(SN)
Solutions
Lecture 8
9/25/2008

➢ Summarizing Intermolecular forces

Weakest to strongest attractions:

- **London dispersion forces**: occurs with non-polar molecules, and is also weakest attraction (when taken individually) of all and holds ALL molecules. This attraction is strongest when molecules are very close to each other. Gets stronger if molecules are larger.
    - Larger molecular weights of molecules dominate the dispersion forces as the strongest forces against hydrogen and dipole bonds.
    - **Polarizability**: during dispersion forces interactions
        - When electrons repel one another, they cause movements of other electron density, thus; a temporary dipole - temporary dipole attraction between the + end of one temporary dipole and the – end of another molecule that is a temporary dipole.
        - The bigger the molecule, the more electrons repelling each other the higher its molecular weight and polarizability--- strong London dispersion attractions
- **Dipole-dipole forces:** occur only on polar molecules when one partially positive end attracts a partially negative end. They're also only effective when polar molecules are close to each other.
- **Ion-Dipole forces**: they are stronger forces because ions hold stronger positive and negative charges, as opposed to polar molecules where they hold partially negative and positive charge.
- **Hydrogen bonding:** The strongest of the van der Waals forces because it is associated with hydrogen reacting with **Cl, F, N** and **O**, which all have the very strong electronegativity.
- **Ion-ion forces:** stronger non dispersion forces that occur when a non-metal anion and a metal cation attract each other.

➢ Comparing Substances

Predict the boiling points from # 1 lowest boiling point and #4 for the highest

1. **CH_4 (least attracted to each other of the choices given)**
    a. Non polar molecule
    b. London dispersion forces
    c. They cancel out when drawn and also have the lowest molecular weight
2. **CH_3OCH_3**
    a. Polar
    b. Dispersion and dipole-dipole forces
    c. They don't cancel each other out since when drawn forms a bent structure.

3. **CH_3OH**
    - **a.** Polar
    - **b.** Dipole-dipole, hydrogen and dispersion forces
    - c. Strong electronegativity
4. **CCl_4**
    - **a.** Non polar
    - **b.** Dispersion forces
    - **c.** Even thought this attraction is non-polar, it is still stronger because of the high molecular weight it has associated with London dispersion, which is in this case is stronger than hydrogen bonding.

Options:

I. London dispersion
II. Dipole-dipole
III. Hydrogen bonding
IV. Ion-ion

➢ I-clicker activity

Practice telling which IM forces; what kinds of IM forces hold the following condensed phases together.

1. **H_2O(l):** hydrogen and dispersion forces
2. **CO_2 (s):** London dispersion attraction only:
    i. They have linear structure; the bond dipoles cancel each other out and make the molecule non-polar, even though it has polar C-O bonds.
    b. **CO_2 (aq) {dissolved in H2O):** Polar and non-polar
    i. Interactions between water and CO_2 which makes both dipole-induced *(polarizability)* and dipole-dipole interactions.
3. **NH_3 (l):** dipole-dipole, hydrogen and dispersion forces
    a. **NH_3 (aq) {dissolved}:** hydrogen, dipole and dispersion forces
    i. Same as H_2O
4. **$CaCl_2$ (s):** Ion-ion forces and London dispersion
    i. Metal ion (+ charge) attracted to nonmetal ion (- charge); strong positive ion charge attracted with strong negative ion charge
5. **Octane, C_8H_{18} (*l*):** dispersion forces
    i. Organic molecule
    ii. Neither polar nor does it have hydrogen bonding
6. **Diethyl ether, Tboil=308K CH3-CH2-O-CH2-CH3**: dipole-dipole forces
    i. When drawn, it has a bent structure, making it a polar molecule
7. **2-butanol, Tboil=372K CH3-CHOH-CH2-CH3:** hydrogen and dispersion forces
    i. O-H group makes it a hydrogen bonding molecule**.**