

KWANTLEN UNIVERSITY COLLEGE
CHEMISTRY 1210 S-10
EXAM No. 1A
October 16, 1997

NAME: _____

Instructions: This exam contains **Seven** questions. Read the exam carefully and judge your time accordingly. A periodic chart is given on the last page of this exam. Return this exam paper with your exam booklet. **ALL CALCULATIONS MUST BE SHOWN TO RECIEVE ANY CREDIT!** Maximum Score: **61** points

USEFUL INFORMATION:

1 Faraday = 96,485 Coulombs/mole e⁻

R = 8.314 J/mol·K = 0.08206 L·atm/mol·K

ln(X) = 2.303 log₁₀(X)

Nernst equation at 25 °C: $\mathcal{E} = \mathcal{E}^\circ - (0.05916 / n) \log Q$

Arrhenius equation: $k = Ae^{-E_a/RT}$

Temperature dependence of k:

$$\ln(k_2 / k_1) = \frac{-E_a}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right) = \frac{E_a (T_2 - T_1)}{R T_1 T_2}$$

Integrated Rate Laws:

Zero Order:

$$[A_0] - [A_t] = kt$$

First Order:

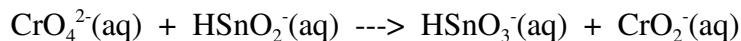
$$\ln[A_0] - \ln[A_t] = kt$$

Second Order:

$$[1/A_t] - [1/A_0] = kt$$

Question One: (8 MARKS)

For the following oxidation-reduction reaction which takes place in **basic** solution.



- Balance the above chemical equation. (5)
- Which Species is the reducing agent? (1)
- What is the equivalent weight of K_2CrO_4 (molar mass = 194.20) used in the above reaction for CrO_4^{2-} ? (2)

Question Two: (6 MARKS)

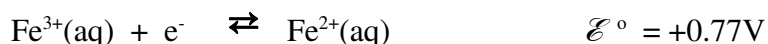
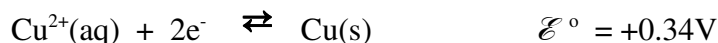
A mixture of NaCl and NaNO_2 was to be used in processing meat to make sausage. Before being used it was analyzed as follows: A 1.124 g portion of the mixture was dissolved in water and acidified converting NO_2^- to HNO_2 . The HNO_2 that was formed was titrated with 0.2000 N $\text{K}_2\text{Cr}_2\text{O}_7$, which oxidized HNO_2 to NO_3^- . The titration required 21.47 mL of the $\text{K}_2\text{Cr}_2\text{O}_7$ solution.

- How many equivalents of HNO_2 reacted in the titration? (2)
- How many moles of NaNO_2 were in the 1.124 g sample? (2)
- What was the percentage of NaNO_2 in the sample? (2)

(Note: Na^+ and Cl^- do not react in this titration. You do not need to write the complete balanced chemical equation.)

Question Three: (14 MARKS)

An electrochemical cell is constructed in which a platinum wire dips into a solution containing 2.00 M Fe^{3+} and 1.00 M Fe^{2+} , the other half-cell consists of copper metal immersed in a 1.00 M Cu^{2+} solution. The two half-cells are connected by a salt bridge and the temperature is maintained at 25.0 °C. Given the following reduction potentials:



- Write the overall cell reaction and calculate $\mathcal{E}_{\text{cell}}$. (4)
- Write the conventional cell notation for this electrochemical cell operating under the above conditions. (2)
- Write the half reaction which takes place at the anode. (1)
- What is the sign at the cathode? (1)

Question Three: (Continued)

- e) Determine the equilibrium constant for the cell reaction. (3)
- f) The copper electrode is placed in a solution of an unknown $[\text{Cu}^{2+}]$. The measured potential at 298K is +0.54V. What is the $[\text{Cu}^{2+}]$? (3)

Question Four: (8 MARKS)

The total charge of electricity required to plate out 15.54g of a metal, $\text{M}(\text{s})$, from a solution of M^{2+} ions is 14475 coulombs.

- a) Determine the identity of the unknown metal. (3)
- b) Write the half reaction for the plating out of this metal. (1)
- c) At which electrode does the plating out of this metal take place and what is the sign of this electrode? (2)
- d) If the current used in this electrolysis was 2.00 amperes, how long did it take to plate out the 15.54g of this metal? (2)

Question Five: (9 MARKS)

- a) The thermal decomposition of phosphine (PH_3) into phosphorous and hydrogen gas is a first-order reaction. The observed half-life of this reaction is 35.0s at 680 °C.
 - i) Determine the rate constant for this reaction. (3)
 - ii) How long would it take for for 95.0 percent of the phosphine to decompose at this temperature? (3)

- b) A catalyst speeds up a reaction by proceeding by a different pathway having a lower activation energy. If a reaction with a catalyst proceeds 10^4 times faster than without a catalyst, by how many kJ/mol is the activation energy lowered, if both reactions occur at 26.9 °C? (Note: assume that "A" does not change.) (3)

Question Six: (10 MARKS)

The reaction between mercury(II) chloride and oxalate ions in aqueous solution is given by the equation,



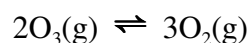
The table below gives the results of four experiments carried out at a constant temperature.

Experiment #	$[\text{HgCl}_2]$ (M)	$[\text{C}_2\text{O}_4^{2-}]$ (M)	$-\text{d}[\text{C}_2\text{O}_4^{2-}]/\text{dt}$ (mol/L·S)
1	0.105	0.15	1.8×10^{-5}
2	0.105	0.30	7.1×10^{-5}
3	0.052	0.30	3.5×10^{-5}
4	0.052	0.15	8.9×10^{-6}

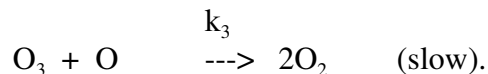
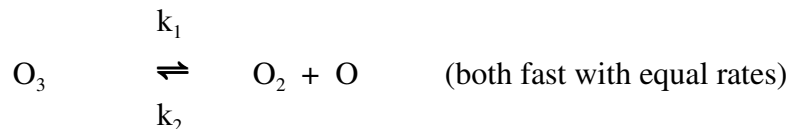
- Determine the rate law for this reaction. (4)
- Determine the numerical value of the rate constant and **its units**. (2)
- Calculate the rate of appearance of $\text{Cl}^-(\text{aq})$ in experiment #3. (2)
- What is the reaction rate when the concentration of HgCl_2 is 0.080 M and that of $\text{C}_2\text{O}_4^{2-}$ is 0.10 M at the same temperature as the above experiments. (2)

Question Seven: (6 MARKS)

The gas phase reaction for the decomposition of ozone is given by the equation:



A proposed mechanism for this reaction is given as,



Determine the rate law based on this proposed mechanism.