10/10

Chemistry 205
Experiment 1: Acid-Base Titration
Pre-lab Assignment

Name: __ **Date:** ________

Section: ____________

1. Potassium hydrogen phthalate is not hygroscopic. What does that mean?

It does not absorb water readily, ~~it's consider~~ ⇒ its mass can be measured very accurately.

(2)

2. a) How many grams of potassium hydrogen phthalate, KHP, (molar mass = 204.23 g/mol) are needed to prepare 250.0 mL of 0.07241 M standard aqueous solution?

aq sln {V = 250 mL, [ ] = 0.07241 M} KHP{m: ??

$n = M \times V = 0.07241 \times 250 \times 10^{-3} = 0.018$ mol.

at the stock & at equivalence, n (aq sln) = n KHP

⇒ $n_{KHP} = 0.018$ mol

$n = \frac{m}{M_{mass}} \Rightarrow m = n \times M = 0.018 \times 204.23$

$m_{KHP} = 3.69$ g.

(2) (1)

b) Practically while preparing the above standard solution, the flask must be filled to its 2/3 capacity with water and **swirled** thoroughly to dissolve the solid completely. Can you at this stage, instead, stopper the flask or cover with parafilm and **invert** several times to affect dissolution? Explain your answer. No, we can't invert the flask at this point since part of the solute will be stuck at the stopper, since it's not homogenized completely. We should wait till ~~the~~ we add to the line mark and then we homogenize by flipping and inverting the flask where no amount will be lost.

(3)

3. The maximum permissible amount of cadmium (Cd^{2+}) in drinking water is 0.0100 mg/L. What is the molarity of such a solution?
(Atomic weight: Cd = 112.41).

(3)

$C_m = \frac{m}{V}$

$M = \frac{n}{V} = \frac{m/M_{mass}}{V} = \frac{m}{M_{molar\ mass} \times V}$

$C_m = C \times M$

$\Rightarrow C = \frac{C_m}{M} = \frac{0.0100 \times 10^{-3}}{112.41} = 8.89 \times 10^{-8}$ mol/L

10/10

Chemistry 205
Experiment 2: Redox Titration
Pre-lab Assignment

Name: _____ **Date:** 22 - 02 - 2013

1. Each of the following processes is a likely change in a redox reaction. Label the chemical change as an oxidation process, a reduction process, or neither:
a. $MnO_2 \rightarrow Mn^{2+}$
b. $Pb^{2+} \rightarrow Pb$
c. $Cl_2O_3 \rightarrow Cl^-$
d. $SO_3 \rightarrow SO_4^{2-}$
e. $I^- \rightarrow I_2$

2. Write the formula of the commercially available salt, ferrous ammonium sulfate hexahydrate, and calculate its molar mass.

$Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$

Molar Mass = $55,8u + 2(14) + 2(4)(1) + 2(32) + 2(4)(16) + 6(2) + 6(16)$

$= 55,84 + 28 + 8 + 64 + 128 + 12 + 96 = 391,84$ g/mol.

3. Oxalic acid ($H_2C_2O_4$), a colorless diprotic acid, is present in many plants and vegetables. A 6.15 mL volume of 0.122 M $KMnO_4$ solution is needed to titrate 15.0 mL of an oxalic acid solution to the equivalence point.
a. Write the balanced net ionic equation involved in the above titration.
b. Write the balanced reduction half-reaction.
c. What is the reducing agent in the above reaction?
d. Suggest a good indicator for the above titration.
e. Calculate the molarity of the oxalic acid solution.

a) $MnO_2 \longrightarrow Mn^{2+}$

$Mn + 2(-2) = 0$ $\quad +2$

$Mn = +4 \longrightarrow Mn = +2$

reduction process

b) $Pb^{2+} \longrightarrow$

$2+ \longrightarrow 0$

reduction process

$Cl_2O_3 \longrightarrow Cl^-$

$2xCl + 3(-2) = 0$

$Cl = \frac{6}{2} = +3 \longrightarrow Cl = -1$

reduction process

d) $SO_3 \longrightarrow SO_4^{2-}$

$S + 3(-2) = 0 \Rightarrow S + 4(-2) = -2$

$S = +6 \longrightarrow S = +6$

neither

$I^- \longrightarrow I_2$

$I = -1 \longrightarrow I = 0$

oxidation process

3)-a) $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

b)
$$\begin{cases} MnO_4^- \longrightarrow Mn^{2+} + 4H_2O \\ (5e^- + 8H^+ + MnO_4^- \longrightarrow Mn^{2+} + 4H_2O) \times 2 \end{cases}$$

c) $C_2O_4^{2-}$ undergoes oxidation. It is reducing agent.

d) I good indicator for the above titration is potassium permanganate solution.

e) 6,15 mL of 0,22 M $KMnO_4$
15,0 mL of oxalic acid

$$\frac{n_{MnO_4^-}}{2} = \frac{n_{C_2O_4^{2-}}}{5}$$

$$C = \frac{n}{V}$$

$$\frac{[MnO_4^-] \times V_{MnO_4^-}}{2} = \frac{[C_2O_4^{2-}] \times V_{C_2O_4^{2-}}}{5}$$

$$[C_2O_4^{2-}] = \frac{5 \times 0,122 \times 6,15 \times 10^{-3}}{2 \times 15,0 \times 10^{-3}} = 0,125\ M$$

10/10

Chemistry 205
Experiment 3: Spectrophotometric Determination of Iron in Vitamin Tablets
Pre-lab Assignment

Name: **Date:** March 1st 2013

1. A particular form of electromagnetic radiation has a frequency of 8.11×10^{14} Hz.
(Speed of light = 3.00×10^8 m/s; Planck's constant, h = 6.626×10^{-34} J.s)
a) What is the wavelength in nanometer?

$c = \lambda \times \nu \Rightarrow \lambda = \frac{c}{\nu} = \frac{3,00 \times 10^8}{8,11 \times 10^{14}} = 3.70 \times 10^{-7}\ m$
$= 370\ nm$

b) Is this radiation visible light? If not, is it less or more energetic than visible light?

No, since the visible light range is from 400nm to 700nm and λ of this radiation is lower than the range. So this radiation is not visible light however it is more energetic than the visible light because E ↑ when λ ↓

2. A 0.0100 M solution exhibits 45.0% transmittance at some wavelength.
a) Calculate its absorbance.

$A = -\log \frac{T\%}{100} = -\log \frac{45.0\%}{100} = -\log 0,45 = 0.34$

b) What will be the %T for a 0.0200 M solution of the same substance?

if 0,00100 M has 45,0% and 0,347 absorbance.
0,0100 ⇒ 0,347 absorbance.
0,0200 M ⇒ ? absorbance

$\frac{0,0200 \times 0,347}{0,0100} = 0,694$ absorbance

$A = -\log T\%$
$T\% = 100 \times 10^{-A}$
$= 100 \times 10^{-0,694} = 100 - 10^{0,694} = 20,2\%$

3. A 3.96×10^{-4} M solution of a compound A exhibited an absorbance of 0.595 at 238 nm in a 1.000-cm cuvet.
a) Calculate the molar absorbtivity of compound A

$A = \varepsilon bc \Rightarrow \varepsilon = \frac{A}{bc} = \frac{0,595}{(1,000)(3.96 \times 10^{-4})} = 1502.5\ M^{-1} cm^{-1}$
$= 1.50 \times 10^3\ M^{-1} cm^{-1}$

b) A volume of 2.00 mL of the above solution was diluted to a final volume of 25.00 mL. Calculate the concentration of the diluted solution.

$n_b = n_a$
$(M.V)_b = (M.V)_a$

$2,00 \times 3,96 \times 10^{-4} = 25,00 \times M$
$\Rightarrow M = \frac{2,00 \times 3,96 \times 10^{-4}}{25,00} = 3,17 \times 10^{-5}\ mol/L$

9.5/10
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Chemistry 205
Experiment 4: Chemical Equilibrium
Pre-lab Assignment

Name: **Date:** 08 - 03 - 2013

1. Complete and balance each of the following reactions and write the net ionic equations.

$Fe(NO_3)_3(aq) + 3\,NaOH(aq) \rightarrow 3\,NaNO_3 + Fe(OH)_3$

$Fe^{3+} + 3OH^- \longrightarrow Fe(OH)_{3(s)}$ (-1/2)

$KSCN(aq) + AgNO_3(aq) \rightarrow AgSCN + KNO_3$

$SCN^-_{(aq)} + Ag^+_{(aq)} \longrightarrow AgSCN_{(s)}$

2. Baking soda (sodium bicarbonate) undergoes thermal decomposition as follows:

$2NaHCO_3(s) + Heat \rightleftharpoons Na_2CO_3(s) + CO_2(g) + H_2O(g)$

a. Write the correct equilibrium constant expression for the above reaction.

$K_c' = \frac{[Na_2CO_3][CO_2][H_2O]}{[NaHCO_3]^2}$ $[Na_2CO_3]$ = Constant, $[NaHCO_3]^2$ = constant

$K_c = [CO_2][H_2O]$
$= K_c \times \frac{[NaHCO_3]^2}{[Na_2CO_3]}$

b. What will happen to the concentration of carbon dioxide if the temperature of this system is raised? If the temperature of this system is raised. Endothermic reaction will happen ⇒ K increases, equil shifts to right ⇒ the concentration of carbon dioxide will increase also

c. Predict the direction of shift in equilibrium when $H_2O(g)$ is removed as it forms. If H_2O removed ⇒ products should increase ⇒ Equilibrium will shift to the right

d. Predict the direction of shift in equilibrium when solid $NaHCO_3$ is added to the system. when solid $NaHCO_3$ is added the Equilibrium will not change. Because $NaHCO_3$ is a solid

3. 4.2 mol of oxygen and 4.0 mol of NO are introduced to an evacuated 0.50 L reaction vessel. At a specific temperature, the equilibrium $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ is reached when [NO] = 1.6 M. Calculate K_c for the reaction at this temperature?

	$2NO_{(g)}$	$+\ O_{2(g)}$	$\rightleftharpoons\ 2NO_{2(g)}$
Initial	4	4,2	0
chang	-2x	-x	2x
Equivalence	0,8	2,6	3,2

[NO] = 1,6 M

n = 1.6 x 0,5 = 0,8 mol

4 - 2x = 0,8

2x = 3,2

x = 1,6

$K_c = \frac{\left[\frac{3,2}{0,5}\right]^2}{\left[\frac{0,8}{0,5}\right]^2\left[\frac{2,6}{0,5}\right]} = \frac{40,96}{2,56 \times 5,2} = 3,077$

9.5

Chemistry 205
Experiment 5: Rate of Iodination of Acetone
Pre-lab Assignment

Name: **Date:** March 15th 2013

Section: _____

1. A reaction has the experimental rate equation, Rate = $k[A]^2[B]$.

a. What is the order of the reaction?

2 order in A. overall order: $2+1=3^{rd}$ order.
1 order in B

b. If the concentration of A is doubled and the concentration of B is halved, what happens to the reaction rate?

Rate 2 = $k[2A]^2[B/2]$

$$\frac{\text{Rate 2}}{\text{Rate 1}} = \frac{k[2A]^2[B/2]}{k[A]^2[B]} = (2)^2 \times \frac{1}{2} = 4/2 = 2$$

therefore the rate doubles

2. The reaction $2A + 3B \rightarrow C$ is first order with respect to A and B. when the initial concentrations are $[A] = 1.6 \times 10^{-2}$ M and $[B] = 2.4 \times 10^{-3}$ M, the rate is 4.1×10^{-4} M/s. Calculate the rate constant of the reaction.

$\text{rate} = k[A]^x[B]^y = k[A]^1[B]^1$ $x=1$ $y=1$

$$\Rightarrow k = \frac{\text{rate}}{[A]_0[B]_0} = \frac{4.1\times10^{-4}}{(1.6\times10^{-2})(2.4\times10^{-3})} = 10.68$$

$k \approx 11 / \text{M.s}$

3. The experimental data for the following reaction are given below:

$2NOCl \rightarrow 2NO + Cl_2$

Temperature (K)	k (L/mol·s)
400	6.6×10^{-4}
500	2.9×10^{-1}
600	16.3

a. What is the slope of an Arrhenius plot for this reaction? Show your work.
b. Calculate the activation energy of this reaction.

a) $k = A \cdot e^{(-E_A/RT)}$

$\ln k = \frac{-E_a}{R} \times \frac{1}{T} + \ln A$

$= -\frac{E_a}{R} \times \frac{1}{T} + \text{ord.}$

$\text{slope} = \frac{-E_a}{R}$

b) $\text{slope} = \frac{y_2 - y_1}{x_2 - x_1}$

* for $k_1 = 16.3$, $\ln k = 2.79$ at $T = 600K \Rightarrow \frac{1}{T} = 1.66 \times 10^{-3}$

$\Rightarrow F(1.66\times10^{-3}, 2.79)$

$+\ln k = 2.9\times10^{-1}$, $\ln k = -1.24$ at $T = 500 \Rightarrow \frac{1}{T} = 8\times10^{-3}$

$\Rightarrow E(2\times10^{-3}, -1.24)$

$\Rightarrow \text{slope} = \frac{-1.24 - 2.79}{(2.0\times10^{-3}) - (1.66\times10^{-3})} = \frac{-4.03}{3.4\times10^{-4}} = -11852.94$

$= -1.2\times10^{4}\ K$ ($\frac{-1}{2}$)

$\text{slope} = \frac{-Ea}{R} \Rightarrow -Ea = \text{slope} \times R$

$-Ea = -1.2\times10^{4} \times 8.314$

$-Ea = -99768.$

$\Rightarrow Ea = 99768\ J/mol.$

10

Chemistry 205
Experiment 6: Electrochemistry
Pre-lab Assignment

Name: _____ **Date:** 22-03-2013

Section: 3

1. Which of the following metals is the strongest reducing agent and which is the weakest at standard-state conditions?

Li, Mg, Ag, Ca

$Li^+ + e^- \rightarrow Li \quad E = -3,05V$

$Mg^{2+} + 2e^- \rightarrow Mg \quad E = -2,37V$

$Ag^+ + 1e^- \rightarrow Ag \quad E = 0,80V$

$Ca^{2+} + 2e^- \rightarrow Ca \quad E = -2,87V$

the more ⊖ E undergoes reduction (oxidizing agent)

the strongest reducing agent: Li

the weakest : Ag

2. Given the following:

Redox Couple	Standard reduction potential, E^0(v)
$Ag^+ + 1e^- \rightarrow Ag$	+ 0.80
$Pb^{2+} + 2e^- \rightarrow Pb$	- 0.13

a) Which redox couple undergoes reduction?

Ag^+/Ag undergoes reduction

b) Write an equation for the reaction that occurs at the:

Anode: $Pb \rightarrow Pb^{2+} + 2e^-$

Cathode: $Ag^+ + 1e^- \rightarrow Ag$

c) Write the equation of the overall cell reaction

$Pb + 2Ag^+ \rightarrow Pb^{2+} + 2Ag$

d) What is the standard cell potential E^0_{cell}, for the galvanic cell?

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

$= E^\circ_{Ag^+/Ag} - E^\circ_{Pb^{2+}/Pb} = 0,8 + 0,13 = 0,93V$

e) Calculate the cell potential when $[Ag^+] = 0.1$ M and $[Pb^{2+}] = 0.001$ M at 25 °C.

$E = E^0 - \frac{0,0257}{n} \ln Q \qquad Q = \frac{[Ag]^2[Pb^{2+}]}{[Ag^+]^2[Pb]} = \frac{0,001}{(0,1)^2} = 0,1$

$E = 0,93 - \frac{0,0257}{2} \times \ln(0,1) = 0,93 - (-0,029) = 0,959V$

3. Write the possible half-reactions that take place at the anode in the electrolytic decomposition of aqueous potassium iodide solution. Use standard reduction potentials to predict which reaction is easier to occur.

$2I^- \rightarrow I_2 + 2e^- \quad (1)$

$2H_2O \rightarrow 4H^+ + O_2 + 4e^- \quad (2)$

Reaction (1) is easier to occur due to standard reduction potentials value.

$I_2 + 2e^- \rightarrow 2I^- \quad E^\circ = 0,53V$

$4H^+ + O_2 + 4e^- \rightarrow 2H_2O \quad E^\circ = +1,23V \rightarrow$

At Anode, oxidation occur. And we know if the E° is more positive it will undergo reduction, that's why reaction(1) is more easier because $E^{\circ}_{reaction(1)} < E^{\circ}_{reaction(2)}$

-8.5

Chemistry 205

Experiment 7: Qualitative Analysis

Pre-lab Assignment

Name: **Date:** 5-04-2013

1. Which of the following salts are water soluble and which are water insoluble?
   a. $PbSO_4$ b. Na_2S c. $Al(OH)_3$ d. AgOH e. $CuBr_2$ f. $HgCl_2$

   soluble : Na_2S - $CuBr_2$ - $HgCl_2$

   Insoluble : $PbSO_4$ - $Al(OH)_3$ - AgOH

   Which of the above salts shows amphoteric properties? Explain using chemical equations. $Al(OH)_3$

   $Al^{3+} + 3OH^- \rightleftharpoons Al(OH)_{3(s)}$

   $Al(OH)_{3(s)} + OH^- \rightarrow Al(OH)_4^-$ $Al^{3+} + 3H_2O$ (-1/2)

   Which of the above salts can form an ammine complex? (Write the chemical equation involved). AgOH

   $Ag^+ + OH^- \rightleftharpoons AgOH$ Cu^{2+} ? (-1)

   $AgOH + 2NH_3 \rightarrow Ag(NH_3)_2^+ + OH^-$

2. Aqueous solution of thioacetamide is a source of sulfide ion when heated. Explain using chemical equation(s).

   $CH_3CSNH_2 + H_2O \xrightarrow{\text{heat}} CH_3CONH_2 + H_2S$

   $H_2S \xrightarrow{\Delta} 2Ae^+ + S^{2-}$

3. Calculate the solubility product constant for silver chromate (Ag_2CrO_4) knowing that its solubility is 7.8×10^{-5} mol/L.

   $Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO_4^{2-}$

   $K_{sp} = [Ag^+]^2[CrO_4^{2-}] = (2s)^2 \times s = 4s^3$

   $= 4(7,8 \times 10^{-5})^3 = 1,9 \times 10^{-12}$

4. Describe a simple test that would allow you to distinguish between $AgNO_3(s)$ and $Cu(NO_3)_2(s)$.

   Add Cl^- from HCl or NaCl reagents.
   Ag^+ will form a white precipitate AgCl
   whereas Cu^{2+} will not react & remain soluble

10

Chemistry 205
Experiment 8: Impurities in Natural Water
Pre-lab Assignment

Name: . **Date:** 12-04-2013

Section: 3

1. Mention one major soluble carbonate salt in sea water and two major insoluble carbonate salts in hard water.

soluble carbonate in sea water: Na_2CO_3
insoluble carbonates in hard water: $CaCO_3$, $MgCO_3$

2. Give the full name of EDTA.
How many bonds can EDTA form with calcium ion?

EDTA: Ethylene diamine tetra acetic acid

every EDTA molecule bonds to 1 Ca^{2+} ion forming 6 bonds.

3. A 25.00 mL sample of calcium unknown requires 16.33 mL of 0.01092 M EDTA to reach the EBT endpoint. Calculate the molarity of the calcium unknown.

$$H_2Y^{2-}_{(aq)} + Ca^{2+}_{(aq)} \longrightarrow CaY^{2-} + 2H^+$$

at the end point $n_{Ca^{2+}} = n_{H_2Y^{2-}}$

$$[Ca^{2+}]V_{sample} = [EDTA]V_{EDTA}$$

$$[Ca^{2+}] = \frac{0,01092 \times 16,33 \times 10^{-3}}{25,00 \times 10^{-3}} = 7,132 \times 10^{-3}\ M$$

4. Deionized water can be obtained by passing water through a deionizing type resin that is a combination of a cation and an anion exchange resins. The cation exchange resin removes all metal ions and replaces them with H^+ ions. The anion-exchange resin removes negative ions and replaces them with OH^- ions. The neutralization reaction $H^+ + OH^- \rightarrow H_2O$ follows. If a substitute for distilled water is needed, would you use deionized water or soft water? Explain briefly.

- Distilled water: pure water containing no minerals or ions
- Deionized water: water containing no ions since cations and anions are being exchanged with H^+ & OH^- respectively.
- Soft water: water containing no hardening ion like Ca^{2+} or Mg^{2+} but contains Na^+ ions & other anions.

⇒ So to substitute distilled water, deionized water should be used since it is more similar to its composition & ions than soft water.

16

Chemistry 205
Experiment 9: Colligative Properties
Pre-lab Assignment

Name:_ **Date:** 19-04-2013

Section: 3

1. Permanent antifreeze is also called "summer-winter" antifreeze. Why is the solution useful for both winter and summer driving?

permanent anti-freeze is used in engines to:
- lower the freezing pt on winter
- elevate the b.p to enable higher temp. before ~~evaporation~~ in summer

2. Arrange the following aqueous solutions in order of:
0.005 m Na_2SO_4, 0.010 m KNO_3, 0.010 m urea [$(NH_2)_2CO$], 0.008 m $BaCl_2$

0,015 0,02 0,01 0,024

a) Increasing freezing point

0,008 m $BaCl_2$ < 0,01 m KNO_3 < 0,005 m Na_2SO_4 < 0,01 m urea

b) Increasing boiling point

0,01 m urea < 0,005 m Na_2SO_4 < 0,01 m KNO_3 < 0,008 $BaCl_2$

3. An aqueous solution freezes at -3.6°C. What is its boiling temperature?

$\Delta T = T_F^\circ - T_F = 0 - (-3,6) = 3,6°$

$\Delta T_F = i k_F m \Rightarrow i m = \frac{\Delta T_F}{K_F} = \frac{3,6}{1,86} = 1,935$

$\Delta T_b = i k_b m = 1,935 \times 0,52 = 1,0062$

$\Delta T_b = T_b - T_b^\circ \Rightarrow T_b = \Delta T_b + T_b^\circ = 100 + 1,0062 = 101,0062°$

4. A sugar solution made to feed hummingbirds contains 453.6 grams of sugar, $C_{12}H_{22}O_{11}$, to 1.81 x 10^3 g of water. Can this solution be put outside without freezing where the temperature falls to 20.0°F at night? Show evidence for your answer.

$n_{sugar} = \frac{m}{M} = \frac{453,6}{366} = 1,239$ moles

$\text{molality} = \frac{n_{solute}}{m_{solvent}} = \frac{1,239}{1,81} = 0,685$ m.

$\Delta T_F = i K_F m = 1 \times 0,685 \times 1,86 = 1,2741$

$\Delta T_F = T_F^\circ - T_F \Rightarrow T_F = T_F^\circ - \Delta T_F = 0 - 1,2741 = -1,2741°$

5. The boiling point of water can be raised by adding salt. At a mountain camp water boils at 95.2°C. How many grams of NaCl should be added to 1L of water to raise the boiling point to 100.0°C

$\Delta T_b = T_b - T_b^\circ = 100 - 95,2 = 4,8°C$

$\Delta T_b = i K_b m = 2 \times 0,52 \times m \Rightarrow m = \frac{4,8}{2 \times 0,52} = 4,615$ m

$\text{molality} = \frac{n_{solute}}{m_{solvent}} \Rightarrow n_{solut}^\circ =$

mass solvent = $V \times \ell = 1 \times 1 = 1$g

n solute = $1 \times 4,625 = 4,625$ moles.

$m = n \times M = 4,625 \times (35,5 + 23) = 270,9$ of added NaCl.