## Chapter 12 Number 1 (Sections 12.1 – 12.3) (Unit 1) 10 January 2018

1. The solubility of potassium bromide is 67.8 g per 100.0 g water at 25 °C.

1a. Calculate the mole fraction for potassium bromide and for water for this solution.

| | MM | mass, m | moles, n |
|---|---|---|---|
| KBr | 119 g/mol | 67.8 g | 0.570 mol |
| $H_2O$ | 18.0 " | 100.0 g | 5.56 mol |

$$X_{KBr} = \frac{0.57}{(0.57+5.56)} = 0.0929$$

1b. Calculate the mass percent for potassium bromide and for water for this solution.

$$\text{Mass \%} = \frac{67.8\ g}{67.8\ g + 100\ g} * 100\%$$

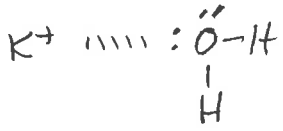
$$= 40.4\%$$

1c. Calculate the molality of potassium bromide.

$$n = \frac{n_{KBr}}{M(kg)} = \frac{0.570\ mol}{0.100\ kg}$$

$$= 5.7\ mol/kg$$

1d. Sketch the interaction between potassium ions and water. Sketch the interaction between bromide ions and water.



1e. Given $\Delta H_{sol'n}$ = +19.9 kJ/mol for the dissolving process, does the solution become warmer or cooler as potassium bromide dissolves? Write a chemical equation for the process that takes place.

Cooler

$KBr(s) \rightarrow KBr(aq)$

2. Strong ammonia solutions are 57 mass percent ammonia and have a density of 0.90 g/cm$^3$. What is the molality of ammonia for this solution?

| | MM | mass, m | moles, n | Vol |
|---|---|---|---|---|
| $NH_3$ | 17.0 g/mol | 57 g | 3.35 mol | |
| $H_2O$ | 18.0 | 43 g | | |

$$\text{Molality} = \frac{3.35\ mol\ NH_3}{0.043\ kg\ H_2O} = 77.9\ molal$$

**Questions in final exam format:**

3. Iodine, $I_2(s)$, is more soluble in dichloromethane, $CH_2Cl_2$ (*l*), than in water because

A. both iodine and dichloromethane have strong ion-dipole interactions.

B. the dipole-dipole forces in dichloromethane are much stronger than the dispersion forces in iodine.

(C) the intermolecular forces are similar in both iodine and dichloromethane.

D. iodine is polar and dichloromethane has a large number of hydrogen bonds.

4. Commercial cold packs often contain solid $NH_4NO_3$ and a pouch of water. The temperature of the pack drops as the $NH_4NO_3$ dissolves in water. Therefore, for the dissolving of $NH_4NO_3$ in water,

A. $\Delta H_{sol'n}$ is negative and $\Delta S_{sol'n}$ may be negative or positive.

B. $\Delta H_{sol'n}$ is negative and $\Delta S_{sol'n}$ is positive.

C. $\Delta H_{sol'n}$ is positive and $\Delta S_{sol'n}$ may be negative or positive.

(D) $\Delta H_{sol'n}$ is positive and $\Delta S_{sol'n}$ is positive.

5. How much water must be added to 42.0 g of $CaCl_2$ (111 g/mol) to produce a solution that is 40.0 wt% $CaCl_2$? (Wt% and mass % are the same)

A. 56.7 g (B) 63.0 g

C. 16.8 g D. 120 g

**Now try these problems from the book:**

Section 12.1. (Solutions)

Section 12.2. (Energy changes) Problems 1, 2, 42, 44, 46, 48, 50, 52, and 54

Section 12.3. (Conc. units) Problems 3, 4, 5, 6, 7, 8, 9, 10, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78 and 80

## Chapter 12 Number 2 (Sections 12.4 – 12.6) (Unit 1) 12 January 2018

1. Strong ammonia solutions are 57 mass percent ammonia and the rest water.

1a. What is the mole fraction of ammonia for this solution?

| | MM | mass, m | moles, n | Vol |
|---|---|---|---|---|
| $NH_3$ | 17 | 57 | 3,35 | |
| $H_2O$ | 18 | 43 | 2,39 | |

$X_{NH3} = \frac{3,35}{3,35+2,39} = 0,58$

1b. What is the molarity of ammonia for this solution? Given: Solution density is 0.88 g/mL

| | MM | mass, m | moles, n | Vol |
|---|---|---|---|---|
| $NH_3$ | | 57 g | 3,35 mol | |
| $H_2O$ | | 43 g | | |
| Solution | | 100 g | | 113,6 mL |

$d = 0.88 \frac{g}{mL}$

$\text{Molarity} = \frac{3,35 mol}{0,1136 L} = 29,5 mol/L$

2. $CHCl_3$ is a polar organic solvent with a vapor pressure of 205 mmHg at 25 °C.

2a. Suppose 10.0 g $C_{10}H_8$ (MM = 128 g/mol), a non-volatile solute was dissolved in 50.0 g $CHCl_3$ (MM = 119.4 g/mol). What is the resulting vapor pressure?

$P_{soln} = P^o_{solv} * X_{solv}$

$n_{solute} = 0,0781$

$n_{CHCl_3} = 0,419$

$X_{solv} = \frac{0,419}{0,419+0,0781} = 0,843$

$P_{soln} = 205 mmHg * 0,843 = 173 mmHg$

2b. $CH_2Cl_2$ has a vapor pressure of 421 mmHg at 25 °C. What is the vapor pressure of solution that contains 0.28 mol $CH_2Cl_2$ and 0.43 mol $CHCl_3$?

$P_{soln} = P_A X_A + P_B X_B$

$= 421 mmHg * 0,39$

$+ 205 mmHg * 0,61$

$289 mmHg$

3. The vapor pressure of water is 24.0 mmHg at 25 °C. What is the vapor pressure of a solution containing 0.110 mol potassium sulfate in 100.0 g water?

$n_{H_2O} = 5,56 mol$

$X_{H_2O} = \frac{5,56}{5,56+0,110*3} = 0,944$

$= 24,0 mmHg * 0,944$

$= 22,7 mmHg$

Questions in final exam format:

4. After methane, ethane, and propane, the next member of this series of hydrocarbons is butane, $C_4H_{10}$. Which statement is false?

A. Butane has a higher bp than propane.

B. Butanol has a higher bp than butane.

(C) Butane's boiling point is explained by hydrogen bonding.

D. Butanol has London dispersion forces and hydrogen-bonding.

5. Sodium hydroxide is available commercially as a 50.0% by weight aqueous solution. Calculate the molality of this sodium hydroxide solution.

A. 0.450 *m* B. 19.1 *m*

(C) 25.0 *m* D. 125. *m*

6. The Henry's Law constant of methyl bromide, $CH_3Br$, is $k$ = 0.159 mol/(L · atm) at 25 °C. What is the solubility of methyl bromide in water at 25 °C and at a partial pressure of 250. mmHg?

(A) 0.0523 mol/L

B. 0.329 mol/L

C. 0.483 mol/L

D. 39.8 mol/L

7. A 2.00 M solution of $CaCl_2$ in water has a density of 1.17 g/mL. What is the mole fraction of $CaCl_2$?

A. 0.0348

B. 0.0360

(C) 0.0366

D. 0.0380

**Now try these problems from the book:**

Section 12.4. (Factors) Problems 11, 12, 82, 84, 86 and 88

Section 12.6. (Vapor pressure lowering) Problems 13, 14, 15, 16, 17, 18, 92, 102, 108 and 110

## Chapter 12 Number 3 (Sections 12.7) (Unit 1) 15 January 2018

1. Drinking water in the US cannot exceed 19 ppb lead (which is always in the form of $Pb^{2+}$). What is the molarity of lead ion, $[Pb^{2+}]$, in water that contains 19 ppb lead? Hint: Water's density is 1.0 g/cm$^3$.

| | MM | mass, m | moles, n | Vol |
|---|---|---|---|---|
| $Pb^{2+}$ | 207 g/mol | 19 g | $9.2\times10^{-2}$ mol | |
| $H_2O$ | 18 g/mol | $1\times10^{9}$ g | → | $1\times10^{6}$ L |

$$[Pb^{2+}] = \frac{9.2\times10^{-2}\ mol}{1\times10^{6}\ L} = 9.2\times10^{-8}\ \frac{mol}{L}$$

2. Benzene, $C_6H_6$ has a relatively large freezing point depression constant, $K_f$ = 5.07 deg/molal, making it a good solvent for freezing point lowering studies. The normal melting point of benzene is 5.53 °C. What is the molality of a solution that freezes at 1.25 °C?

$$\Delta T_f = 5.07 * m * 1$$
$$4.28 = 5.07 * m$$
$$m = 0.844\ molal$$

3. What is the predicted freezing point of water that contains 50.0 g $CaCl_2$ per kg of water? (Given: $K_f$ = 1.86 deg/molal)

| | MM | mass, m | moles, n |
|---|---|---|---|
| $CaCl_2$ | 111 g/mol | 50.0 g | $4.5\times10^{-1}$ mol |
| $H_2O$ | 18 g/mol | 1000 g | |

$$\Delta T = \frac{1.86\ deg}{molal} * \frac{4.5\times10^{-1}\ mol}{kg} * 3$$
$$= 2.5\ deg \quad T_f =$$

4. $CHCl_3$ has a normal boiling point of 61.7 °C and a boiling point elevation constant, $K_b$ = 3.63 deg/molal. When 2.00 g aspirin is dissolved in 50.0 g $CHCl_3$, the boiling point increases to 62.5 °C. What is the molar mass of aspirin?

$\Delta T_b = K_b \cdot m \cdot i$

$$0.80\ deg = \frac{3.63\ deg}{molal} * m * 1$$
$$m = 0.220\ molal/kg$$
$$n = \frac{0.220\ mol}{kg} * 0.050\ kg$$
$$= 1.1\times10^{-2}\ mol$$

$$MM = \frac{2.00\ g}{1.1\times10^{-2}\ mol} = 182\ g/mol$$

5. Ionic substances rarely have the van't Hoff factor predicted from the formula. What is the van't Hoff factor for a 0.50 *m* KCl(aq) solution if it freezes at a temperature of -1.8 °C?

$$1.8\ deg = \frac{1.86\ deg}{molal} * 0.50\ m * i$$
$$i = 1.94$$

Questions in final exam format:

6. What volume of 0.716 M KBr solution is needed to provide 13.0 g of KBr?
   A. 6.55 mL
   B. 9.31 mL
   C. 18.5 mL
   (D) 153 mL

7. Which of the following solutions will have the **lowest** freezing point?
   A. 0.0100 *m* NaCl
   B. 0.0120 *m* $Li_2SO_4$
   C. 0.0400 *m* $CH_3CH_2CH_2OH$
   (D) 0.0150 *m* $MgCl_2$

8. Calculate the freezing point of a solution of 50.0 g methyl salicylate, $C_7H_6O_2$, dissolved in 800. g of benzene, $C_6H_6$. $K_f$ for benzene is 5.10°C/*m* and the freezing point is 5.50 °C for benzene.
   A. -2.61°C B. 2.61°C
   (C) 2.89°C D. 8.39°C

9. When 0.500 g of vitamin K is dissolved in 10.0 g of camphor ($K_f$ = 40.0 °C/*m*), the freezing point of the solution is 4.43 °C lower than that of pure camphor. Assuming vitamin K is a nonelectrolyte in camphor, calculate its molar mass.
   A. 0.451 g/mol
   B. 55.4 g/mol
   (C) 451 g/mol
   D. $3.54 \times 10^4$ g/mol

**Now try these problems from the book:**
Section 12.7. (Boiling point elevation & freezing point depression) Problems 19, 20, 90, 94, 96, 98, 104, 106, 114, 116 and 128

## Chapter 12 Number 4 (12.8) (Unit 1)

## 17 January 2018

1. Circle the member of each pair with the higher predicted boiling point.
   A. ethane OR propane
   B. propanol OR propane
   C. methanol OR methanal
   D. propane OR propanoic acid
   E. methane OR methyl amine

2. Predict the value for i for each of these aqueous solutions.
   A. 0.20 molal potassium nitrate $i = 2$
   B. 0.10 M HCl(aq) $i = 2$
   C. $X_{glucose} = 0.220$ $i = 1$
   D. 2.26 mass% sodium sulfate $i = 3$
   E. $[CH_2O] = 0.117$ M $i = 1$

3. What is the osmotic pressure of a 0.150 M ammonium perchlorate solution at 25 °C?

$\Pi = MRTi \quad i = 2$

$= 0.150 \text{ mol/L} \times 0.0821 \text{ L atm/mol K} \times 298 \text{ K} \times 2$

$= 7.34 \text{ atm}$

4. A solution was prepared by dissolving 20.0 g of an unknown carbohydrate ($C_xH_yO_z$) in 50.0 g water and determining the freezing point of the solution to be -2.17 °C. What is the molar mass of the unknown? Given: $K_f = 1.86$ deg/molal

$\Delta T_f = k_f \cdot m \cdot i \quad i = 1$

$2.17 \text{ deg} = 1.86 \cdot m \cdot 1$

$m = 1.17 \text{ molal} = 1.17 \text{ mol carbohy / kg } H_2O$

$n = 1.17 \text{ mol carbo / kg } H_2O \times .050 \text{ kg}$

$= 5.83 \times 10^{-2} \text{ mol}$

$MM = 20.0 \text{ g} / 5.83 \times 10^{-2} \text{ mol}$

$= 343 \text{ g/mol}$

5. A nitrate salt, thought to be $LiNO_3$, $NaNO_3$, $KNO_3$, $RbNO_3$ or $CsNO_3$, was dissolved in water. When 4.75 g of the salt was dissolved in water to make 100.0 mL solution, the osmotic pressure was determined to be 23 atm at 25 °C. What is the identity of the salt? What flame test color would you expect?

$i = 2 \quad \Pi = MRTi$

$23 \text{ atm} = M \times 0.0821 \text{ L atm/mol K} \times 298 \text{ K} \times 2$

Molarity = 0.47 mol/L

$n = 0.47 \text{ mol/L} \times 0.10 \text{ L} = 0.047 \text{ mol}$

$MM = 4.75 \text{ g} / 0.047 \text{ mol} = 101 \text{ g/mol} \Rightarrow KNO_3$

Questions in final exam format:

6. When ethylene glycol, $HOCH_2CH_2OH$, is added to the water in an automobile radiator, the effect is to
   A. lower the boiling point and lower the freezing point.
   B. lower the boiling point and raise the freezing point.
   C. raise the boiling point and lower the freezing point.
   D. raise the boiling point and raise the freezing point.

7. The coolant in automobiles is often a 50/50 % by volume mixture of ethylene glycol, $HOCH_2CH_2OH$, and water. At 20°C, the density of ethylene glycol is 1.1088 g/mL and the density of water is 0.9982 g/mL. Assuming that the volumes are additive, what is the expected freezing point of a 50/50(v/v)% ethylene glycol/water solution? $K_f$ = 1.86°C/*m* for water.
   A. -16 °C
   B. -17 °C
   C. -30 °C
   D. -33 °C

8. Red blood cells are placed into pure water. Which of the following statements is true?
   A. Water molecules flow out of the red blood cells, causing them to collapse.
   B. Water flows into the red blood cells, causing them to swell and burst.
   C. The osmotic pressure of the cell contents increases, causing the cells to burst.
   D. The osmotic pressure inside the cells equals the osmotic pressure outside.

**Now try these problems from the book:**
Section 12.8. (Osmotic pressure) Problems 21, 22, 23, 24, 118, 120, and 124