KEY

HOW WELL DO YOU UNDERSTAND INTERMOLECULAR FORCES?

When contemplating the following problems it often helps to draw a Lewis structure for the included molecules.

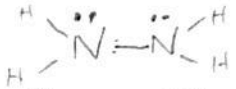
$-C-C\equiv N:$ $-C-I$ I's EN = 2.5

1. The dipole moments of acetonitrile, CH_3CN, and methyl iodide, CH_3I, are 3.9 D and 1.62 D, respectively.
   A) Which of these substances will have the greater dipole-dipole attractions among its molecules?
   B) Which of these substances will have the greater London dispersion attractions?
   C) The boiling points of CH_3CN and CH_3I are 354.8 K and 315.6 K, respectively. Which substance has the greatest overall attractive forces?

(A) CH_3CN ← A electroneg. more attractions to itself.
(B) more massive molecules have more e's to shift (CH_3I) 142 Amu / CH_3CN 41 Amu
(C) CH_3CN (more attractive forces due to dipole-dipole)

2. Of Br2, Ne, HCl, HBr, and N_2, which is likely to have
A) the largest intermolecular dispersion forces? Br_2 (most mass) 159.8 Amu most e's!
B) The largest dipole-dipole attractive forces?
— H-Cl largest electronegativity difference.

3. In which of the following substances is hydrogen bonding most likely to play an important role in determining physical properties: methane (CH_4), hydrazine (H_2NNH_2), methyl fluoride (CH_3F), or hydrogen sulfide (H_2S)? Hydrogen bonding occurs between H-X w/ X being O, F or N. These dipole-dipole attractions (H bonds) occur.
hydrazine (only actual H-X bonds)



4. In which of the following substances is significant hydrogen bonding possible: methylene chloride (CH_2Cl_2), phosphine (PH_3), hydrogen peroxide (HOOH), or acetone (CH_3COCH_3)?

HOOH (only X-H bonds)

1813K 20K 83K 293K 27K

5. List the substances $BaCl_2$, H2, CO, HF, and Ne in order of increasing boiling points.

non polar → $H_2 < Ne < CO < HF < BaCl_2$ ← ionic!
H bonds
very slightly polar more mass than

6. (mass) dispersion only

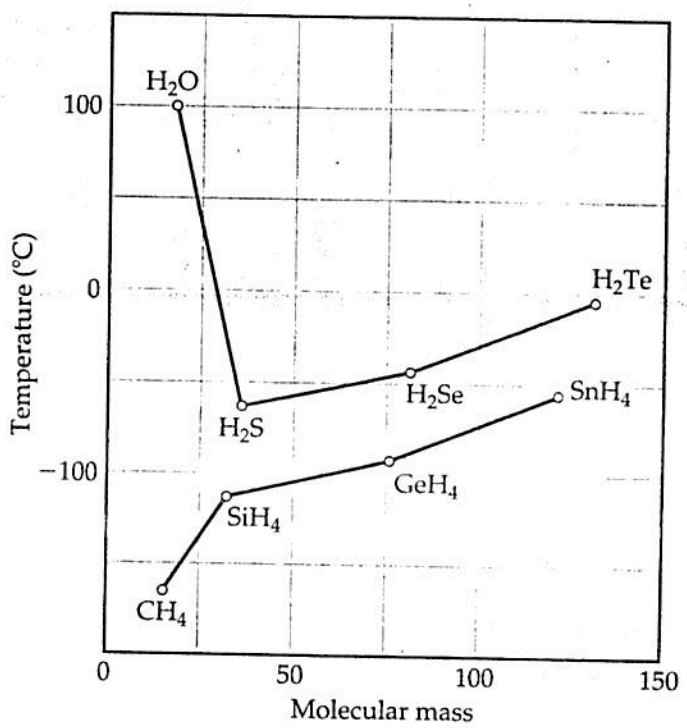
$:C\equiv O:$ more electroneg.

A)Identify the intermolecular forces present in the following substances, and
B) select the substance with the highest boiling point:
CH_3CH_3, CH_3OH, CH_3CH_2OH

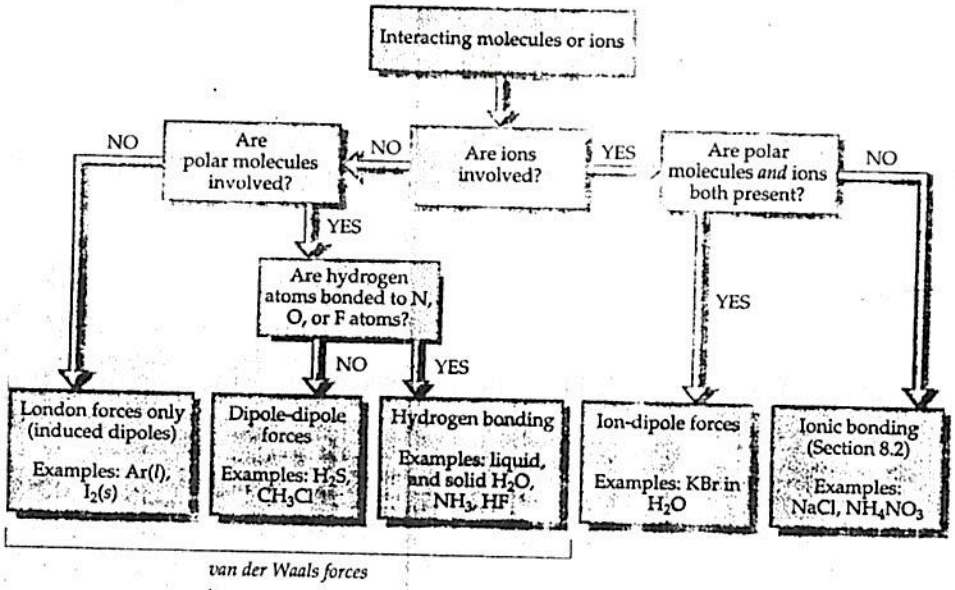
(A) 1 dispersion, disp + H bonds, disp + H bonds

(B) ethanol CH_3CH_2OH because of disp + OH dipole - H bonds more mass

T-110 **Figure 11.7 Boiling Points of Hydrides**



T-112 **Figure 11.12 Flowchart for Intermolecular Forces**

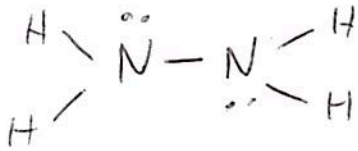


3. In which of the following substances is hydrogen bonding most likely to play an important role in determining physical properties: methane (CH_4), hydrazine (H_2NNH_2), methyl fluoride (CH_3F), or hydrogen sulfide (H_2S)?

Hydrogen bonding occurs between H-X with X being F, N, O with Free pairs of electrons

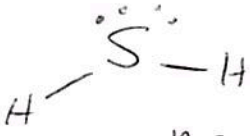
- CH_4 has no O, N, F

- Hydrazine (H bonding!) the only one!



has H bonded to N w/ Free pairs

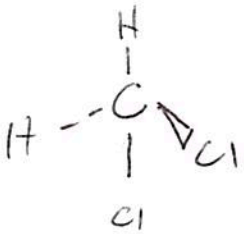
CH_3F - The F is bonded to C! There is no H-F bond (Know your structures!)



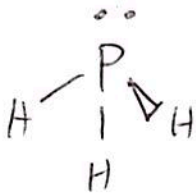
no H-X bond!

4. In which of the following substances is significant hydrogen bonding possible: methylene chloride (CH_2Cl_2), phosphine (PH_3), hydrogen peroxide (HOOH), or acetone (CH_3COCH_3)?

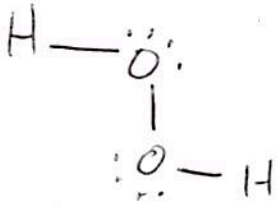
CH_2Cl_2



no H-X bond!

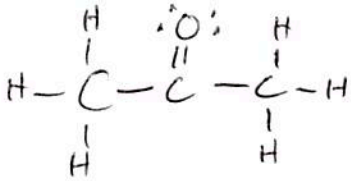


no H-X bond!



Yes! two possibilities for H bonding!

CH_3COCH_3 (acetone)



no H-X bond.

but peroxides H could H-bond to the $=\ddot{O}$

5. List the substances $BaCl_2$, H2, CO, HF, and Ne in order of increasing boiling points.

$BaCl_2$ is ionic! (even boiled salt?)

H_2 (weak dispersion, low mass)

CO :C≡O: (polar bond, dipole-dipole)

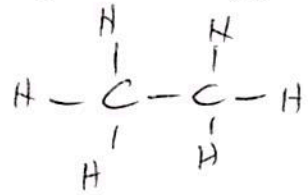
HF H—F: (very polar bond, stronger dipole-dipole)

Ne (noble gas, no bonds, weak dispersion, but more mass than H_2)

$$H_2 < He < CO < HF < BaCl_2$$

6.
A) Identify the intermolecular forces present in the following substances, and
B) select the substance with the highest boiling point:
CH_3CH_3, CH_3OH, CH_3CH_2OH

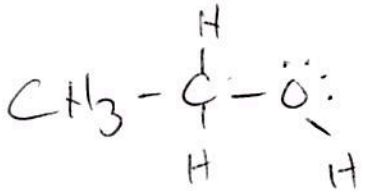
CH_3CH_3 (ethane)



all non-polar bonds, only disp. forces.
Molar mass = 30.06g.

CH_3-Ö: (methanol)
H

Hydrogen bonding w/ dispersion H-Ö bond (w/ free pairs)



H-bonding + dispersion (has more mass & dispersion than methanol)

$\boxed{\text{Ethanol has highest b.p!}}$