Chemistry 10123, **Exam 1** Name: _____
February 5, 2020 (Please Print)

1. (8 points) **SHOW ALL WORK.** Concentrated hydrochloric acid, $HCl_{(aq)}$, has a density of 1.19 g/mL and is 37.0 % HCl by weight. Determine the ***molar concentration*** of HCl in the solution. (Formula masses: H_2O = 18.0 g/mole; HCl = 36.5 g/mole)

2. (4 points) Consider the aqueous solutions labeled **A - E** as follows.

   A: pure H_2O **B**: 1.0 m HNO_2 **C**: 1.0 m KNO_2

   D: 1.0 m glucose, $C_6H_{12}O_6$ **E**: 1.0 m K_2SO_4

   Arrange these in order of increasing boiling point, lowest to highest.
   Write only the letters of the solutions in the blanks below.

   _____ < _____ < _____ < _____ < _____
   lowest bp highest bp

3. (2 points) (a) The conjugate base of $H_2PO_4^-$ is _____.
   (b) _____ is the conjugate acid of P_2H_4.

4. (2 points) ***Circle*** any of the following common substances that are colloidal dispersions.
   fog sand table salt milk antifreeze Jell-O

5. (2 points) The vapor pressure of water is 23.8 torr at 25 °C. If 2.0 moles of a non-volatile solute are dissolved in 8.0 moles of water at that temperature, the vapor pressure of the resulting solution should be _____ torr.

6. (7 points) **SHOW ALL WORK.** For the following reaction, K_c = 64. A quantity of HI is placed in an empty container and the system is allowed to reach equilibrium. At that point, the ***total pressure*** in the container is found to be 3.00 atm. Calculate the partial pressure of H_2 (in atm) at equilibrium.

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2\,HI_{(g)}$$

7. **SHOW ALL WORK.** Glycerol, $C_3H_5(OH)_3$ (92.0 g/mole) is a non-dissociating, non-volatile liquid that is very soluble in water. A certain aqueous solution of glycerol has a boiling point of 105.5 °C. Determine the quantities in parts (a) and (b) below, related to this solution.
[Some constants for H_2O (18.0 g/mole): K_b = 0.51 °C/m and K_f = 1.86 °C/m]

   (a) (7 points) The freezing point of the solution in °C.

   (b) (7 points) The weight percent of glycerol in the solution.

8. (3 points) At a pressure of 380 torr, the solubility of O_2 gas in water is 6.50×10^{-4} M. If the pressure is increased to 25 atm, the solubility of O_2 should be _____ M.

9. (4 points) The heat of solution ($\Delta H°_{soln}$) of an ionic compound in water is approximately equal to the sum of the _____ energy of the crystalline solid and the _____ energy of the ions in solution.

10. (7 points) **SHOW ALL WORK.** Using the data,

$$2\ NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2\ NOCl_{(g)} \qquad K_{c1} = 3.20 \times 10^{-3}$$

$$NO_{2(g)} \rightleftharpoons NO_{(g)} + 1/2\ O_{2(g)} \qquad K_{c2} = 3.95$$

determine the value of K_c for the following reaction.

$$NOCl_{(g)} + 1/2\ O_{2(g)} \rightleftharpoons NO_{2(g)} + 1/2\ Cl_{2(g)}$$

11. In a lab experiment, you are given two aqueous solutions labeled **A** and **B** as follows and asked to determine the molar concentration of H_2SO_4 in Solution **B**.

Solution **A**: NaOH, M = 0.250 Solution **B**: H_2SO_4, M = ???

(a) (3 points) Write a balanced, ***net ionic equation*** for the reaction that occurs when these two solutions are mixed together.

(b) (10 points) **SHOW ALL WORK.** After carefully mixing 100 mL of solution **A** with 100 mL of solution **B**, you determine that the resulting solution has a pH of 12.63 at 25 °C. Calculate the molar concentration of the original H_2SO_4 solution (**B**).

12. (12 points) Consider the following reaction from the viewpoint of the Lewis acid-base concept. Write ***Lewis electron dot formulas*** (including formal charges and/or resonance forms if needed) for all four species in this reaction. *Clearly indicate which reactant is the Lewis acid and which is the Lewis base*. Use arrow(s) to illustrate the formation and/or breaking of any chemical bond(s) during the reaction.

$$CN^- + BrNO_2 \rightleftharpoons BrCN + NO_2^-$$

13. A 3.00 g sample of solid $NH_2CO_2NH_{4(s)}$ (78.1 g/mole) was placed in an *empty* 1.00-L container and heated to 400 K until the following equilibrium is established. The mass of solid $NH_2CO_2NH_{4(s)}$ remaining at equilibrium was found to be 1.75 g.
[From other experiments, the reaction is known to be endothermic with $\Delta H° = 665$ kJ.]

$$NH_2CO_2NH_{4(s)} \rightleftharpoons 2\ NH_{3(g)} + CO_{2(g)}$$

(a) (5 points) How will the equilibrium amount of $CO_{2(g)}$ be affected by each of following changes? Indicate your answer by writing the appropriate letter.

[**I** = increase, **D** = decrease, **N** = no change]

Change	**moles $CO_{2(g)}$**
add some $NH_{3(g)}$	
add a catalyst	
decrease the volume	
remove some $NH_2CO_2NH_{4(s)}$	
increase the temperature	

(b) (2 points) If the temperature of the above equilibrium system is reduced, the actual value of K_c should (circle one): increase decrease stay the same

(c) (8 points) **SHOW ALL WORK.** Determine the equilibrium constant (K_c) at 400 K for this reaction using the data provided above.

14. (7 points) **SHOW ALL WORK.** At 50 °C the value of K_w is 5.6×10^{-14}. Determine the pH of a solution made by dissolving 1.50 g of $Ba(OH)_2$ (171 g/mole) in enough water to make 500 ml of solution at this temperature.