bonded to either "nitrogen, oxygen, or fluorine".
If both conditions aren't met, it's **not** hydrogen bonding.
The best examples of hydrogen bonding between molecules are **H_2O and NH_3.**



Note that the hydrogen bonds are between the H of one molecule and the N or O of another molecule. They are **not** between the H and O or N of the **same** molecule.
Also note that the hydrogen bonds are **dotted lines**, not solid lines. This is because the H-bond is not a true chemical bond. It has about one tenth the strength of covalent bond. It is call a "bond" because it is such a strong intermolecular attractive force.
Final note: the molecule **must be** a polar molecule with polar bonds. For example, NH_4^+ is an ion with H—N bonds. The bonds are polar but the molecule is tetrahedral and non-polar so there are no H-bonds between the molecules (ions).

2) Dipole-Dipole Intermolecular Forces

Dipole-Dipole intermolecular forces are forces between **polar molecules** that do not H-bond. In other words, they are the intermolecular forces between **all other polar molecules.**
So, if a molecule is polar, but there is no H bonded to N, O, or F, the intermolecular forces are dipole-dipole.

SO_2 was a molecule we constructed in class on our worksheets. The bonds were polar and the molecule was "bent" which is a **polar molecule**. There are not H—O, H—N, or H—F bonds, so the intermolecular forces are **Dipole-Dipole**.
All other polar molecules have dipole-dipole forces between molecules.

3) London Forces (London or VanderWall Dispersions)

London Forces are the weakest of the intermolecular forces. They are the intermolecular forces between **non-polar molecules**. All non-polar molecules have London Forces.
Non-polar molecules have virtually no attractive forces because they do **not** have **dipole moments.** However, they do have what is call **momentary dipoles**. These are very weak dipoles that are set up in a non-polar molecule due to the electrons in the bonds moving more to one side than another. When this happens it lasts virtually a **moment** in time. Then the electrons go back to an even sharing. However, these momentary dipoles are happening trillions and trillions of times, flashing on and off setting up very weak dipole forces between the molecules. (If this didn't happen then there would be not attractive forces between any non-polar molecules and they could never be liquids. They would all be gases. Substances like octane and hexane would not be liquids.)
So, **all non-polar molecules have London Forces** as their intermolecular forces.

Some optional practice compounds: We will do these in class but you can try if you like to see how well you can do.

$SnCl_2$
PCl_5
SeF_4
IF_5
XeF_4