

Secret Code \_\_\_\_\_

There are 100 points.

Closed book, closed Internet, closed notes, closed cell phone, closed neighbor!

**CLARIFICATIONS ARE ALLOWED BUT NO OTHER QUESTIONS!**

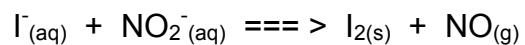
I'll be in every 30 minutes or so. If you need me come to my lab or office.

$R = 8.314 \text{ J/mol}\cdot\text{K}$  or  $0.0821 \text{ L}\cdot\text{atm/mol}\cdot\text{K}$

$1 \text{ F} = 96,500 \text{ C/mol}$  or  $\text{J/V}\cdot\text{mol}$

$$E = E^\circ - \frac{RT}{nF} \ln Q$$

1. (10 pts) Balance the following reaction that occurs in acidic solution. Show all steps.



What is the oxidation state of I? \_\_\_\_\_

What is the oxidation state of N in  $\text{NO}_2^-$ ? \_\_\_\_\_

What is the oxidation state of I in  $\text{I}_2$ ? \_\_\_\_\_

What is the oxidation state of N on NO? \_\_\_\_\_

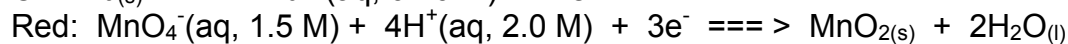
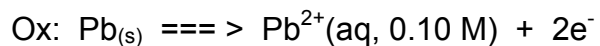
Which reactant is being oxidized?

Which reactant is being reduced?

What is the oxidizing agent?

What is the reducing agent?

2. (20 pts) An electrochemical cell is based on the following two half-reactions

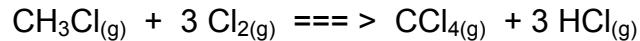


- Compute the cell potential at 25 C
- Is the cell a voltaic or electrolytic cell?
- Calculate the  $\Delta G$  for the reaction conditions given above.
- Draw a "beaker cell setup" of these reactions, following the convention we used in class, label ALL components, solutions, things, and show the flow of electrons.
- For the reactions and conditions used in this electrochemical cell, give the shorthand abbreviation for this system. i.e. the chemical shorthand for the reactions, solutions, conditions with bars and double bars like we did in class.

CIRCLE EACH ANSWER CLEARLY

3. (10 pts) What mass of aluminum metal can be produced per hour in the electrolysis of a molten aluminum salt by a current of 25 Amp?

4. (10 pts) The data below were collected for the following reaction:

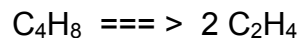


$\text{CH}_3\text{Cl}_{(g)}$ (units of M)	$\text{Cl}_{2(g)}$ (units of M)	Initial Rate (M/s)
0.050	0.050	0.014
0.100	0.050	0.029
0.100	0.100	0.041
0.200	0.200	0.115

Write the expression for the rate law and calculate the value of the rate constant,  $k$ .

What is the overall order of the reaction?

5. (10 pts) The data below show the conversion of cyclobutane ( $C_4H_8$ ) to ethylene ( $C_2H_4$ ) by the reaction:



Time (s)	$[C_4H_8]$ M
0	1.000
10	0.894
20	0.799
30	0.714
40	0.638
50	0.571
60	0.510
70	0.456
80	0.408
90	0.364
100	0.326

Plot the data on the following sheet and determine the rate order for the conversion of reactant to product.

What is the value of  $k$ ?

What is the rate of reaction with the reactant concentration is 0.35 M?

Show your work below and draw your plot on the next page.

6. (10 pts) A piece of wood is found at on old fire ring and is carbon dated. The test indicates that 45 percent of the original carbon has degraded. The half-life of carbon-14 is 5730 years. How old is the piece of wood?

7. (10 pts) Draw an exothermic reaction coordinate diagram (the book refers to these as Energy diagrams) showing a relatively high energy of activation. Label everything (axes, reactants, products, energy of activation, enthalpy). Draw a dashed line showing what happens when a catalyst is added.

8. (10 pts) Name three types of radioactive emissions:

\_\_\_\_\_

Which is the most dangerous of these and how/when is it dangerous (there's more than one answer to this so explain your answer very well).

What is the most common, natural nuclear radiation exposure to humans?

What type of kinetics does all radioactive decay follow (0, 1<sup>st</sup>, or 2<sup>nd</sup> order)?

Contrast fission versus fusion.

9. (10 pts) What is the difference between the rate and the rate constant?  
In words and mathematical expressions

Who is the father of electrochemistry, and maybe even smarter than Einstein?

Chemical A reacts with a half-life of 1.105 days. Chemical B reacts with a half-life of 800 minutes.

What is the reaction order of each reaction?

Which chemical, A or B, has the faster rate constant,  $k$ ?