Name ____ **AP Chemistry**

Chapter 11 HW 3: Due 2/23/16 Complete both free response questions. One will be graded. Show all work. Box and clearly label all final answers for question 1. Write the answers to question 2 on the line with the correct unit.

1. The formula and the molecular weight of an unknown hydrocarbon compound are to be determined by elemental analysis and the freezing-point depression method.
(a) The hydrocarbon is found to contain 93.46 percent carbon and 6.54 percent hydrogen. Calculate the empirical formula of the unknown hydrocarbon.
(b) A solution is prepared by dissolving 2.53 grams of p-dichlorobenzene (molecular weight 147.0) in 25.86 grams of naphthalene (molecular weight 128.2). Calculate the molality of the p-dichlorobenzene solution.
(c) The freezing point of pure naphthalene is determined to be 80.2°C. The solution prepared in (b) is found to have an initial freezing point of 75.7°C. Calculate the molal freezing-point depression constant of naphthalene.
(d) A solution of 2.42 grams of the unknown hydrocarbon dissolved in 26.7 grams of naphthalene is found to freeze initially at 76.2°C. Calculate the apparent molecular weight of the unknown hydrocarbon on the basis of the freezing-point depression experiment above.
(e) What is the molecular formula of the unknown hydrocarbon?

a. C: 93.46 ÷ 12.01 = 7.78 ÷ 6.47 = 1.20 × 5 = 6 [C_6H_5]
H: 6.54 ÷ 1.01 = 6.47 ÷ 6.47 = 1 × 5 = 5

b. 2.53 ÷ 147.0 = 0.0172 ÷ 0.02586 = [0.666 m]

c. $\Delta T = imK$
4.5 = (1)(0.666)(K)
[K = 6.76 °C kg mol^{-1}]

d. $\Delta T = imK$
(4.0) = (1)(m)(6.76)
m = 0.592 mol/kg × 0.0267 = 0.0158 mol

2.42 ÷ 0.0158 = [153 g/mol]

e. C_6H_5 = 77 g/mol
153 ÷ 77 = 2 [$C_{12}H_{10}$]

2. Many years ago on a Friday at 2:45 PM at Herndon High School while working late and avoiding my responsibilities at home I prepared a solution (it didn't solve any problems but did create a bunch of questions –see some of them below). I added 21.47 grams of NaCl to 330.00 mL of water. There was no change in volume. The temperature of the solution was 20.0˚C. I did not cover the solution and man it started evaporating. The density of water at 20.0˚C is 0.99823g/mL. The vapor pressure of water at 20.0˚C is 17.5 mm Hg. The molal boiling point elevation constant of water is 0.51 ˚C kg/mol. The molal freezing point depression constant of water is 1.86˚C kg/mol. Write the answer to each question on the line after the question. **Attach all work on a separate sheet of paper. If there is no work you will not receive any credit.**

a. Calculate the molarity of the initial solution. 0.367 ÷ 0.33 = 1.11 M

b. Calculate the mole fraction of sodium chloride in the initial solution. 0.367 ÷ 18.65 = 0.0197

c. Calculate the mass percent of sodium chloride in the initial solution. 21.47 ÷ 350.89 × 100 = 6.12%

d. Calculate the molality of the initial solution. 0.367 ÷ 0.32942 = 1.11 m

e. Calculate the density of the initial solution. 350.89 ÷ 330.00 = 1.06 g/mL

f. Calculate the vapor pressure of the initial solution. P = (17.5)(0.962) = 16.8 mm Hg

g. Calculate the boiling point of the initial solution. ΔT = (2)(1.11)(0.51) = 1.13 T = 101.13˚C

h. Calculate the freezing point of the initial solution. ΔT = (2)(1.11)(1.86) = 4.13 T = -4.13˚C

i. Calculate the osmotic pressure of the initial solution at 20.0˚C. $\pi = iMRT$ = (2)(1.11)(0.08206)(293) = 53.4 atm

j. When I returned on Monday I reweighed the sample at 8:15 AM. The new mass was 322.31 grams. Calculate the number of water molecules that evaporated over the weekend. 9.55×10^{23} molecules

k. Calculate the average number of water molecules that evaporated per second. 4.05×10^{18} molecules/sec

l. Calculate the molality of the solution on Monday morning at 8:15 AM. $\frac{0.367}{0.30084}$ = 1.22 m

f. X = (0.367 × 2) = 0.734 18.28 + 0.734 = 19.01

18.28 / 19.01 = 0.962

j. 350.89 − 322.31 = 28.58 ÷ 18.02 × 6.022 × 10^{23} = 9.55×10^{23}

K 65.5 hr × $\frac{60\text{ min}}{1\text{ hr}}$ × $\frac{60\text{ sec}}{1\text{ min}}$ = 235800 sec

9.55×10^{23} ÷ 235800 = 4.05×10^{18}

58.44 18.02

	Solute +	Solvent =	Solution
volume	% volume	% volume 330.00	% volume Molarity 330.00
convert between volume and mass using density			
mass	% mass 21.47	% mass molality (in kg) 329.42	% mass 350.89
convert between mass and moles using the gram formula mass			
moles	mole fraction Molarity molality 0.367	mole fraction 18.28	mole fraction 18.65

	Solute +	Solvent =	Solution
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convert between volume and mass using density			
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	Solute +	Solvent =	Solution
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