CHEM 3530 - Exam 3 - March 31, 2017

Constants and Conversion Factors

$N_A = 6.02 \times 10^{23}$ mol^{-1}

R = 8.31 J/mol-K = 8.31 kPa-L/mol-K

1 bar = 100 kPa = 750 torr

1 kPa = 7.50 torr

1 J = 1 kPa-L

1 kcal = 4.18 kJ

Molar Masses

	CH_3OH - 32	$C_6H_{12}O_6$ - 180	H_2O - 18
	$C_{10}H_8$ - 128	$Ca(NO_3)_2$ - 164	

Quadratic Equation: If $ax^2+bx+c=0$, then $x = \frac{-b+\sqrt{b^2-4ac}}{2a}$

CHEM 3530 - Exam 3 – March 31, 2017

Name______________________________

(76) **PART I. MULTIPLE CHOICE (Circle the ONE correct answer)**

1. When 16 grams of methanol, CH_3OH, is added to 108 grams of water, the density of the solution is 0.90 g/mL. The Molarity of methanol in this solution is approximately:

   (A) 3.6 M (B) 4.2 M (C) 4.5 M (D) 4.6 M

2. What is the mole fraction of Glucose, $C_6H_{12}O_{12}$, in a 4.50 molal solution of Glucose in water, H_2O?

   (A) 0.081 (B) 0.045 (C) 0.93 (D) 0.075

3. The vapor pressure of water (M=18) at 60 ^oC is 150.0 torr. When 135 grams of glucose (M=180) is dissolved in 108 grams of water (M=18), the vapor pressure of the solution at 40 ^oC is approximately:

   (A) 83 torr (B) 169 torr (C) 133 torr (D) 17 torr

4. The freezing point of pure CCl_4 is T_f^o = -23 ^oC. When 25 grams of napthalene, $C_{10}H_8$, are placed in 600 grams of CCl_4 (K_f = 30 $^oC/m$,), the freezing point of the solution is approximately:

   (A) -9.8 ^oC (B) -32.8 ^oC (C) -13.2 ^oC (D) -24.6 ^oC

5. When 25. grams of an unknown compound is dissolved in 500. g of water (K_f=1.9 $^oC/m$), the freezing point of the solution is -1.10 ^oC. The Molar Mass of the compound is approximately

   (A) 58 g/mol (B) 105 g/mol (C) 86 g/mol (D) 29 g/mol

6. When 41 grams of the **strong electrolyte**, $Ca(NO_3)_2$ (M=164) is dissolved in 250 grams of water (K_f=1.9 $^oC/m$), the freezing point of the solution is

   (A) -5.7 ^oC (B) -17.1 ^oC (C) -1.9 ^oC (D) +17.1 ^oC

7. What is the osmotic pressure, **in bar**, of a solution prepared by dissolving 20 grams of Glucose (M=180) in 500 mL of aqueous solution at 50 ^oC?

   (A) 92 bar (B) 600 bar (C) 3.0 bar (D) 6.0 bar

8. When a solution of an unknown compound is prepared by putting 10 grams of an unknown compound into 500 mL of solution, the osmotic pressure of the solution is 1.0 bar at 25 ^oC. The Molar Mass of the unknown compound is approximately

   (A) 50,000 g/mol (B) 500 g/mol (C) 250 g/mol (D) 5,000 g/mol

9. A 0.5 M solution of the dissociated sodium salt of a polymer, Na^+P^-, is placed in the left compartment, 0.3 M NaCl is placed in the right compartment, and the compartments are in contact through a semipermeable membrane, which permits diffusion of Na^+ and Cl^-, but not P^-. In order to reach equilibrium.

(A) Na^+ will move from left to right and Cl^- will move from right to left.
(B) Na^+ will move from right to left and Cl^- will move from left to right.
(C) Both Na^+ and Cl^- will move from left to right.
(D) Both Na^+ and Cl^- will move from right to left.

For #10 - #13: Consider the equilibrium, $2\,POCl_3(g) \leftrightarrow 2\,PCl_3(g) + Cl_2(g)$. The enthalpy change for this reaction is +510 kJ. The value of the equilibrium constant at 100 ^oC is 25.

10. For the above reaction, if the volume of the container is **increased**, then

(A) the equilibrium will move to the left and K will decrease
(B) the equilibrium will move to the right and K will increase
(C) the equilibrium will move to the right and K will remain constant
(D) the equilibrium will move to the left and K will remain constant

11. For the above reaction, if the temperature is **decreased**, then

(A) the equilibrium will move to the left and K will decrease
(B) the equilibrium will move to the right and K will increase
(C) the equilibrium will move to the left and K will remain constant
(D) the equilibrium will move to the right and K will remain constant

12. What is the Standard Gibbs Energy Change, ΔG^o (in kJ) , for the above reaction at 100 ^oC?

(A) -4.3 kJ (B) -80 kJ (C) +4.3 kJ (D) -10.0 kJ

13. For the related reaction, $POCl_3(g) \leftrightarrow PCl_3(g) + (1/2)\,Cl_2(g)$, the equilibrium constant is

(A) 625 (B) 12.5 (C) 5 (D) 0.20

14. The gas phase molecule, A, dissociates according to the equilibrium,

$A(g) \leftrightarrow B(g) + 2\,C(g)$. The equilibrium constant is $1x10^{-3}$. If one puts an initial pressure of 3 bar of A into a flask, what is the pressure **of C** at equilibrium? [**NOTE**: You may assume that very little A dissociates]

(A) 0.03 bar (B) 0.18 bar (C) 0.14 bar (D) 0.09 bar

For #15 - #16: We learned in class that the average number of ligands bound to a protein, R, is related to the ligand concentration, L, by:

$$R = \frac{n[L]}{K + [L]}$$ where n is the maximum number of bound ligands and K is the dissociaton constant

A series of equilibrium dialysis experiments yielded a double reciprocal plot (1/R vs. 1/[L]) with a slope of 0.005 and an intercept of 0.015.

15. The maximum number of bound ligands, n, is:

(A) 3 (B) 67 (C) 84 (D) 200

16. The dissociation constant, K, is:

(A) 7.5×10^{-5} (B) 3.0 (C) 67 (D) 0.33

17. A hypothetical biochemical reaction is written as: A(aq)) = B(eq) + $2H^+$(aq). The Gibbs energy difference using the Physical Chemists' Standard State is ΔG^o= +25 kJ. What is the Gibbs energy difference, $\Delta G^{o'}$, for this reaction using the Biochemists' (or Biological) Standard State?

(A) +105 kJ (B) +65 kJ (C) -15 kJ (D) -55 kJ

18. In the first step in the glycolysis cycle, a phosphate group is added to glucose (GLU) to give (G6P). The net reaction for this step is:

GLU + P_i + ATP $\rightarrow$ G6P + ADP $\Delta G^{o'}$ = -16.7 kJ

This is an example of a step driven by:

(A) Coupled Reactions (B) Tandem Reactions
(C) Physiological Concentrations (D) Biological Standard State driven reaction

19. Which of the following statements is/are true concerning the binding of O_2 to Myoglobin (Mb) and Hemoglobin (Hb)?

(i) Hb molecules consist of a hexamer of six Mb-like molecules
(ii) In muscle tissue after exercise (in which the O_2 has dropped to 20 torr), Mb retains most of its bound O_2, but Hb has depleted its O_2 reserve
(iii) The curve of O_2 saturation vs. P_{O2} in Hb is sigmoidal because the first bound O_2 makes it easier for additional O_2 molecules to bind to Hb

(A) i and ii (B) i and iii (C) ii and iii (D) iii only

PART II. TWO (2) PROBLEMS FOLLOW (Show work for partial credit)

(12) 1. Consider the solution phase reaction, A(aq) ↔ B(aq) + C(aq). At 50 °C, the equilibrium is $K_c = 2.0$.

(8) (a) If one prepares a solution with $[A]_0 = 1.0$ M, what are the concentrations of A, B, and C after the reaction has reached equilibrium?

Notes: You **CANNOT** assume that only a small fraction of A has reacted.
The quadratic equation is given on the cover sheet.

(4) (b) What is the Gibbs Energy change (in kJ) at 50 °C for the above reaction when the concentrations are [A] = 0.2 M, [B] = [C] = 0.8 M ?

(12) 2. For the reaction, $A(g) \leftrightarrow B(g)$, the Standard Enthalpy Change is $\Delta H^o = -70.$ kJ/mol and the equlibrium constant is $K = 5.0x10^4$ at 100 ^oC.

(6) (a) Calculate the Standard Entropy Change, ΔS^o, for this reaction.

(6) (b) Calculate the value of the equilibrium constant at 150 ^oC.