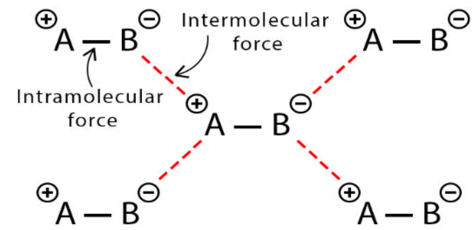
# Intermolecular Forces (IMF)

Forces and bonding with molecules is either...

INTRAmolecular
- Attraction WITHIN a molecule
- Types: Ionic, covalent

INTERmolecular
- Attraction BETWEEN molecules
- Weaker than intramolecular forces
- Types: Ion-Ion, Ion-Dipole, Dipole-Dipole, Hydrogen-Bonding, London Forces




| *INTERmolecular Forces* |
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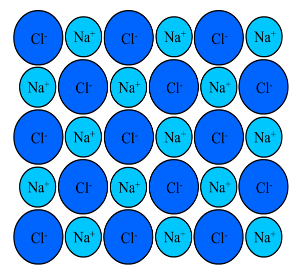
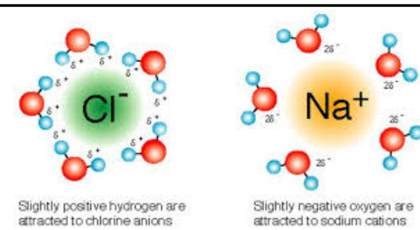
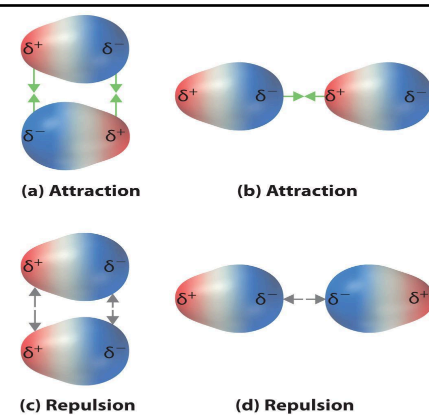
| Ion-Ion Interactions (Strongest IMF) | These are the Ionic Bonds found in ionic crystals<br>• Forces very hard to break, very strong<br>• The strength of an ionic bond is referred to as lattice energy.<br>• Takes a lot of energy (high temperatures) to cause them to split from one another and change states<br>• Strength of the interaction is proportional to the magnitude of the charges and decreases as the distance between the particles increases.<br>• These two factors combined is referred to as charge density |   |
| Ion-Dipole Interaction (2nd Strongest IMF) | Occurs when a fully charged ion interacts with polar molecules (molecules that have a dipole)<br>• Negative end of dipole on polar molecule attracted to a positive ion<br>• Positive end of dipole on polar molecule attracted to a negative ion<br>• Since a dipole is not a FULL charge, this attraction is not as strong as ion-ion |   |
| Dipole-Dipole Interactions (3rd Strongest IMF) | When molecules have dipoles negative end on one molecule attracted to the positive end of another<br>• This attraction will hold the molecules together, and keep them from separating<br>• There will also be a repulsive force between likely charged sides<br><br>As they are an electrostatic attraction, the strength of DP-DP interactions are affected by:<br>1) The distance between both molecules<br>• Molecules that are further apart will experience a weaker attraction to one another<br>2)The degree of charge separation (ie. how polar are they?)<br>• Molecules with a smaller charge separation will experience a weaker attraction |   |

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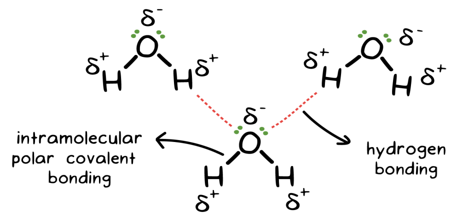
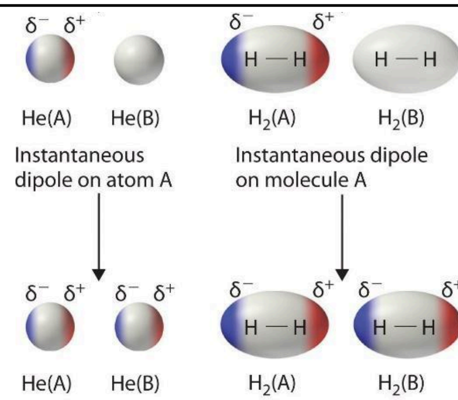
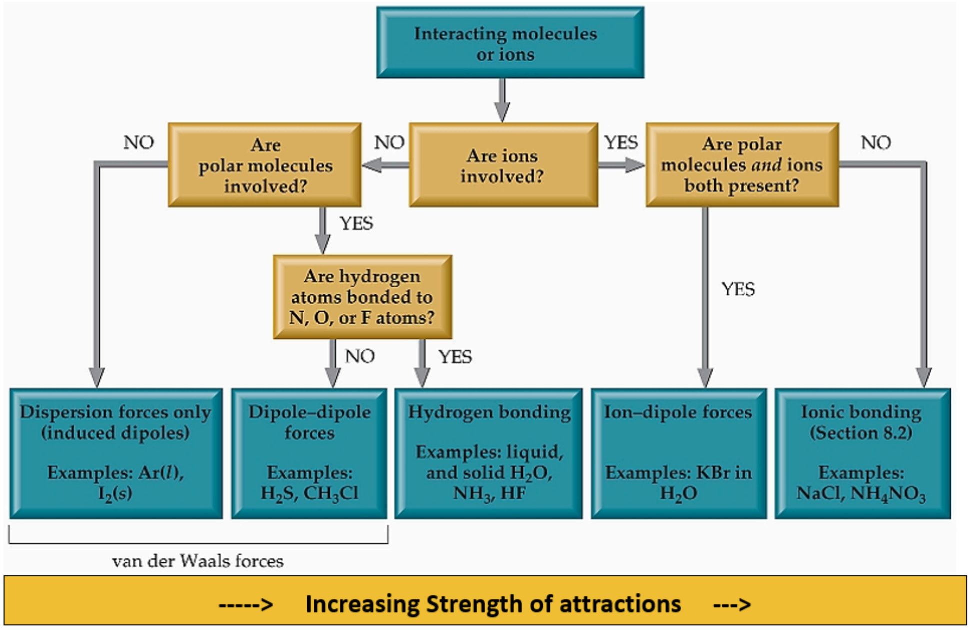
| Hydrogen Bonding (Strong version of Dipole-Dipole) | When Hydrogen is a part of a dipole with O, F or N, it is a special case of Dipole-Dipole Interaction<br>• Dipole-Dipole but STRONGER than other forms of Dipole-Dipole due to large ΔEN between H and the atom (N,O, or F)<br>• Hydrogen gets a partial positive charge<br>• Hydrogen is small and has no shielding electrons<br>• It will attract to the lone pair of electrons on the electronegative atom of neighboring molecules<br>• This attraction is very strong, and gives these molecules high melting/boiling points<br>Careful! This only works when Hydrogen is bonded to N, O or F, not every single Hydrogen bond |  |
| London Forces (Weakest Intermolecular Force) | Occur in ALL molecules<br>• Attraction of proton from one molecule to electrons of another molecule due to temporary fluctuations in the electron cloud shifting randomly within atoms and nonpolar molecules result in the formation of short-lived instantaneous dipole moments<br>• Once an instantaneous dipole is formed on a molecule or atom, the partial charges can induce a dipole on neighboring atom or molecules<br>• This induced dipole will be complimentary to the instantaneous dipole, causing an electrostatic attraction to form between both molecules<br>• These interactions are SO much weaker than the others, that we only study them in terms of non-polar (pure) covalent molecules<br>• They are overpowered by the other forces<br>• They are dependent on size  the larger the molecule, the stronger their London Forces, because as they increase in mass, they also increase in number of electrons.<br>• This increases the number that can be temporarily unbalanced to one side, therefore increasing the strength of LDF. |  |




**London dispersion force is a sub-type of the Van der Waals force that is predominant in non-polar molecules.