Solids, Liquids & IMF's Practice

1. Use appropriate chemical principles to account for each of the following observations. In each part, your response must include specific information about both substances. F-F I-I

(a) At 25° C and 1 atm, F_2 is a gas whereas I_2 is a solid.

The intermolecular forces of I_2 are stronger than those of F_2, thus I_2 is a solid. I_2 has more electrons than F_2, thus I_2 is more polarizable than F_2 and will have stronger London Dispersion forces.

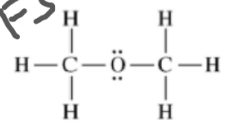
(b) The melting point of NaF is 993° C, whereas the melting point of CsCl is 645°C.

NaF has stronger ionic bonds than CsCl. Na^+ is a smaller ion than Cs^+, therefore the Na^+ ion is attracted more to its negative ion than Cs^+ to its negative ion.

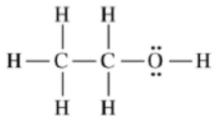
2. Answer the following questions by using principles of molecular structure and intermolecular forces.

(a) Structures of the dimethyl ether molecule and the ethanol molecule are shown below. The normal boiling point of dimethyl ether is 250 K, whereas the normal boiling point of ethanol is 351 K. Account for the difference in boiling points. You must discuss both of the substances in your answer.

LDF's



Dimethyl Ether



Ethanol

H-bonding

Bp = 250 K Bp = 351 K

Ethanol has stronger attractions (IMF's) than dimethyl ether. Ethanol has H-bonding between its molecules whereas dimethyl ether has LDF's. Since H-bonding is a stronger attraction than LDF's, the boiling point of ethanol is higher than that of dimethyl ether.

(b) SO_2 melts at 201 K, whereas SiO_2 melts at 1,883 K. Account for the difference in melting points. You must discuss both of the substances in your answer.

SiO_2 melts when covalent bonds are broken whereas SO_2 melts when LDF's are broken. Since covalent bonds are stronger than LDF's, SiO_2 will melt at a higher temperature.

(c) The normal boiling point of $Cl_2(l)$ (238 K) is higher than the normal boiling point of $HCl(l)$ (188 K). Account for the difference in normal boiling points based on the types of intermolecular forces in the substances. You must discuss both of the substances in your answer.

Cl_2 has stronger IMF's than HCl. The London Dispersion forces of Cl_2 are stronger than the dipole-dipole forces of HCl.

Multiple Choice

3. The London (dispersion) forces are weakest for which of the following gases under the same conditions of temperature and pressure?

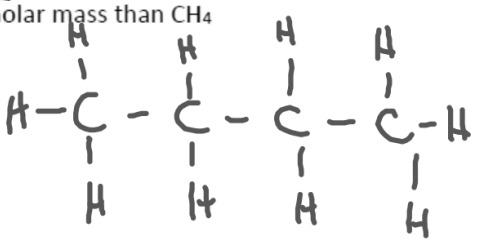
   (a) H_2
   (b) O_2
   (c) F_2
   (d) N_2

weakest LDF = fewest # of e-

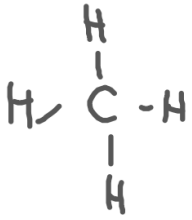
4. Which of the following best accounts for why C_4H_{10} has a higher normal boiling point than CH_4?

   (a) C_4H_{10} exhibits more hydrogen bonding than CH_4
   (b) C_4H_{10} has greater dispersion forces than CH_4
   (c) C_4H_{10} is a more polar molecule than CH_4
   (d) C_4H_{10} has a higher molar mass than CH_4

C_4H_{10} nonpolar



CH_4 nonpolar



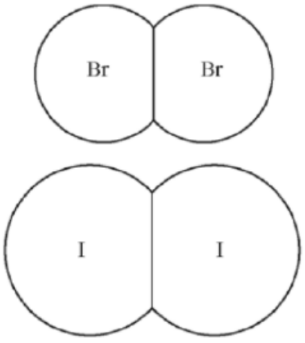
Substance	Equilibrium Vapor Pressure at 20°C (torr)
$C_6H_6(l)$	75
$C_2H_5OH(l)$	44
$CH_3OH(l)$	92
$C_2H_6O_2(l)$	0.06

= greatest # gas particles

5. Based on the data in the table above, which of the following liquid substances has the weakest intermolecular forces?

↖ easiest to separate molecules from one another

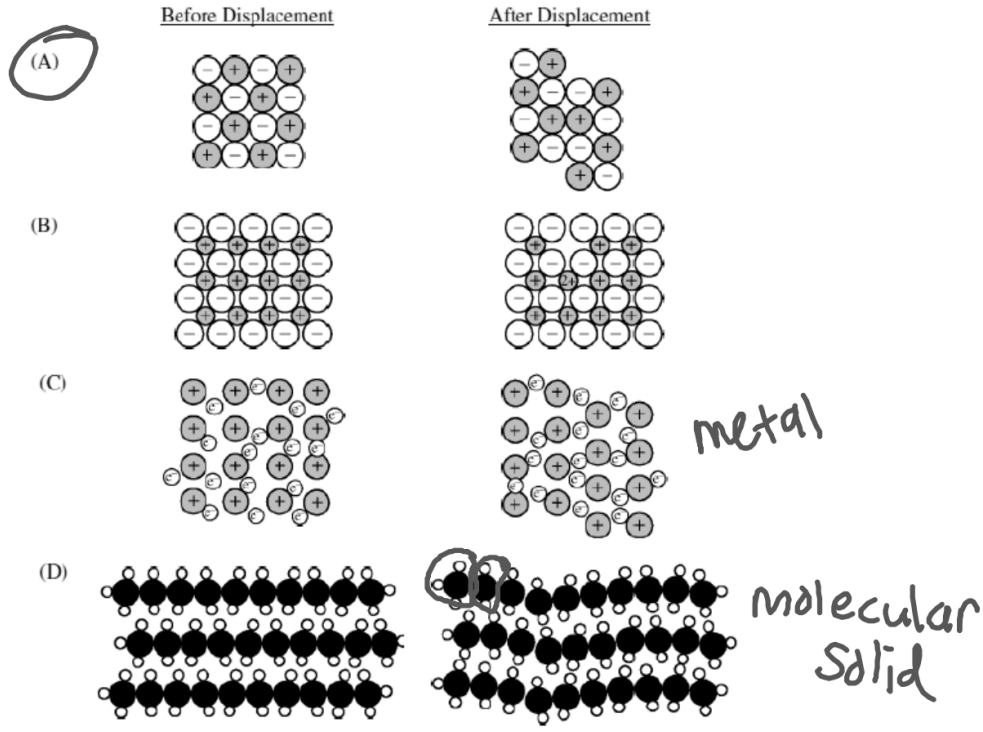
(a) $C_6H_6(l)$
(b) $C_2H_5OH(l)$
(c) $CH_3OH(l)$
(d) $C_2H_6O_2(l)$



6. The diagram above shows molecule of Br_2 and I_2 drawn to the same scale. Which of the following is the best explanation for the difference in the boiling points of liquid Br_2 and I_2, which are 59°C and 184°C, respectively?

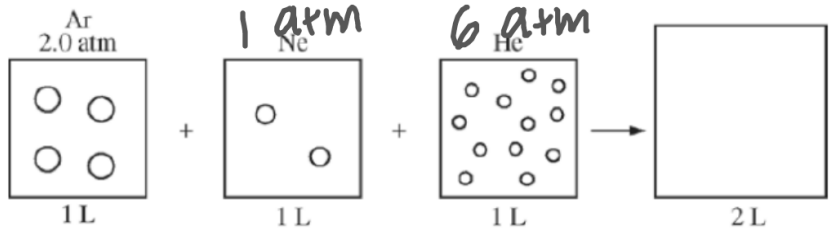
(a) Solid iodine is a network covalent solid, whereas solid bromine is a molecular solid.
(b) The covalent bonds in I_2 molecules are weaker than those in Br_2 molecules.
(c) I_2 molecules have electron clouds that are more polarizable than those of Br_2 molecules, thus London dispersion forces are stronger in liquid I_2.
(d) Bromine has a greater electronegativity than iodine, thus there are stronger dipole-dipole forces in liquid bromine than in liquid iodine.

7. Which of the following diagrams best illustrate how a displacement in an ionic crystal results in cleavage and brittleness?



metal

molecular solid



1 atm

6 atm

8. The figure above represents three sealed 1.0 L vessels, each containing a different inert gas at 298 K. The pressure of Ar in the first vessel is 2.0 atm. The ratio of the numbers of Ar, Ne, and He atoms in the vessels is 2 : 1 : 6, respectively. After all the gases are combined in a previously evacuated 2.0 L vessel, what is the total pressure of the gases at 298 K?

(a) 3.0 atm
(b) 4.5 atm
(c) 9.0 atm
(d) 18 atm

All 3 gases in 1.0 L container

$P_T = 2 + 1 + 6 = 9$ atm

All 3 gases in 2 L container,

$P_T = \frac{9}{2} = 4.5$ atm