Honors Chemistry
Colligative Properties Worksheet

Name: Key Date: _____

PART A – BACKGROUND SKILLS

1. Indicate how many particles are formed when the following solutes dissolve.

SOLUTE	# OF PARTICLES	SOLUTE	# OF PARTICLES
sucrose ($C_{12}H_{22}O_{11}$) molecular →	1	magnesium chloride ($MgCl_2$)	3
sodium sulfate (Na_2SO_4) $2Na^+ + SO_4^{2-}$	3	methanol (CH_3OH) ← molecular	1

2. Calculate the mole fraction of solvent in each of the following solutions:

a. 3.0 moles of LiBr dissolved in 6.0 moles water

$X_{solvent} = \frac{\text{moles solvent}}{\text{total moles}}$ $\frac{6.0 \text{ moles } H_2O}{9.0 \text{ moles total}} = .67$

b. 125.0 g KNO_3 dissolved in 800.0 g water

K $1 \times 39.10 = 39.10$
N $1 \times 14.01 = 14.01$
O $3 \times 16.00 = 48.00$
101.11 g/mol

$125.0 \text{ g } KNO_3 \left(\frac{1 \text{ mol}}{101.11 \text{ g}}\right) = 1.2363 \text{ mol}$

+

H $2 \times 1.01 = 2.02$
O $1 \times 16.00 = 16.00$
18.02 g/mol

$800.0 \text{ g } H_2O \left(\frac{1 \text{ mol}}{18.02 \text{ g}}\right) = 44.3951 \text{ mol}$

$44.3951 \text{ mol } H_2O$ / $45.6314 \text{ mol total}$

.9729

3. Calculate the molality of each of the following solutions

a. 2.3 moles glucose dissolved in 500.0 g of water

$m = \frac{\text{moles solute}}{\text{Kg solvent}}$ $\frac{2.3 \text{ moles glucose}}{.5000 \text{ Kg } H_2O} = 4.6 \text{ m}$

$500.0 \text{ g} \left(\frac{1 \text{ kg}}{1000 \text{ g}}\right) = .5000 \text{ Kg}$

b. 131 g KNO_3 dissolved in 750.0 g of water

$131 \text{ g } KNO_3 \left(\frac{1 \text{ mol}}{101.11 \text{ g}}\right) = 1.29562 \text{ mol}$

$750.0 \text{ g } H_2O \left(\frac{1 \text{ Kg}}{1000 \text{ g}}\right) = .750 \text{ Kg } H_2O$

$m = \frac{1.29562 \text{ mol}}{.750 \text{ Kg}}$

$m = 1.727493$

1.73m

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PART B – CALCULATIONS

4. Calculate the vapor pressure of a solution containing 34.0 g of glycerol ($C_3H_8O_3$) in 500.0 g of water at 60°C

C 3(12.01) = 36.03
H 8(1.01) = 8.08
O 3(16.00) = 48.00
92.11 g/mol

$VP_{solution} = X_{solvent} \cdot VP_{solvent}$

$VP_{solution} = \frac{27.74694 \text{ mol } H_2O}{(27.74694 + .36912) \text{ mol}} \cdot (19.9 \text{ kPa})$ ← FROM CHART

$VP_{solution} = 19.6 \text{ kPa}$

$34.0 \text{ g} \left(\frac{1 \text{ mol}}{92.11 \text{ g}}\right) = .36912 \text{ mol glycerol}$

$500.0 \text{ g } H_2O \left(\frac{1 \text{ mol}}{18.02}\right) = 27.74694 \text{ mol } H_2O$

5. When 5.0 g of LiBr dissolves in 50.0 g of water, what is the boiling point of the solution?

Li 1×6.94 = 6.94
Br 1×79.90 = 79.90
86.84 g/mol

$5.0 \text{ g} \left(\frac{1 \text{ mol}}{86.84 \text{ g}}\right) = .057577 \text{ mol}$

LiBr → Li^+ Br^- i = 2

$K_{bp} = .515 \text{ °C/m}$

$\Delta T_{bp} = K_{bp} \times m \times i$

$\Delta T_{bp} = (.515 \text{ °C/m})\left(\frac{.057577 \text{ mol}}{.050 \text{ kg}}\right)(2)$

$\Delta T_{bp} = 1.186089 = 1.2 \text{ °C}$

new bp = 100 + 1.2 = **101.2 °C**

6. Find the boiling point of a solution containing 6.0 g benzene, C_6H_6, in 35 g of napthalene. (K_b of naphthalene = 5.65 °C/*m*)

elevation

molecular i = 1

C_6H_6
C 6×12.01 = 72.06
H 6×1.01 = 6.06
78.12 g/mol

$6.0 \text{ g } C_6H_6 \left(\frac{1 \text{ mol}}{78.12 \text{ g}}\right) = .0768 \text{ mol}$

$\Delta T_{bp} = K_{bp} \times m \times i$

$\Delta T_{bp} = (5.65 \text{ °C/m})\left(\frac{.0768 \text{ mol}}{.035 \text{ kg}}\right)(1)$

$\Delta T_{bp} = 12.3985 \Rightarrow$ **12 °C**

7. Calculate the freezing point depression of a 1.50 *m* $CaCl_2$ solution. (aqueous ⇒ H_2O = solvent)

K_{fp} H_2O = 1.853 °C/m

↳ i = 3

$\Delta T_{fp} = K_{fp} \times m \times i$

$\Delta T_{fp} = (1.853 \text{ °C/m})(1.5 \text{ m})(3)$

$\Delta T_{fp} = 8.3385 =$ **8.34 °C**

8. Ether has a K_{4p} = 1.79°C/m. When 3.8 g of an unknown molecular solute is dissolved in 100g of ether, the resulting solution has a freezing point depression of 0.570°C. What is the molecular mass of the solute?

$\Delta T_{fp} = K_{fp} \times m \times i$

$0.570 \text{ °C} = (1.79 \text{ °C/m})(x)(1)$

$x = 0.318435 \text{ mol/kg}$

$\frac{.318435 \text{ mol}}{\text{kg}} \cdot (0.100 \text{ kg}) = .0318435 \text{ mol}$

The solution contains .0318435 mol OR 3.8 g so

$\frac{3.8 \text{ g}}{.0318435 \text{ mol}} =$

119.339 g/mol