MULTIPLE CHOICE (2 pts each): Write the ONE letter corresponding to the correct answer on the line next to each question. The LETTER ASSOCIATED WITH THE CORRECT ANSWER <u>MUST BE WRITTEN ON THE LINE NEXT TO THE QUESTION</u> in order to receive full credit.

1) The solubility of which type of solution is most impacted by pressure?

    a) gases in liquids   b) solids in solids

    c) solids in liquids   d) liquids in liquids

1)   _A_

2) Which type of solution is the least stable?

    a) unsaturated   b) saturated

    c) homogeneous   d) supersaturated

2)   _D_

3) A crystal that is a good conductor of heat an electricity is most likely to be

    a) ionic   b) covalent   c) molecular   d) metallic

3)   _D_

4) A phase change associated with the molar heat of fusion would be

    a) boiling   b) melting

    c) sublimation   d) condensation

4)   _B_

5) The strongest **<u>intermolecular</u>** attractive force is a

    a) dipole-dipole interaction   b) covalent bond

    c) dispersion force   d) hydrogen bond

5)   _D_

6) A carbon atom with one double bond and two single bonds would have which geometry?

    a) tetrahedral   b) bent

    c) linear   d) trigonal planar

6)   _D_

7) The measure of resistance to flow is referred to as

    a) viscosity   b) surface tension

    c) adhesion   d) cohesion

7)   _A_

8) Shared electron density directly between two nuclei forms a

    a) beta bond   b) sigma bond   c) pi bond   d) James Bond

8)   _B_

9) For greater stability, it is best to have electrons in

    a) antibonding orbitals   b) ice cream

    c) coffee   d) bonding orbitals

9)   _D_

10) Which geometry requires a violation of the octet rule?

    a) octahedral   b) trigonal planar

    c) tetrahedral   d) linear

10)   _A_

MULTIPLE CHOICE (5 pts each): Write the ONE letter corresponding to the correct answer on the line next to each question. The LETTER ASSOCIATED WITH THE CORRECT ANSWER <u>MUST BE</u> <u>WRITTEN ON THE LINE NEXT TO THE QUESTION</u> in order to receive full credit.

1) What is the molality of a 100.0 g aqueous solution containing 25.0 g NaCl (58.4428 g/mol).   1) __B__

    a) 4.3 m   (b) 5.7 m   c) 2.9 m   d) 3.4 m

2) How much energy would be required to vaporize 25.0 g ethanol (46.0684 g/mol) at 78.4°C (its normal boiling point)? $\triangle H_{vap}$ = 42.3 kJ/mol.   2) __B__

    a) 115 kJ   (b) 23.0 kJ   c) 91.8 kJ   d) 45.9 kJ

3) What concentration of ~~salt~~ NaCl would be needed to obtain an osmotic pressure of 2.9 atm at 25°C?   3) __0.041 M__

    ~~a) 9.8 M~~   ~~b) 9.1 M~~   ~~c) 8.4 M~~   ~~d) 10.6 M~~ (original exam had error)

4) What is the boiling point of a 1.36 m solution of methanol in ethanol. Ethanol boils at 78.4°C and has a K_b value of 1.22°C/m.   4) __D__

    a) 76.7°C   b) 1.66°C   c) -1.66°C   (d) 80.1°C

5) What is the freezing point of a 0.518m aqueous solution of NaCl? K_f = 1.86°C/m   5) __D__

    a) -0.96°C   b) 0.96°C   c) 1.93°C   (d) -1.93°C

6) What is the concentration of a gas at 2.5 atm if its k value is 0.278 mol L^{-1}atm^{-1}?   6) __B__

    a) 0.639 M   (b) 0.695 M   c) 0.584 M   d) 0.751 M

① $m = \dfrac{\text{moles solute}}{\text{kg solvent}} = \dfrac{0.4278 \text{ mol}}{0.0750 \text{ kg}} = 5.7034 \text{ m}$

$25.0g\left(\dfrac{1 mol}{58.4428g}\right) = 0.4278 \text{ mol}$

$kg\ solvent = 100.0g - 25.0g = \dfrac{75.0g}{1000 g/kg} = 0.0750 kg$

② $25.0g\left(\dfrac{1mol}{46.0684g}\right) = 0.54267 mol\left(\dfrac{42.3 kJ}{mol}\right) = 22.95 kJ$

③ $\pi = iMRT$ $2.9 atm = (2)(M)\left(0.0821 \frac{L\ atm}{mol\ K}\right)(298.15 K)$

    $2.9 atm = (M)\left(70.9865 \frac{L\ atm}{mol}\right)$

    $M = 0.04085 \text{ mol}/L$

④ $\Delta T = i k_B m = (1)(1.22°C/m)(1.36 m) = 1.6592°C + 78.4°C = 80.06°C$

⑤ $\Delta T = i k_f m = (2)(1.86°C/m)(0.518 m) = 1.927°C$ $0°C - 1.927°C$
                                                   $= -1.927°C$

⑥ $C = kP = (0.278 \text{ mol } L^{-1}atm^{-1})(2.5 atm) = 0.695 \text{ mol}/L$

SHORT ANSWER (10 pts each): Completely answer all of the following questions. Read all questions carefully!!! Show all work. Make sure to include units and report all mathematical answers to the correct number of significant figures. Write final answers in designated locations when indicated.

1. How much energy, in kJ, would be needed to covert 125.0 g water at 30.0 °C into steam at 110.0°C? $\Delta H_{vap} = 40.79$ kJ/mol, specific heats on cover sheet.

Boil

100°C   110.0°C

30°C

on cover sheet

Answer: 332.1 kJ

70.0°C
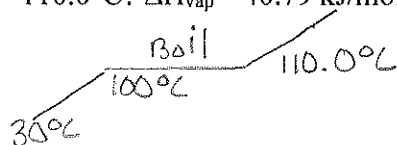
① $q = ms\Delta T = (125.0g)(4.184 \text{ J/g°C})(100.0°C - 30.0°C) = 36610 J \rightarrow 36.610 kJ$

② $125.0g\left(\frac{1mol}{18.01528g}\right) = 6.93855 \text{ mol} \left(\frac{40.79 kJ}{mol}\right) = 283.02 kJ$ 283.02 kJ

10.0°C

③ $q = ms\Delta T = (125.0g)(1.99 \text{ J/g°C})(110.0°C - 100.0°C) = 2487.5 J$

2.4875 kJ
_____
332.12 kJ

↳ 332.1 kJ

2. Draw Lewis Structures for the molecules listed in the following table and use those structures to fill in the table.

Molecule	Electron Pair Geometry	Molecular Geometry	Is the molecule polar or nonpolar?
OF$_2$	tetrahedral	bent	polar
NF$_3$	tetrahedral	trigonal pyramidal	polar
CHCl$_3$	tetrahedral	tetrahedral	polar
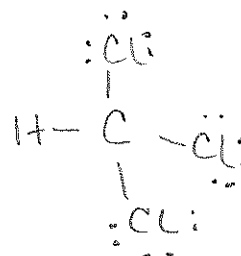
3. For the molecule below, what is the number of sigma (σ) and pi (π) bonds? What is the hybridization for each numbered carbon?
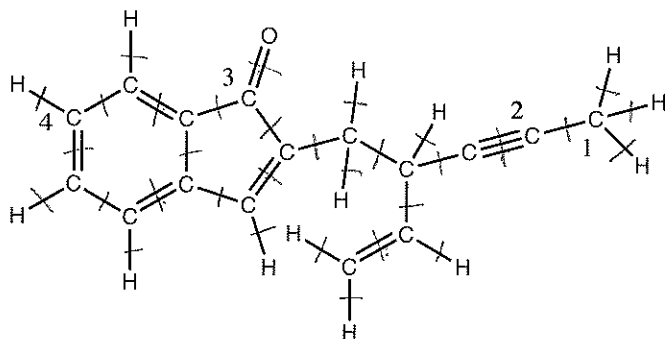
sigma bonds

$$32$$

pi bonds

$$8$$

Hybridization For Carbon #

1	2	3	4
sp^3	sp	sp^2	sp^2

4. What is the vapor pressure of <u>benzene</u> (78.114 g/mol) in a 120.0 g solution containing 5.00 g of butane (58.123 g/mol) at 25°C? The vapor pressure of pure benzene is 94.8 mmHg at 25°C.

$$P_a = X_a P^o_a$$

Answer: __89.6 mm Hg__

$$X_a = \frac{mole\ benzene}{total\ moles} = \frac{1.4722\ mol}{(1.4722 mol + 0.086024 mol)} = \frac{1.4722 mol}{1.5582 mol} = 0.9448$$

$$1.5582 mol$$

mass benzene : 120.0g − 5.00g = 115.0g

moles benzene : $115.0g \left(\frac{1 mol}{78.114g}\right) = 1.4722\ mol$

moles butane : $5.00g \left(\frac{1 mole}{58.123\ g}\right) = 0.086024\ mol$

$$P_a = (0.9448)(94.8\ mmHg) = 89.57\ mm\ Hg$$

5. List the most important intermolecular attractive force that can be used by each of the following structures, and then circle the appropriate structure for each question.
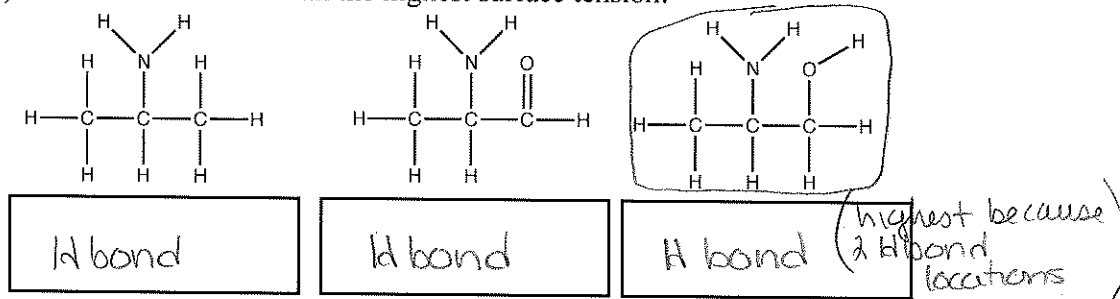
a.) Circle the molecule with the highest boiling point:

| dispersion | dispersion | dispersion |
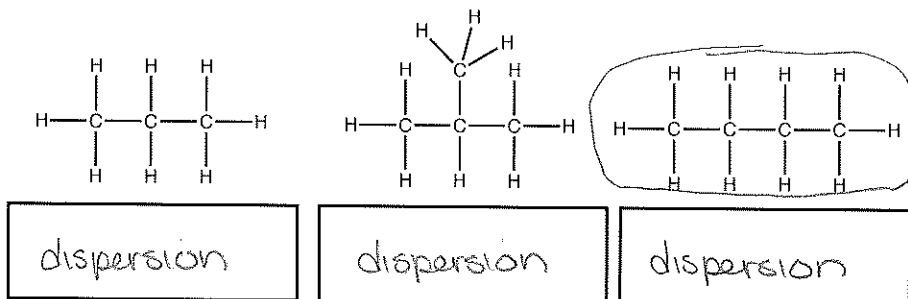
b.) Circle the molecule with the highest water solubility:

| dispersion | H bond | dipole-dipole |
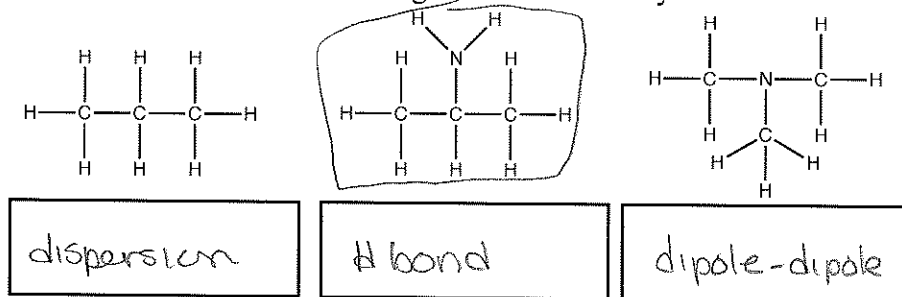
c.) Circle the molecule with the highest surface tension:

| H bond | H bond | H bond (highest because 2 H bond locations) |

d.) Circle the molecule with the highest vapor pressure:

| dipole-dipole | H bond | H bond |

(highest because also has dipole-dipole)