Name:_____

Chem II Final Exam #3

Instructions

Each problem on this exam is worth 10 points. You may complete your choice of five problems. Since credit will be given for both the correct answer and work, make sure your work is clear, logical, and well labeled. Insufficient space was given to work most of the problems, therefore you will have to use additional sheets of paper. The last page of the exam contains formulas, constants, and other related information. Good Luck!

1. Complete and balance the following redox equation:

   $ClO_3^{1-} + Cr(OH)_3$ ------> $CrO_4^{2-} + ClO_2^{1-}$
   (basic soln.)

   Determine the electrochemical potential of the reaction at a pH of 8.2 when the concentration of all other ionic species is at 0.1 M.

2. A two gram sample of iron ore was dissolved in acid and all iron present was reduced to Fe^{2+}. The resultant solution was titrated with a 0.5 M soln of permanganate. The volume required to reach the endpoint was 35.71 ml. During the titration Fe^{2+} was oxidized to Fe^{3+} and MnO_4^{1-} was reduced to Mn^{2+}. Determine the percentage of iron, as the metal, present in the sample.

3. A buffer solution is made up of equal volumes of 0.1 M acetic acid and 0.5M sodium acetate. What is the pH of the solution.

4. In an experiment a sample of sodium chlorate was 95% decomposed in 48 minutes. Approximately how long would this decomposition have taken if the same sample had been heated at a temperature 20 degrees celcius higher?

5. Hydrogen chloride, HCl, and ammonia, NH_3, escape from bottles of their solutions and react to form the white glaze often seen on glass in chemistry laboratories.

   $HCl + NH_3$ ------> NH_4Cl

   a) Calculate the free energy change, ΔG, for this reaction.

b) At what temperature will ΔG for the reaction be equal to zero?

6. The equilibrium constant K for the reaction

PCl_5 ------> $PCl_3 + Cl_2$

is 0.0211 at a certain temperature. What are the equilibrium concentrations of PCl_5, PCl_3, and Cl_2 starting with a concentration of PCl_5 of 1.00M?

7. At what temperature does the decomposition of dinitrogen trioxide become spontaneous. The unbalanced reaction is given below. (All substances are in the gaseous state.)

N_2O_3 ------> $NO + NO_2$

8. Given the following relationship: $\log N_0 - \log N = 0.301 * t / t_{1/2}$. .
What information can be gained from the slope and the y-intercept of the line obtained when one plots log N vs. t?

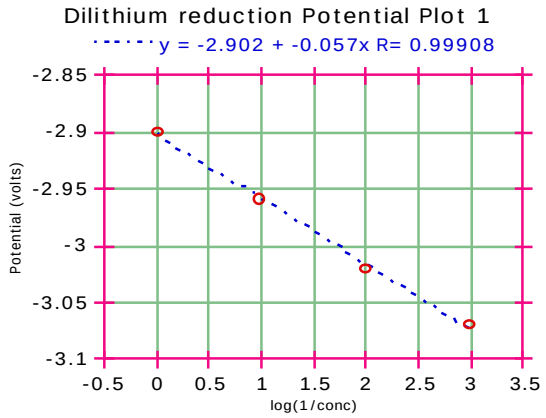
9. The data in the table below apply to the following reaction:
$A + 3B + 2C$ ------ AB_3C_2

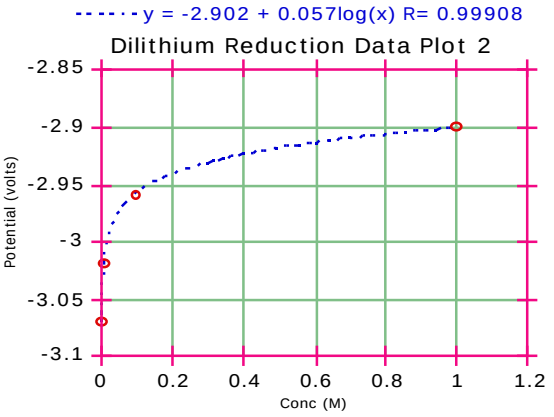
[A]	[B]	[C]	Rate
0.2	0.4	0.1	1
0.4	0.4	0.2	8
0.2	0.2	0.2	1
0.4	0.4	0.1	4

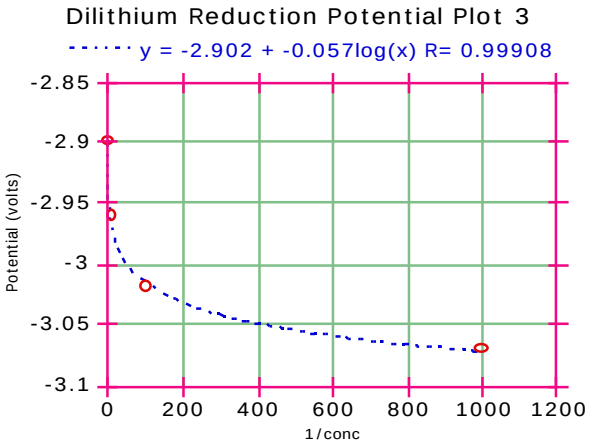
Determine the rate law.

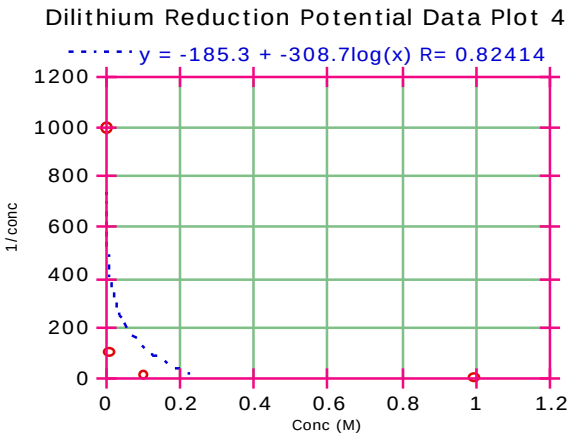
10. According to the Star Trek manual the element Dilithium will be discovered in the year 2049 on Jupiter V. Dilithium was analyzed by Professors Wolfram Boron and Sally Samarium in an attempt to determine the periodic group that the element belongs to. These eminent professors decided to take the scenic route to the answer (long way) by making electrochemical cell potential measurements for the reduction of the ion at various concentrations vs. the standard hydrogen electrode. The data collected is given below along with several plots. Determine the periodic group that the element belongs to if it is assumed that Di^{n+} is the ion that results when only the valence electrons are removed.

Trial	$[Di^{n+}]$	$1/[Di^{n+}]$	$\log(1/[Di^{n+}]$	Potential (volts)
1	1	1	0.0	-2.90
2	0.1	10	1.0	-2.96
3	0.01	100	2.0	-3.02
4	0.001	1000	3.0	-3.07


Dilithium reduction Potential Plot 1
y = -2.902 + -0.057x R= 0.99908
Potential (volts)
-2.85
-2.9
-2.95
-3
-3.05
-3.1
-0.5 0 0.5 1 1.5 2 2.5 3 3.5
log(1/conc)


y = -2.902 + 0.057log(x) R= 0.99908
Dilithium Reduction Data Plot 2
Potential (volts)
-2.85
-2.9
-2.95
-3
-3.05
-3.1
0 0.2 0.4 0.6 0.8 1 1.2
Conc (M)


Dilithium Reduction Potential Plot 3
y = -2.902 + -0.057log(x) R= 0.99908
Potential (volts)
-2.85
-2.9
-2.95
-3
-3.05
-3.1
0 200 400 600 800 1000 1200
1/conc


Dilithium Reduction Potential Data Plot 4
y = -185.3 + -308.7log(x) R= 0.82414
1/conc
1200
1000
800
600
400
200
0
0 0.2 0.4 0.6 0.8 1 1.2
Conc (M)

Reference Material

Special Notes:

J=Joule	cm^3=mL	nM=nanometer=10^{-9}=1Angstrom
L=Liter	M=Molar	amu=atomic mass unit
mol=mole	torr=mm Hg	K=degrees Kelvin
C=Celsius	s=second	c=speed of light.
V=volume	T=temperature	[ ]=concentration in Molar units
E=energy	ln=natural logs	log=common logs
t=time	k_b=Bohr's constant	ev=electron volts
r=radius	Z=atomic number	k=reaction rate constant
ν=frequency	λ=wavelength	∏=osmotic pressure

E_n=energy of the n'th electronic level

F=Faraday=96,487 columbs=96,487 J $Volt^{-1}$

A notation such as "g mol^{-1}" is read as "grams per mol"

Constants and Conversion Factors

R=8.314 J mol^{-1} K^{-1} = 1.99 cal mol^{-1} K^{-1} = 0.821 L atm mol^{-1}

Volume of an ideal gas at STP= 22.4 L mol^{-1}

a_0=0.529 angstroms

1 J=10^7 ergs	1calorie=4.184 J
h=6.63 X 10^{-34} J sec	c=3.00 X 10^8 m s^{-1}
$K_a(H_2S)$= 1 X 10^{-7}	K_a (HS^{1-})=1.3 X 10^{-13}
K_w= 1 X 10^{-14}	k_b=13.60 ev=2.179 X 10^{-18} J

Formulae

PV=nRT	E=hν
c=λν	$pH=pK_a + \log([A^-]/[HA])$
$t_{1/2}=0.693/k$ (1st. order)	$t_{1/2}=1/(k*[A_0])$ (2nd. order)
ln(x)= 2.303 log(x)	$E=E_0 - 0.0591/n * \log Q$
$\log([A_0]/[A])=k*t/2.303$	$\ln([A_0]/[A])=k*t$
$\Delta G = \Delta H - T\Delta S$	$\Delta G = -RT \ln(K_{eq})$
$\Delta G^0 = -nFE^0$	$E_n=-k_bZ^2/n^2$
$r=n^2a_0/Z$	∏=MRT