Chem 116

Lecture 7 - September 23, 2008 (EC)

How Intermolecular Forces Explain Behaviors of Particles in Condensed Phases (Liquids & Solids)

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a) CCl_4

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  Cl
Cl-C-Cl
  Cl
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b) CH_3OH

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  H
H-C-O-H
  H
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c) CH_3OCH_3

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  H   H
H-C-O-C-H
  H   H
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d) CO_2 O-C-O

*CH_3OH and CH_3OCH_3 both have Hydrogen in them but when the Lewis structures are drawn, there is only Hydrogen bonding in the CH_3OH since the O in CH_3OCH_3 is bonded to 2 Carbon atoms. (Hydrogen bonding only occurs between H and N, O, F, and Cl atoms)

*Since hydrogen bonding is the strongest of the 3 types of intermolecular forces, b is the answer.

3 Types of intermolecular forces:

1. London dispersion force
   a. Weakest of the 3 if in small molecule, but actually very strong in large molecules
   b. Occurs between all molecules
   c. Larger molecules have larger dispersion forces
2. Dipole-Dipole force
   a. Occurs between polar molecules
   b. Smaller polar molecules have larger dipole attractions
3. Hydrogen bond
   a. Occurs between H atoms with N, O, F, and Cl atoms

Things that increase the degree of polarity in a molecule:

1. The charges of the atoms of the molecule make the molecule polar
    a. H_2S,and CH_3Cl being polar because of the charges
    b. CH_4 being non polar because of the charges being neutral charge and the symmetric Lewis structure
2. The number of polar bonds
    a. CH_3Cl has only 1 negative Cl polar bond (somewhat polar)
    b. CH_3Cl_2 has 2 negative Cl polar bonds (more polar than CH_3Cl)
3. If they are Ions or not
    a. Ions form a especially strong Coulomb force due to their charges
    b. NaCl (which is Na^+Cl^- ions), and NH_4Cl, and NH_4NO_3 are examples of ionic compounds that have ionic forces of attraction holding the ions together in the solid state. Also hold ions together in the liquid ("molten") state.
    c. If they are ions
        i. An increase in the distance between the ion-ion molecules reduces the charge
            1. So larger the molecules, the smaller the ionic charge
            2. HCl (Cl is larger, wants e^- less) would be less polar than HF because Cl is less electronegative than F (smaller wants e^- more)
        ii. The number of positive or negative charges
            1. A +2 -1 ionic bond would have a stronger attraction than a +1 -1 ion
4. If they're Hydrogen bonding or not
    a. Hydrogen bonds are a special type of very strong dipole-dipole force with their own name
    b. Only happens when hydrogen bonds with N, O, F, or Cl (book leaves out Cl)
    c. Examples of Hydrogen bonds
        i. HCl
        ii. H_2O
        iii. CH_3COOH
        iv. NH_3
        v. NH_2Cl
    d. CH_3-O-CH_3 Is not a type of hydrogen bonding b/c the H's are only bonded to the C's (not to N, O, F, or Cl)
    e. In the follow acids
        i. $C_{11}H_{23}COOH$ 44ºC melting point
        ii. $C_{13}H_{27}COOH$ 58ºC melting point
        iii. $C_{15}H_{31}COOH$ 63ºC melting point
        iv. $C_{17}H_{35}COOH$ 70ºC melting point
            1. Hydrogen bonding is not the cause of the increase in melting point because they all have the same OH hydrogen bonds.
            2. The increase in the size of the molecules causes their dispersion forces to be greater, and therefore greater melting point.