WORKSHEET:SOLUTIONS AND COLLIGATIVE PROPERTIES

SET A:

1. Find the molarity of all ions in a solution that contains 0.165 moles of aluminum chloride in 820. ml solution.

Answer: $[Al^{3+}]$= 0.201 M , (Cl^-) = 0.603M.

2. Find the molarity of each ion present after mixing 27 ml of 0.25 M HNO_3 with 36 ml of 0.42 M $Ca(NO_3)_2$ (Note: There is no reaction taking place.)

Answer: $[H^+]$= 0.11 M, $[NO_3^-]$= 0.59M, $[Ca^{2+}]$= 0.24 M .

3. Find the molarity of each ion present after mixing 35 ml of 0.42 M K_2SO_4 with 27 ml of 0.17M K_3PO_4.

Answer: $[K^+]$ = 0.71 M, $[SO_4^{2-}]$= 0.24 M, $[PO4^{3-}]$= 0.074 M.

4. Calculate the concentration of each ion and the mass of any precipitate when a 0.300 mole of aluminum hydroxide is added to 50.0 ml of 2.5 M nitric acid solution (Assume that there is no volume change upon the addition of the aluminum hydroxide to the solution).
Hint: Write a balanced equation for the reaction taking place.

Answer: 20 g $Al(OH)_3$ left over, $[Al^{3+}]$=0.83 M, $[NO_3^-]$= 2.5M

5. A solution consists of 3.88 g benzene,C_6H_6 , and 2.45 g toluene ,$C_6H_5CH_3$. The vapor pressure of pure benzene at 20. °C is 75 mm Hg and that of toluene at 20.0 °C is 22 mm Hg. Assume that Raoult's law holds for each component of the solution, calculate the mole fraction of benzene in the **vapor**. (molar mass of benzene= 78.0 g/mole and toluene = 92.0 g/mole.)

Answer= 0.87

6. The freezing point of a glucose solution ($C_6H_{12}O_6$;molar mass= 180.0 g/mole) is - 10.3 °C . The density of the solution is 1.50 g/ml. What is the molarity of the glucose solution? (K_f for water is 1.86 °C.kg/mole)

Answer: 4.16 mole/L

7. What is the normal boiling point of a 2.70 M solution of KBr that has a density of 1.80 g/ml?(K_B for H_2O is 0.512 °C .kg/mole) Answer=: 101.9 °C

8. 28.00 ml of 0.670 M potassium carbonate solution is mixed with 15.00 ml of 0.940 M cobalt(III) chloride
a. Write a balanced equation for the reaction.

b. Write the total-ionic and net-ionic equations for the above reaction.
Total ionic:
Net-ionic:
c. Give the name and mass of any precipitate(s)that may have formed.

Answer: 1.87 g of $Co_2(CO3)_3$ precipitate.

Calculate the molar concentration of each ion remaining in solution after the reaction is complete.

Answer:concentration of potassium ions= 0.874 M,
concentration of cobalt (III) ions= 0.0372 M
concentration of carbonate ions= 0 M
concentration of chloride ions= 0.986 M

SET B:

1. A solution that contains 12.6 g of a nonvolatile nondissociating solute in 400. g of benzene freezes at 3.6 °C . The normal freezing point of benzene is 5.5 °C. What is the molar mass of the solute? (K_F for benzene= 4.96 °C .kg/mole)

Answer: 82 g/mole

2. Chloroform and methanol form an ideal solution. The solution boils at 22 °C and 0.255 atm . At 22 °C , the vapor pressure of pure methanol is 0.192 atm and the vapor pressure of pure chloroform is 0.311 atm. What is the mole fraction of chloroform in the solution?

Answer: 0.529

3. What is the normal boiling point of 1.21 M solution of CaI_2 that has a density of 1.92 g/ml? (K_B for H_2O =0.512 °C .kg/mole) Answer: 101.2 °C

4. Calculate the freezing point of a 36.0 % by mass Na_3PO_4 solution. (K_f for H_2O = 1.86 °C .kg/mole)
Answer: -25.5 °C

5. 32.00 ml of 0.311 M aluminum nitrate is mixed with 64.00 ml of 0.177 M sodium carbonate and allowed to react.
a. Write a balanced equation for the reaction.
b. Write total-ionic and net-ionic equations for the above reaction.
Total-ionic:
Net-ionic:
c. Give the name and mass of any precipitate that may have formed.
Answer: 0.884 g of $Al_2(CO_3)_3$ precipitate
d. Calculate the molar concentration of each ion remaining in solution after reaction is complete.
Answer: Concentration of carbonate ions= 0 M
Concentration of aluminum ions = 0.0252 M
Concentration of nitrate ions= 0.312 M
Concentration of sodium ions = 0.236 M

SET C:

1. What is the molarity of an aqueous solution of $C_6H_{12}O_6$ that has a normal boiling point of 101.40 °C and density of 1.68 g/ml? K_B for water is 0.512 °C .kg/mole. ($C_6H_{12}O_6$ is a nonvolatile nondissociating solute.)
Answer: 3.07 mole/L

2. Calculate the normal freezing point of a 0.6837 M aqueous solution of $C_{12}H_{22}O_{11}$ that has a density of 1.35 g/ml. ($C_{12}H_{22}O_{11}$ is a nonvolatile nondissociating solute.) The molal freezing point depression constant of water is 1.86 °C .kg/mole.
Answer: Freezing point= -1.14 °C

3. Heptane, C_7H_{16}, and octane,C_8H_{18}, form an ideal solution. At 40. °C , the vapor pressure of pure heptane is 0.522 atm , and the vapor pressure of pure octane is 0.238 atm. A solution is made of 5.32 g heptane and 8.80 g octane. Calculate the mole fraction of octane **in the vapor** at the above temperature.
Answer: 0.398

4. What is the molar mass and molecular formula of a nondissociating compound whose empirical formula is C_4H_2N , if 3.84 g of the compound in 500. g benzene give a freezing point depression of 0.307 °C? (The molal freezing point depression constant for benzene is 5.12 °C .kg/mole.)
Answer: 128 g/mole; $C_8H_4N_2$

5. Liquids **A** and **B** form an ideal solution. The vapor pressure of pure **A** is 0.700 atm at the normal boiling point of a solution prepared from 0.250 mole of **B** and 0.650 mole of **A**. What is the vapor pressure of pure **B** at this temperature?
Answer: 1.77 atm

6. A 0.900 L aqueous solution contains 30.0 g of a protein. The osmotic pressure of the solution is 12.7 torr at 25 °C. What is the molar mass of the protein?
Answer: 4.88×10^4 g/mole

7. Acetone and methanol form ideal solution. At 25 °C, the vapor pressures of pure acetone and pure methanol are 0.342 atm and 0.188 atm respectively. Calculate the mole fraction of methanol in a solution that boils at 25 °C and 0.248 atm.
Answer: X= 0.610