11/28/05

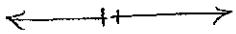
Lecture – CHM 123 (Monday, 10:30am)

Quiz 6 – next week, 12/5/05 (Tuesday) and 12/8/05 (Thursday)

Molecular Polarity

- Bonds between atoms can be polar.
- A molecule with polar bonds may or may not be polar.
  - If the polar bonds line up so that they cancel each other out, the molecule is nonpolar.

e.g. O=C=O

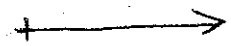


– Although C=O bond is polar (difference in electronegativity between C and O), the molecular is nonpolar because the 2 polarity vectors are equal in magnitude but opposite in direction and cancel each other out.

  - If the polar bonds do not line up so that they don't cancel each other, the molecule is polar.

e.g. Cl – Cl

nonpolar molecule



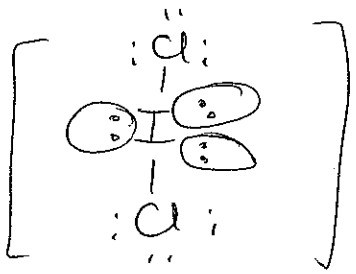
$\delta+$ H — Cl $\delta-$

polar molecule, HCl.

General trends regarding dipole moments:

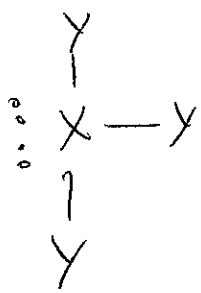
- A central atom with no lone pairs on it, surrounded by other atoms of all the same type will NOT have a dipole moment (CH_4, CO_2, SF_6)
- Central atom with no lone pairs, surrounded by other atoms of not all the same type WILL usually have a dipole (CH_3Cl, NO_2Cl, OCN).
- Central atom with lone pairs, surrounded by other atoms of any type WILL almost always have a dipole moment (H_2O, NH_3, ICl_3). There are exceptions to this trend.
- Diatomic molecules containing the same atoms will NOT have a dipole moment (O_2); a diatomic molecule containing different atoms WILL have a dipole moment (CO).

Exceptions to trend #3



- Molecule has no dipole moment.
- Symmetrically distributed lone pairs.

BUT



- Presence of dipole moment.
- Assymetric distribution of lone pairs.

Intermolecular Interactions

- Responsible for the internal 'structure' of liquids and solids.
  - always weaker than chemical bonds.
  - less directional than covalent bonds but more directional than ionic bonds.
  - operate at longer ranges than covalent bonds but at shorter ranges than ionic bonds.

Stronger the intermolecular interactions the higher the m.p (melting point) and b.p (boiling pt.) of a compound.

Types of Intermolecular Interactions

(a) London (dispersion forces):

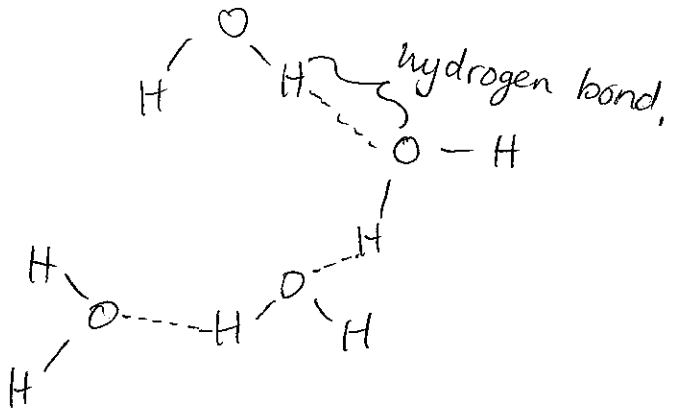
- occur in all molecular substances
- result from attraction between positive and negative ends of induced dipoles in adjacent molecules.
- Induced dipoles – instantaneous dipoles formed because of the movement of electrons in molecule (polarization).
- Increase with increasing number of electrons in molecule. e.g. I_2 should have stronger dispersion forces than F_2.

(b) Dipole – Dipole Interactions:

- Exist between polar molecules
- Result from attraction between positive and negative ends of permanent dipoles in adjacent molecules.
- Usually stronger than London forces.

(c) Hydrogen Bonding:

- special type of dipole-dipole interaction.
- attraction between partially positive hydrogen and lone pair of electrons on a small, very electronegative atom (O, F, N).
- strongest intermolecular ~~attraction~~ interaction, e.g. in water.



- Water has high surface tension & high boiling point due to hydrogen bonding.