

1. A bottled soft drink has a liquid-phase concentration of CO_2 of 0.12 M at 25°C . The partial pressure of CO_2 is 4.0 atm above the liquid at the same temperature. Determine the Henry's law constant for CO_2 at 25°C .

- a. 4.5×10^{-3} mol/L-atm
 b. 8.5×10^{-3} mol/L-atm
 c. 3.0×10^{-2} mol/L-atm
 d. 8.4×10^{-2} mol/L-atm
 e. 4.8×10^{-1} mol/L-atm

$$S_g = k P_g$$

$$k = \frac{S_g}{P_g} = \frac{0.12 \text{ M}}{4.0 \text{ atm}} = 3.0 \times 10^{-2} \text{ mol/L-atm}$$

2. Which of the following concentration units is dependent on temperature?

- a. Mass %
 b. Parts per million (ppm)
 c. Molarity
 d. Molality
 e. Parts per trillion (ppt)

- mass does not change w/ Temp
- Vol of soln expands/contracts w/ Temp.

$$\text{Mass \%} = \frac{\text{mass of component in soln}}{\text{total mass of soln}} \times 100$$

$$\text{ppm} = \frac{\text{mass of component in soln}}{\text{total mass of soln}} \times 10^6$$

$$\text{ppt} = \frac{\text{mass of component in soln}}{\text{total mass of soln}} \times 10^{12}$$

$$\text{molality} = \frac{\text{moles solute}}{\text{kg of solvent}}$$

$$\text{Molarity} = \frac{\text{mol solute}}{\text{L soln}}$$

← changes w/ Temp

3. How many grams of KOH are required to prepare a 250.0 mL solution of 0.50 M KOH? (K = 39.10 amu, O = 16.00 amu, H = 1.008 amu)

- a. 16 g
- b. 13 g
- c. 11 g
- d. 9.0 g
- e. 7.0 g

$$M = \frac{\text{mol solute}}{\text{L sol'n}}$$

$$0.50 \frac{\text{mol KOH}}{\text{L}} = \frac{x}{0.250 \text{ L}}$$

$$x = 0.50 \frac{\text{mol KOH}}{\text{L}} (0.250 \text{ L}) \times \frac{56.10 \text{ g}}{1 \text{ mol KOH}} = \boxed{7.0 \text{ g KOH}}$$

4. A 1.350 g sample of a non-volatile, non-electrolytic organic molecule is dissolved in 10.0 g of benzene and the freezing point is lowered by 3.66°C. What is the molar mass of the molecule (in g/mol)? (Benzene: $K_f = 5.12^\circ\text{C}/m$)

- a. 189 g/mol
- b. 176 g/mol
- c. 173 g/mol
- d. 243 g/mol
- e. 312 g/mol

$$\text{molar mass} = \frac{\text{g}}{\text{mol}}$$

\uparrow given \uparrow calc.

$$\Delta T_f = K_f m$$

$$m = \frac{\Delta T_f}{K_f} = \frac{3.66^\circ\text{C}}{5.12^\circ\text{C}/m} = \frac{0.71484 \text{ mol sample}}{\text{kg benzene}} \times 0.0100 \text{ kg benzene}$$

$$= 0.00714844 \text{ mol sample}$$

$$\text{molar mass} = \frac{\text{g}}{\text{mol}} = \frac{1.350 \text{ g}}{0.00714844 \text{ mol}} = \boxed{188.85 \text{ g/mol}}$$

5. What is the mole fraction of CBr_4 in the vapor above a solution of 25.00 g of CBr_4 and 50.00 g C_7H_8 at 100°C ? The vapor pressures of pure CBr_4 and pure C_7H_8 are 47.20 and 493.19 torr respectively at 100°C . (C = 12.01 amu, H = 1.008 amu, Br = 79.90 amu)

- a. 0.040
- b. 0.073
- c. 0.090
- d. 0.013
- e. 0.15

$$P_{\text{CBr}_4} = X_{\text{CBr}_4} P_{\text{CBr}_4}^{\circ}$$

$$P_{\text{Tot}} = P_{\text{CBr}_4} + P_{\text{C}_7\text{H}_8}$$

$$P_{\text{C}_7\text{H}_8} = X_{\text{C}_7\text{H}_8} P_{\text{C}_7\text{H}_8}^{\circ}$$

$$P_{\text{Tot}} = X_{\text{CBr}_4} P_{\text{CBr}_4}^{\circ} + X_{\text{C}_7\text{H}_8} P_{\text{C}_7\text{H}_8}^{\circ}$$

$$25.00 \text{ g CBr}_4 \times \frac{1 \text{ mol}}{331.9 \text{ g}} = 0.07539 \text{ mol CBr}_4$$

$$50.00 \text{ g C}_7\text{H}_8 \times \frac{1 \text{ mol}}{92 \text{ g}} = 0.543478 \text{ mol C}_7\text{H}_8$$

$$X_{\text{CBr}_4} = \frac{P_{\text{CBr}_4}}{P_{\text{C}_7\text{H}_8}}$$

$$P_{\text{CBr}_4} = \frac{0.07539 \text{ mol}}{(0.543478 \text{ mol} + 0.07539 \text{ mol})} (47.20) = \cancel{5.7499 \text{ torr}} = 5.7499 \text{ torr} = \frac{5.7499 \text{ torr}}{433.1099 \text{ torr}}$$

$$P_{\text{C}_7\text{H}_8} = \frac{0.543478 \text{ mol}}{(0.543478 + 0.07539 \text{ mol})} (493.19 \text{ torr}) = 433.1099 \text{ torr}$$

$$\boxed{0.013}$$

6. Rank the following solute-solvent interactions in order of INCREASING strength of attraction.

I. KCl in H_2O

II. $\text{CH}_3\text{CH}_2\text{OH}$ in H_2O

III. CO_2 in CCl_4

I'd accept either on an exam

- a. I < II < III
- b. III < II < I
- c. II < III < I
- d. I < III < II
- e. III < I < II

The stronger the attractions between solute + solvent molecules, the greater the solubility of the solute in the solvent

I K-Cl in H_2O
ion dipole

II. $\text{CH}_3\text{CH}_2\text{O-H}$ H_2O
H-Bond

III CO_2 in CCl_4
dispersion

7. The magnitudes of K_f and K_b depend on which of the following?

- a. Nature of the solute
- b. Nature of the solvent**
- c. Properties of the solution
- d. Magnitude of intermolecular forces between solvent and solute
- e. All of the above

K_b : molal boiling point elevation constant
depends only on solvent

K_f : molal freezing point depression constant
~~directly proportional to~~
depends on solvent

See tables 13.3 + pg 533

8. Thyroxine is a hormone present in the thyroid gland. A solution of 1.138 g of thyroxine in 25.0 mL of benzene has an osmotic pressure of 1.24 atm at 20°C. What is the molecular weight of thyroxine?

- a. 883 g/mol**
- b. 841 g/mol
- c. 782 g/mol
- d. 902 g/mol
- e. 743 g/mol

$$\pi = MRT$$

$$M = \frac{\pi}{RT} = \frac{1.24 \text{ atm}}{0.08206 \frac{\text{L atm}}{\text{mol K}} (293 \text{ K})}$$

MW = g/mol
↑
given

$$M = 0.051573 \frac{\text{mol thyroxine}}{\text{L soln}} (0.0250)$$

$$0.001289 \text{ mol}$$

$$1.138 \text{ g} / 0.001289 \text{ mol} = \boxed{882.854 \text{ g/mol}}$$

9. Which substance is not miscible with water?

- a. CH_3OH
- b. $\text{CH}_3\text{CH}_2\text{OH}$
- c. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- d. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- e. All species a-d are completely immiscible with water

Parts of liquids that mix in all proportions are miscible

From table 13.2 the # of C atoms in an alcohol affects its solubility in water.

\uparrow # C's \Rightarrow \downarrow solubility (d) is the best answer

10. Which of following substances become **LESS** soluble in water as temperature **INCREASES**?

NaNO_3 (s)
(I)

$\text{K}_2\text{Cr}_2\text{O}_7$ (s)
(II)

N_2 (g)
(III)

CO_2 (g)
(IV)

- a. I and II
- b. III
- c. III and IV
- d. I, II, III, and IV
- e. None of the substances

The solubility of most solid solutes in water increases as the soln temp. increases

The solubility of gases in water decreases w/ increasing temp.

III and IV become less soluble as temp \uparrow

11. Which is the following statements about solutions is FALSE?

- a. Two liquids that mix in all proportions are miscible with each other.
- b. Solubility of a gas solute in a liquid is directly proportional to pressure.
- c. A positive value for ΔS_{soln} means the solution is more ordered than the pure solute and pure solvent.
- d. The formation of a solution is possible when ΔH_{soln} is negative and ΔS_{soln} is positive.
- e. The formation of a solution is not possible when ΔH_{soln} is positive and ΔS_{soln} is negative.

(a) T: pg 521

(b) T: solubility of a gas in any solvent is increased as the partial pressure of the gas above the solvent increases (pg 523)

✓(c) F: $\uparrow \Delta S \Rightarrow$ more random/disorder

(d) T: Spont when $\Delta H = \ominus$ and $\Delta S = \oplus$

(e) T: soln formation does not occur.

12. A bottle containing 0.500 L water is pressurized with a mixture of 77.5% helium in nitrogen (by mass) to a total pressure of 5.50 atm at 30°C. The Henry's law constants for He in water at 30°C is $3.7 \times 10^{-4} \text{ M/atm}$ and the constant for N_2 in water at 30°C is $6.0 \times 10^{-4} \text{ M/atm}$. How many mg of helium and nitrogen dissolve in water at 30°C?

- a. 3.9 mg He and 1.8 mg N_2
- b. 2.0 mg He and 0.13 mg N_2
- c. 5.3 mg He and 0.22 mg N_2
- d. 4.2 mg He and 8.7 mg N_2
- e. 1.3 mg He and 4.2 mg N_2

$$P = \chi \cdot P_{\text{tot}}$$

$$77.5 \text{ g He} \times \frac{1 \text{ mol He}}{4.0 \text{ g}} = 19.375 \text{ mol He}$$

$$22.5 \text{ g N}_2 \times \frac{1 \text{ mol N}_2}{28.0 \text{ g}} = 0.803571 \text{ mol N}_2$$

$$\chi_{\text{He}} = \frac{19.375 \text{ mol}}{19.375 \text{ mol} + 0.803571 \text{ mol}} = 0.960177$$

$$\chi_{\text{N}_2} = \frac{0.803571 \text{ mol}}{19.375 + 0.803571 \text{ mol}} = 0.039823$$

$$S_{\text{N}_2} = k_{\text{g}} P_{\text{g}}$$

$$= 6.0 \times 10^{-4} \text{ M/atm} (0.039823 (5.50 \text{ atm}))$$

$$= 1.314159 \times 10^{-4} \frac{\text{mol}}{\text{L}} \times 0.500 \text{ L} \times \frac{28.0 \text{ g}}{\text{mol}}$$

$$= \boxed{1.84 \text{ mg N}_2}$$

$$S_{\text{He}} = k_{\text{g}} P_{\text{g}}$$

$$= 3.7 \times 10^{-4} \text{ M/atm} (0.960177 (5.50 \text{ atm}))$$

$$= 0.001954 \frac{\text{mol}}{\text{L}} \times 0.500 \text{ L} \times \frac{4.0 \text{ g}}{\text{mol}}$$

$$= \boxed{3.90 \text{ mg He}}$$

13. A recent analysis of drinking water in central Ohio revealed the presence of chloroform (CHCl_3) at a concentration of 19.5 ppb (parts per billion). What is the molarity of chloroform at 20°C if the water sample has a density of 0.9983 g/mL at 20°C ?

- a. $1.63 \times 10^{-2} \text{ M}$
- b. $1.63 \times 10^{-4} \text{ M}$
- c. $1.63 \times 10^{-6} \text{ M}$
- d. $1.63 \times 10^{-7} \text{ M}$**
- e. None of the above

$$\text{ppb} = \frac{\mu\text{g}}{\text{kg}}$$

$$\begin{aligned}
 & \frac{19.5 \mu\text{g CHCl}_3}{\text{kg soln}} \times \frac{1 \text{ kg}}{1000 \text{ g}} \times \frac{0.9983 \text{ g}}{\text{mL}} \times \frac{1 \times 10^{-6} \text{ g}}{1 \mu\text{g}} \times \frac{1 \text{ mol}}{119.5 \text{ g}} \times \frac{1000 \text{ mL}}{1 \text{ L}} \\
 & = \boxed{1.63 \times 10^{-7} \text{ M}}
 \end{aligned}$$

14. Concentrated hydroiodic acid, HI (aq.), is 47.0% HI by mass and has a density of 1.50 g/mL . What is the MOLARITY and MOLALITY of this solution?

- a. $5.52 \text{ M}, 3.67 \text{ m}$
- b. $5.52 \text{ M}, 6.93 \text{ m}$**
- c. $10.4 \text{ M}, 3.67 \text{ m}$
- d. $10.4 \text{ M}, 6.93 \text{ m}$
- e. $2.45 \text{ M}, 6.93 \text{ m}$

100 g soln

47.0 g HI

53.0 g H_2O

$$\begin{aligned}
 & 47.0 \text{ g HI} \times \frac{1 \text{ mol HI}}{127.9 \text{ g}} = 0.367475 \text{ mol HI} \\
 & \frac{0.367475 \text{ mol HI}}{100 \text{ g soln}} \times \frac{1.50 \text{ g}}{\text{mL}} \times \frac{1000 \text{ mL}}{1 \text{ L}} \\
 & = \boxed{5.51 \text{ M}}
 \end{aligned}$$

$$\begin{aligned}
 m &= \frac{\text{mol solute}}{\text{kg solvent}} = \frac{0.367475 \text{ mol HI}}{0.053 \text{ kg H}_2\text{O}} = \boxed{6.93 \text{ m}}
 \end{aligned}$$

15. The vapor pressure of pure carbon tetrachloride (CCl_4) at 65°C is 531 mm Hg. 20.0 g of a non-volatile, non-electrolyte but otherwise unknown solute is added to 154.0 g of CCl_4 at 65°C , which reduces the vapor pressure by 27 mm Hg. What is the molecular weight of the solute?

a. 343 g/mol

b. 359 g/mol

c. 374 g/mol

d. 399 g/mol

e. 415 g/mol

$$\Delta P = \chi_{\text{solute}} P_{\text{solvent}}^{\circ}$$

$$27 \text{ mmHg} = \chi_{\text{solute}} (531 \text{ mmHg})$$

$$\chi_{\text{solute}} = \frac{27 \text{ mmHg}}{531 \text{ mmHg}} = 0.050847$$

$$\frac{\text{mol } x}{\text{mol } x + \text{mol } \text{CCl}_4} = 0.050847$$

$$154.0 \text{ g } \text{CCl}_4 \times \frac{1 \text{ mol}}{154 \text{ g}} = 1 \text{ mol}$$

$$\text{mol } x = 0.050847 (\text{mol } x + \text{mol } \text{CCl}_4)$$

$$x = 0.050847x + 0.050847$$

$$0.949153x = 0.050847$$

$$x = 0.053571 \text{ mol } x$$

$$MW = \frac{20.0 \text{ g}}{0.053571 \text{ mol}}$$

$$MW = \frac{373.3 \text{ g/mol}}$$

16. A solution at 0°C consists of 40.0 g of CH_2Cl_2 and 60.0 g of CH_2Br_2 . The vapor pressures of pure CH_2Cl_2 and CH_2Br_2 are 0.175 atm and 0.015 atm respectively at 0°C . What is the total pressure of the vapor above the solution?

a. 0.138 atm

b. 0.132 atm

c. 0.125 atm

d. 0.117 atm

e. 0.107 atm

$$40.0 \text{ g } \text{CH}_2\text{Cl}_2 \times \frac{1 \text{ mol } \text{CH}_2\text{Cl}_2}{85 \text{ g}} = 0.470588 \text{ mol}$$

$$60.0 \text{ g } \text{CH}_2\text{Br}_2 \times \frac{1 \text{ mol } \text{CH}_2\text{Br}_2}{173.8 \text{ g}} = 0.345224 \text{ mol}$$

$$P_{\text{tot}} = \chi_{\text{CH}_2\text{Cl}_2} P_{\text{CH}_2\text{Cl}_2} + \chi_{\text{CH}_2\text{Br}_2} P_{\text{CH}_2\text{Br}_2}$$

$$P_{\text{tot}} = \frac{0.470588}{0.815812} (0.175 \text{ atm}) + \frac{0.345224}{0.815812} (0.015 \text{ atm})$$

$$P_{\text{tot}} = 0.100946 \text{ atm} + 0.006347 \text{ atm}$$

$$P_{\text{tot}} = 0.107 \text{ atm}$$

17. What is the freezing point of a solution of 0.640 g of azulene ($C_{10}H_8$) in 100.0 g of camphor ($C_{10}H_{16}O$)? The molal freezing point constant of camphor is $40.0^\circ\text{C}/m$ and its freezing point is 179.75°C .

- a. 176.85°C
- b. 177.75°C
- c. 178.25°C
- d. 181.75°C
- e. 182.25°C

$$\Delta T_f = K_f m$$

$$m = \frac{\text{mol solute}}{\text{kg solvent}} = \frac{(0.640\text{g} \times \frac{1\text{mol}}{128\text{g}})}{0.1000\text{kg}} = 0.05\text{m}$$

$$\Delta T_f = 40.0^\circ\text{C}/m (0.05\text{m})$$

$$\Delta T_f = 2.0^\circ\text{C}$$

Freezing point depression

$$179.75^\circ\text{C} - 2.0^\circ\text{C} = 177.75^\circ\text{C}$$

18. Lysozyme is an enzyme that cleaves cell walls. A 0.100 L aqueous solution of lysozyme that contains 75.0 mg of the enzyme has an osmotic pressure of 1.00 torr at 25°C . What is the molecular weight of lysozyme?

- a. $1.02 \times 10^3\text{g/mol}$
- b. $1.39 \times 10^4\text{g/mol}$
- c. $1.06 \times 10^5\text{g/mol}$
- d. $1.39 \times 10^6\text{g/mol}$
- e. $1.06 \times 10^7\text{g/mol}$

$$\Pi = MRT$$

$$M = \frac{\Pi}{RT} = \frac{1.00\text{torr} \left(\frac{1\text{atm}}{760\text{torr}}\right)}{0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} (298\text{K})}$$

$$M = 5.38 \times 10^{-5} \frac{\text{mol lysozyme}}{\text{L soln}} \times 0.100\text{L} = 5.38 \times 10^{-6} \text{mol}$$

$$\text{MW} = \text{g/mol} = \frac{0.075\text{g}}{5.38 \times 10^{-6} \text{mol}}$$

$$\text{MW} = 1.39 \times 10^4 \text{g/mol}$$

19. Which of the following correctly identifies the most important solute-solvent attraction in the given solution?

- a) CH_3OH in C_6H_6 hydrogen bonding \times C_6H_6 is non-polar
b) $\text{Cu}(\text{NO}_3)_2$ in H_2O London \times ion-dipole
c) CHBr_3 in $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$ dipole $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$ is non-polar
d) CH_3NH_2 in $\text{C}_2\text{H}_5\text{OH}$ dipole \checkmark
e) Choose this answer if all statements, a-d, are correct. \times

20. Rank the following compounds in order of decreasing solubility in water.

- I. $\text{CH}_3\text{-CH}_2\text{-OH}$
II. $\text{CH}_3\text{-CH}_2\text{-O-CH}_2\text{-CH}_3$
III. $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_3$
IV. $\text{CH}_3\text{-OH}$

- a) II, III, I, IV
b) III, II, I, IV
c) IV, I, II, III
d) I, II, III, IV
e) No order is correct

I and IV are polar w/
H-Bonding
IV is more soluble than I
because the $-\text{OH}$ group is
a larger portion of the molecule.

II and III are both non-polar, but since II has
a greater MW it has \uparrow dispersion forces + is
more soluble than III

most soluble $\text{IV} < \text{I} < \text{II} < \text{III}$ least soluble

21. The density of a 48.0% by weight aqueous solution of sulfuric acid, H_2SO_4 , is 1.3783 g/cm³? What is the molality (m) of this solution? (Atomic weights: S = 32.07, H = 1.008, O = 16.00)

- a) 4.88 m
- b) 7.52 m
- c) 2.53 m
- d) 0.551 m
- e) 9.42 m

48.0% by weight

$$\begin{array}{r} 48.0 \text{ g } \text{H}_2\text{SO}_4 \\ 52.0 \text{ g } \text{H}_2\text{O} \\ \hline 100.0 \text{ g solution} \end{array}$$

$$m = \frac{\text{mol solute}}{\text{kg solvent}}$$

$$48.0 \text{ g } \text{H}_2\text{SO}_4 \times \frac{1 \text{ mol } \text{H}_2\text{SO}_4}{98.0 \text{ g}} = 0.489797 \text{ mol } \text{H}_2\text{SO}_4 / 0.052 \text{ kg } \text{H}_2\text{O} = \boxed{9.41 \text{ m}}$$

$$100.0 \text{ g soln} \times \frac{\text{mL}}{1.3783 \text{ g}} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.07255 \text{ L}$$

$$M = \frac{0.489797 \text{ mol } \text{H}_2\text{SO}_4}{0.07255 \text{ L soln}} = 6.74 \text{ M}$$

22. A 5.52 M NaBr solution has a density of 1.42 g/mL. What is the molality of this solution? (Atomic weights: Na = 23.0, Br = 79.9)

- a) 5.58 m
- b) 5.82 m
- c) 6.01 m
- d) 6.21 m
- e) 6.48 m

$$m = \frac{\text{mol NaBr}}{\text{kg H}_2\text{O}}$$

Assume 1 L of soln

$$5.52 \text{ mol NaBr} \times \frac{102.9 \text{ g}}{1 \text{ mol NaBr}} = 568.01 \text{ g NaBr}$$

$$1000 \text{ mL soln} \times \frac{1.42 \text{ g}}{\text{mL}} = 1.42 \text{ kg soln}$$

$$1.42 \text{ kg soln} - 0.56801 \text{ kg NaBr} = 0.852 \text{ kg H}_2\text{O}$$

$$m = \frac{5.52 \text{ mol NaBr}}{0.852 \text{ kg}} = \boxed{6.48 \text{ m}}$$

23. A 2.48 L sample of He at 739 torr and 25°C is mixed with a 6.08 L sample of Ar at 325 torr and 25°C. Then, the mixture is placed in a 4.80 L container at 25°C. What is the partial pressure (atm) of He? (Atomic weights: He = 4.00, Ar = 39.95)

- a) 0.48
- b) 0.50
- c) 0.42
- d) 0.54
- e) 0.38

He $P_1 V_1 = P_2 V_2$
 $739 \text{ torr} (2.48 \text{ L}) = P_2 (4.80 \text{ L})$
 $P_2 = 0.50239 \text{ atm}$

Ar $325 \text{ torr} (6.08 \text{ L}) = P_2 (4.80 \text{ L})$
 $P_2 = 0.5417 \text{ atm}$

$P_{\text{tot}} = P_{\text{He}} + P_{\text{Ar}} = 0.50239 \text{ atm} + 0.5417 \text{ atm}$
 $P_{\text{tot}} = 1.044 \text{ atm}$

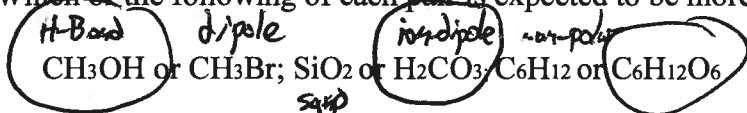
He $n = \frac{PV}{RT} = \frac{739 \text{ torr} \left(\frac{1}{760}\right) (2.48 \text{ L})}{0.08206 \frac{\text{L atm}}{\text{mol K}} (298 \text{ K})} = 0.098613 \text{ mol He}$

Ar $325 \text{ torr} \left(\frac{1}{760}\right) (6.08 \text{ L}) = 0.1063226 \text{ mol Ar}$
 $0.08206 \frac{\text{L atm}}{\text{mol K}} (298 \text{ K})$

$P_{\text{He}} = \chi_{\text{He}} \cdot P$
 $= 0.48119 (1.044 \text{ atm})$
 $= \boxed{0.50 \text{ atm}}$

$\chi_{\text{He}} = \frac{0.098613 \text{ mol}}{0.098613 \text{ mol} + 0.1063226 \text{ mol}} = 0.48119$

24. Which of the following of each pair is expected to be more soluble in water?



- a) CH_3OH SiO_2 $\text{C}_6\text{H}_{12}\text{O}_6$
- b) CH_3OH H_2CO_3 $\text{C}_6\text{H}_{12}\text{O}_6$
- c) CH_3Br SiO_2 C_6H_{12}
- d) CH_3Br SiO_2 $\text{C}_6\text{H}_{12}\text{O}_6$
- e) CH_3OH H_2CO_3 C_6H_{12}

25. What is the molality of a 1.06 M aqueous solution of sugar ($C_6H_{12}O_6$, 342.3 g/mol) which has a density of 1.14 g/mL?

- a) 1.36 molal
- b) 1.06 molal
- c) 0.927 molal
- d) 0.634 molal
- e) 0.442 molal

Assume 1.0L of soln $\frac{342.3g}{1mol} = 342.3g$
 $1.06 \text{ mol } C_6H_{12}O_6 \times \frac{342.3g}{1mol} = 362.838g$

$$1.0L \text{ soln} \times \frac{1000mL}{1L} \times \frac{1.14g}{1mL} = 1.14kg \text{ soln} - 0.362838kg \text{ sugar} = 0.777162kg \text{ H}_2O$$

$$m = \frac{\text{mol sugar}}{\text{kg H}_2O} = \frac{1.06 \text{ mol}}{0.777162 \text{ kg}} = 1.36 \text{ m}$$

26. Calculate the mole fraction of ethanol in the vapor phase at 63.5°C for an ideal solution containing 96.0 gm of pure methanol (CH_3OH , 32.0 g/mol) and 92.2 gm of pure ethanol (CH_3CH_2OH , 46.1 g/mol). The vapor pressure of methanol and ethanol at 63.5°C is 717.2 mm and 400.0 mm mercury, respectively.

- a) 0.943
- b) 0.701
- c) 0.466
- d) 0.271
- e) none of the above

$$96.0g \text{ } CH_3OH \times \frac{1mol}{32.0g} = 3.0 \text{ mol } CH_3OH$$

$$92.2g \text{ } CH_3CH_2OH \times \frac{1mol}{46.1g} = 2.0 \text{ mol } CH_3CH_2OH$$

$$P_{CH_3OH} = \left(\frac{3.0 \text{ mol}}{3.0 + 2.0 \text{ mol}} \right) (717.2 \text{ mm Hg}) = 430.32 \text{ mm Hg}$$

$$P_{CH_3CH_2OH} = \left(\frac{2.0 \text{ mol}}{3.0 + 2.0 \text{ mol}} \right) (400.0 \text{ mm Hg}) = 160.0 \text{ mm Hg}$$

$$X_{CH_3CH_2OH} = \frac{P_{CH_3CH_2OH}}{P_{Tot}} = \frac{160.0 \text{ mm Hg}}{(430.32 + 160.0 \text{ mm Hg})}$$

$$X_{CH_3CH_2OH} = 0.271 \text{ mm Hg}$$

27. What is the boiling point change for a solution containing 0.328 moles of naphthalene (a nonvolatile, nonionizing compound) in 250. g of liquid benzene ($K_b = 2.53 \text{ }^\circ\text{C}/m$, BP = 80.1°C)

- a) 3.32°C
- b) 7.41°C
- c) 1.93°C
- d) 4.31°C
- e) 10.7°C

$$\Delta T_f = K_f m$$

$$m = \frac{0.328 \text{ mol naphthalene}}{0.250 \text{ kg}}$$

$$\Delta T_f = 2.53 \text{ }^\circ\text{C}/m \left(\frac{1.31}{m} \right)$$

$$\Delta T_f = 3.32^\circ\text{C}$$

28. When a 20.0 g sample of an unknown compound is dissolved in 500.0 g of benzene, the freezing point of the resulting solution is 3.77°C . The freezing point of pure benzene is 5.48°C and the K_f for benzene is $5.12^\circ\text{C}/m$. Calculate the molar mass of the unknown compound.

- a) 160. g/mol
- b) 80.0 g/mol
- c) 100. g/mol
- d) 140 g/mol
- e) 120 g/mol

$$\Delta T_f = K_f m$$

$$m = \frac{\Delta T_f}{K_f}$$

$$m = \frac{5.48^\circ\text{C} - 3.77^\circ\text{C}}{5.12^\circ\text{C}/m}$$

$$m = \frac{0.333 \text{ mol} \times}{\text{kg benzene}} \times 0.500 \text{ kg benzene}$$

$$= 0.16689 \text{ mol} \times$$

$$MW = \frac{g}{\text{mol}} = \frac{20.0 \text{ g}}{0.16689 \text{ mol}}$$

$$= 120. \text{ g/mol}$$

29. The molar mass of a solid as determined by freezing point depression is 10% higher than the true molar mass. Which of the following experimental errors could not account for this discrepancy?

$$\Delta T_f = K_f m$$

- a) Not all the solid was dissolved.
- b) ~~More than the recorded amount of solvent was pipetted into the solution.~~
- c) The solid dissociated slightly into two particles when it dissolved.
- d) Some solid was left of the weighing paper.
- e) Before the solution was prepared, the container was rinsed with solvent and not dried.

van't Hoff factor i

30. Cox-1 is a protein that acts as an enzyme to speed up the production of prostaglandins. A solution contains 2.88 g of Cox-1 in 125 mL of water. This solution has an osmotic pressure of 24.8 mm Hg at 27°C. What is the molecular weight of this sample of Cox-1?

- a) 4.81×10^3 g/mol
- b) 3.20×10^4 g/mol
- c) 8.05×10^5 g/mol
- d) 5.75×10^3 g/mol
- e) 1.74×10^4 g/mol

$$\Pi = MRT \quad M = \frac{\Pi}{RT}$$

$$M = \frac{(24.8 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}})}{0.08206 \frac{\text{L atm}}{\text{mol K}} (300\text{K})}$$

$$M = 1.326 \times 10^{-3} \frac{\text{mol Cox-1}}{\text{L soln}} \times 0.125 \text{ L}$$

$$\text{MW} = \frac{g}{\text{mol}} = \frac{2.88 \text{ g}}{1.6575 \times 10^{-4} \text{ mol}} = 1.74 \times 10^4 \text{ g/mol}$$