CHEM 5200 - Exam 3 - November 1, 2018

INFORMATION PAGE (Use for reference and for scratch paper)

Constants and Conversion Factors:

R = 8.31 J/mol-K = 8.31 kPa-L/mol-K = 0.00831 kJ/mol-K

1 L-atm = 101 J

1 L-bar = 100 J

1 kPa-L = 1 J

1 bar = 100 kPa

1 bar = 750 torr

1 atm = 760 torr

1 kPa = 7.50 torr

The relation between the Molar Mass (M), density (ρ) and Molar Volume (V_m) of a material is: $\rho = \frac{M}{V_m}$

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Name_____

(36) MULTIPLE CHOICE [3 points per question] (Circle the ONE correct answer)

1. Consider a mixture of two liquids, A and B. When 8.0 moles of A and 4.0 moles of B are mixed together, the volume of the solution is 700 cm^3. The Partial Molar Volume of B is 80. cm^3/mol. Therefore, the Partial Molar Volume of A is approximately:

   (A) 48 cm^3/mol (B) 15 cm^3/mol (C) 62 cm^3/mol

   (D) Cannot be determined without the density of the solution

2. The vapor pressure of CCl_4 is 54.6 kPa at 60 ^oC. When an unknown amount of an organic solid is dissolved in 5.0 moles of CCl_4, the vapor pressure above the solution at 60 ^oC is 50.6 kPa. Approximately how many moles of the solid were dissolved in the CCl_4?

   (A) 0.27 mol (B) 0.40 mol (C) 0.083 mol

   (D) Insufficient information. The Molar Mass of the organic solid is needed.

3. When a sample of glucose, $C_6H_{12}O_6$ (M=180), is dissolved in 600 grams of water (K_b = 0.5 ^oC/m), the boiling point is raised to 100.8 ^oC. Approximately how many grams of glucose are in the sample?

   (A) 290 g (B) 480 g (C) 220 g (D) 170 g

4. When 50 grams of an unknown compound is dissolved in 500 of water (K_f=1.9 ^oC/m), the freezing point of the solution is -2.20 ^oC. The Molar Mass of the compound is approximately

   (A) 58 g/mol (B) 86 g/mol (C) 105 g/mol (D) 43 g/mol

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

6. The boiling point of pure toluene is 111.0 ^oC and the Boiling Point Elevation Constant is 3.40 ^oC/m. When 25 grams a compound, A (M_A=100), is dissolved in 500 grams of Toluene, the boiling point of the solution is 113.2 ^oC. Therefore, the activity coefficient of the compound (γ_A) in the solution is approximately:

   (A) 1.3 (B) 0.65 (C) 0.8

   (D) Insufficient data to determine activity coefficient

7. Consider the gas phase equilibrium, 4 $NO_2(g)$ + $O_2(g)$ ⇌ 2 N_2O_5(g

   For the above reaction, if $N_2(g)$ is added to the container at **constant pressure**,

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

For #8 - #9: Consider the gas phase equilibrium, 2 $NO_2(g)$ ⇌ $N_2O_4(g)$. At 25°C, the Gibbs Energies of Formation of $NO_2(g)$ and $N_2O_4(g)$ are +51.3 kJ/mol and +97.9 kJ/mol, respectively.

8. The value of the equilibrium constant, K, for the above reaction at 25 °C, is approximately:

   (A) 6.7×10^{-9} (B) 0.15 (C) $1.5 \times 10^{+8}$ (D) 6.7

9. The value of ΔG for the above reaction at 25 °C when the pressures of NO_2 and N_2O_4 are 0.3 bar and 5.0 bar, respectively, is approximately:

   (A) +2.3 kJ (B) +5.2 kJ (C) +14.6 kJ (D) -2.3 kJ

10. Consider the gas phase equilibrium, $2\,A(g) \underset{\longleftarrow}{\overset{K}{\longrightarrow}} B(g)$. When the pressures of A and B are each 0.10 bar at 100 °C, the Gibbs Energy change for the reaction is +0.70 kJ. What is the approximate value of the equilibrium constant at 100 °C?

    (A) 1.3 (B) 10.0 (C) 8.0 (D 0.13

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

    A(g) ⇌ 2 B(g) + C(g). The equilibrium constant is 3×10^{-3}. If one puts an initial pressure of 6. bar of A into a flask, what is the approximate pressure **of B** at equilibrium? [**NOTE**: You may assume that very little A dissociates]

    (A) 0.33 bar (B) 0.17 bar (C) 0.13 bar (D) 0.52 bar

12. Consider the gas phase equilibrium, A(g) ⇌ 2 B(g). If one puts 2.0 moles of A (no B initially) into a container and the system is allowed to reach equilibrium, it is found that the equilibrium mixture contains 1.2 moles of A at a total pressure of 3.0 bar. The value of the equiibrium constant is approximately:

    (A) 0.3 (B) 2.3 (C) 0.8 (D) 6.8

FIVE (5) problems follow: NOTE: You Must show your work to receive credit.

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(12) 1. The densities of solid and liquid Chromium [M = 52.] are 7.1 g/mL and 6.4 g/mL, respectively. The normal melting point of Chromium is 1907 ^{o}C. When a pressure of 800 atm. is applied to Chromium, its melting point rises to 1914 ^{o}C

Use the above data to calculate the Enthalpy of Fusion of Chromium, **kJ/mol**.

(12) 2. The normal boiling point of iodobenzene is 188 ^{o}C and the vapor pressure is 40. torr at 90 ^{o}C. Calculate the Enthalpy of Vaporization, $\Delta_{vap}H^{o}$ of iodobenzene (in kJ/mol)

(14). 3. Consider the mixing of two ideal gases, Ethane and Butane. Determine the following quantities when 120 grams of $C_2H_6(g)$ [M=30], and 120. grams of $C_4H_{10}(g)$ [M=58], are mixed together at 85 ^oC.

(10) (a) The Gibbs Energy of Mixing, $\Delta_{mix}G$ (in kJ)

(4) (b) The Enthalpy of Mixing, $\Delta_{mix}H$ (in kJ)

(12) 4. Consider the gas phase dissociation equilibrium, $A(g) \overset{K}{\rightleftharpoons} 3B(g) + C(g)$. At 25 °C, the percent dissociation of A is 40% at a total pressure of 3.0 bar. Calculate the equilibrium constant, K.
Note: You cannot assume that very little A reacts.

(14) 5. Consider the gas phase equilibrium: $2\,A(g) \overset{K}{\rightleftharpoons} B(g) + C(g)$.

The equilibrium constant for this reaction Is K = 2.0

If one starts with pure A at an initial pressure of 5.0 bar (and no B or C initially), calculate the pressures of A and B at equilibrium.

Notes: 1. You **Cannot** assume that very little B and C react.

2. However, it should **not** be necessary to use the quadratic equation for this problem.