Chemistry 103 Practice HE 2 (150 pts)

Student Info: name, _____________________________________ SID, _____________

Lab Instructor: _____________________

Ground Rules

In solving word problems, you must show sufficient work that the grader may follow your logic, for example, show chemical formulas and the corresponding molar masses you calculate, etc.. Many questions have multiple parts. **Clearly** indicate your answer to each part.

If you cannot complete a part of a problem due to what you see as missing information, describe what is missing and how the problem could be solved using that information and you may receive partial credit depending upon the validity of your arguments.

Finally, this exam is a reflection of *your* understanding of the material. Cheating is a serious offense that bears many penalties, outlined in the student handbook. If you do succeed in cheating, the greatest penalty will be when you are required to apply the material you were to have learned.

Each of the 5 questions is worth 30 points.

Potentially Useful Information for Chem. 103:

$R = 8.314$ J/mol•K

$PV = nRT$

760 mm Hg = 1 atm

$h = 6.626 \times 10^{-34}$ J•s

$c = 3.00 \times 10^{8}$ m/s

$m_{electron} = 9.109 \times 10^{-31}$ kg

$R = 0.0821$ L•atm/mol•K

$N_o = 6.022 \times 10^{23}$ mole

0° C = 273.15 K

$KE = \frac{1}{2} mv^2$

$\ln k = \ln A - (E_a/RT)$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$K_W = 1.00 \times 10^{-14}$ AT 298K

$K_A K_B = K_W$

$\Delta H = \Delta E + \Delta nRT$

$\Delta S = \frac{q}{T}$

$S = k \ln W$

$\Delta G° = \Delta H° - T\Delta S°$

$\Delta G = \Delta G° + RT\ln Q$

$\Delta G° = -RT\ln K$

$\Delta E = q + w$

1 L•atm = 101.27 J

$q = nC_p\Delta T$

$w = -P_{ext}\Delta V$ or F•d

$q = C\Delta T$

$\Delta H = q_P$

Significant Figures figure Significantly in your answer!

1. Calculate the pH of each of the following solutions:

1.1 A mixture of 25.0 mL of 0.0200 M $Ba(OH)_2$ (a strong base) and 15.0 mL of 0.0300 M HCl (a strong acid); assume the volumes are additive.

1.2 A 0.0150 M solution of phenol, a weak acid, for which $K_a = 1.0 \times 10^{-10}$

2. Time for a buffer problem. You prepare 1.0L of a solution of 0.20 mol of sodium hydrogen carbonate, $NaHCO_3$, in water. For the diprotic acid H_2CO_3 $Ka_1 = 4.5 \times 10^{-7}$; $Ka_2 = 4.7 \times 10^{-11}$.

2.1 Calculate the pH of the sodium hydrogen carbonate solution you just prepared.

2.2 You add 10.0 mL of 0.40 M HCl, a strong acid, to the solution in 2.1. Calculate the new pH.

2.3 You add 20.0mL of 0.40M KOH, a strong base, to the solution in 2.2. Calculate the new pH.

3. And now for the titration problem! Calculate the pH at the following points in the titration of 50.0 mL of a 1.0×10^{-2}M solution of pyridine, a weak base with $K_b = 1.7 \times 10^{-9}$ with 0.10 M HCl, a strong acid.

3.1 At the start, before any acid has been added; 3.2 At the half stoichiometric (half equivalence) point; 3.3 At the stoichiometric (equivalence) point ; 3.4 When 0.20 mL of acid has been added beyond the stoichiometric (equivalence) point.

4. A volume of 250L of waste water contains 3.0 millimoles of cadmium chloride, a toxic compound. To remove the cadmium 2.0L of 6.0M NaOH solution is added to the waste water. How many moles of $Cd(OH)_2$ precipitate, and what is the Cd^{2+} concentration in the resulting solution as a percentage of the original concentration?

K_{sp} for $Cd(OH)_2 = 7.2 \times 10^{-15}$

5.1 Balance the following redox reaction in acidic solution by the half-reaction method:

$K_2Cr_2O_7$ + $K_2C_2O_4$ + H_2SO_4 = CO_2 + $Cr_2(SO_4)_3$ + K_2SO_4

You may use H_2O as an additional reagent or product.

5.2 Use the listed standard reduction potentials to determine the net spontaneous reaction and the standard cell potentials for the following systems: Fe^{2+} and Cr^{3+}; Ag^{+} and Au^{3+}. For ONE of the two cells make a sketch showing the essential components, including the anode, cathode, and direction of electron flow.
E^o/V Fe^{2+} + 2e = Fe, -0.45; Cr^{3+} + 3e = Cr, -0.74; Ag^{+} + e = Ag, 0.80; Au^{3+} + 3e = Au, 1.50.