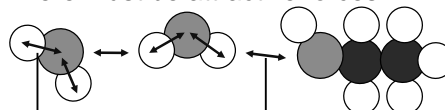


Intermolecular forces and solubility



Why mixtures mix

- Consider a glass of wine. Why do alcohol, water, & pigment mix together?
- There must be attractive forces.



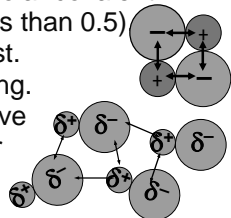
Intramolecular forces occur between atoms

Intermolecular forces occur between molecules

- The factors that determine solubility are the strength of IMFs and speed of molecules.
- 4 types of intermolecular forces: ionic, dipole-dipole, hydrogen bonding, and London forces.

Electronegativity & IMFs

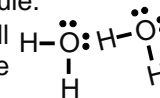
- ΔEN essentially defines the type of IMF.
- Ionic bonds form if the ΔEN is 1.7 or greater.
- Dipole-dipole (polar covalent) is around 0.5-1.7.
- Hydrogen bonding is a type of dipole-dipole.
- London forces exist in all molecules, but are especially important in non-polar covalent molecules (where ΔEN is less than 0.5)
- Recall that ionic are strongest.
- Dipole-dipole are not as strong.
- Hydrogen bonds are about five times stronger than a regular dipole-dipole bonds.
- London forces are weakest.



Hydrogen bonding

- H-bonding is a special type of dipole-dipole attraction that is very strong.
 - It occurs when N, O, or F are bonded to H.
- Q- Calculate the ΔEN for HCl and H₂O

- The high ΔEN of NH, OH, and HF bonds cause these to be strong forces.
- Also, because of the small size of hydrogen, it's positive charge can get very close to the negative dipole of another molecule.
- It is so strongly positive that it will sometimes exert a pull on a "lone pair" in a non-polar compound

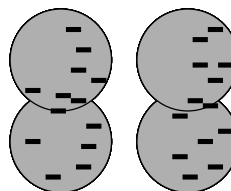


London forces

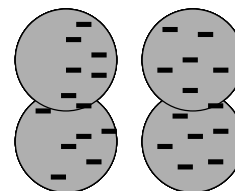
- Non-polar molecules do not have dipoles like polar molecules. How, then, can non-polar compounds form solids or liquids?
- London forces result from a type of tiny dipole.
- These forces exist between all molecules.
- They are masked by stronger forces (e.g. dipole-dipole) so are sometimes insignificant, but they are important in non-polar molecules.
- Because electrons are moving around in atoms there will be instants when the charge around an atom is not symmetrical.
- The resulting tiny dipoles result in attractions between atoms and/or molecules.

London forces

Instantaneous dipole:



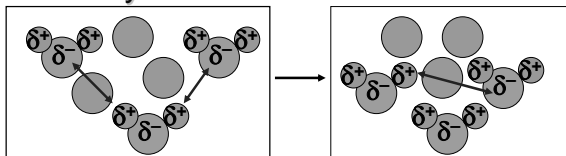
Induced dipole:



Eventually electrons are situated so that tiny dipoles form

A dipole forms in one atom or molecule, inducing a dipole in the other

Why oil and water don't mix



The non-polar substance is pushed away. If it were moving faster it might break through the attractive forces. Solubility is a balance between speed and attraction.

Also, the more similar the strength of their dipoles the more likely two compounds are to mix.

Temperature and Solubility

- Solubility is influenced by temperature.
- In warmer water, more solid will dissolve.
- This is because a high temperature means H₂O molecules are moving faster (keeping more solid molecules suspended).
- Conversely a gas will be less soluble at a higher temperature.
- This is because when gas molecules are moving faster they are able to escape from the liquid surface.
- Think of cold soda vs. warm soda. Warm soda goes flat faster.

