CH 222 Winter 2026:
Problem Set #6
Instructions

Step One:

• **Learn the material** for Problem Set #6 by **reading Chapter 17 and Chapter 20** of the textbook and/or by watching the videos found on the website (https://mhchem.org/222video)

• **Try the problems** for Problem Set #6 found on the next pages on your own first. Write your answers in the space provided or write your answers on separate paper (your choice.) Include your name on your problem set!

Step Two:

Watch the recitation video for Problem Set #6:

http://mhchem.org/2/6

Self correct *all* of the problems while viewing the video. Mark correct problems with a star (or other similar mark), and correct all incorrect problems (show the correct answer and the steps required to achieve it.)

Step Three:

Turn the Problem Set in at the beginning of recitation to the instructor on **Monday, March 9 (section L1), Wednesday, March 11 (section L2)** *or* **Friday, March 13 (section L3)** The graded problem set will be returned to you the following week during recitation.

Do *not* include this page to avoid a point penalty; your front page should be page II-6-3.

If you have any questions regarding this assignment, please email (mike.russell@mhcc.edu) the instructor! Good luck on this assignment!

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CH 222 Problem Set #6

Name:

Complete the problem set on your own first using these sheets for your work or separate paper (your choice.) **Self correct your work *(all problems!)*** using the recitation video for this problem set, found here: **http://mhchem.org/2/6**

***** *Covering:* **Chapter Seventeen and Chapter Twenty** *and* **Chapter Guide Six**

***** *Important Tables and/or Constants:* **periodic table** found here: http://mhchem.org/pertab**, R = 8.3145 J mol^{-1} K^{-1}**, "**Reaction Mechanisms Guide**" *(Handout)*

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1. Give the equation for the relative rates of disappearance of reactants and formation of products for the following reaction:
   a. $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$
   b. If $\Delta[H_2]/\Delta t = -4.5 \times 10^{-4}$ M min^{-1}, what is $\Delta[NH_3]/\Delta t$?

2. Nitrosyl bromide, NOBr, is formed from NO and Br_2. Experiments show that this reaction is second order in NO and first order in Br_2. The equation:

   $$2\ NO(g) + Br_2(g) \rightarrow 2\ NOBr(g)$$

   a. Write the rate law equation for the reaction.
   b. How does the initial reaction rate change if the concentration of Br_2 is changed from 0.0022 M to 0.0066 M?
   c. What is the change in the initial rate if the concentration of NO is changed from 0.0024 M to 0.0012 M?

3. The reaction:

$$2\ NO(g)\ +\ 2\ H_2(g)\ \rightarrow\ N_2(g)\ +\ 2\ H_2O(g)$$

was studied at 904 °C and the data in the table below were collected.

Reactant Concentration (M)		
[NO]	**[H_2]**	**Rate of Appearance of N_2 (M s^{-1})**
0.420	0.122	0.136
0.210	0.122	0.0339
0.210	0.244	0.0678
0.105	0.488	0.0339

a. Determine the order of the reaction for each reactant.
b. Write the rate law equation for the reaction.
c. Calculate the rate constant for the reaction.
d. Find the rate of appearance of N_2 at the instant when [NO] = 0.350 M and [H_2] = 0.205 M.

4. The decomposition of N_2O_5 in CCl_4 is a first order reaction. If 2.56 mg of N_2O_5 is present initially, and 2.50 mg is present after 4.26 min at 55 °C, what is the value of the rate constant, *k*, at 55 °C?

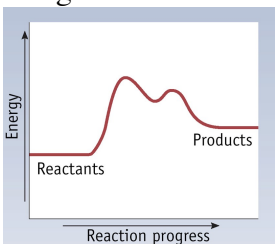
5. Gold-198 is used in the diagnosis of liver problems. The half-life of ^{198}Au is 2.69 days. If you begin with 2.8 μg of this gold isotope, what mass remains after 10.8 days?

6. Ammonia decomposes when heated according to the equation shown below. The data in the table for this reaction were collected at a high temperature. Plot $[NH_3]$ versus time, ln $[NH_3]$ versus time and $1/[NH_3]$ versus time. **What is the order with respect to NH_3?** Find the **rate constant, k** for the reaction from the appropriate slope.

The reaction: $NH_3(g) \rightarrow NH_2(g) + H(g)$

Time (h)	**$[NH_3]$ (M)**
0	8.00×10^{-7}
25	6.75×10^{-7}
50	5.84×10^{-7}
75	5.15×10^{-7}

7. Answer the following questions based on the reaction coordinate diagram shown on the right.
   a. Is the reaction exothermic or endothermic?
   b. Does this reaction occur in more than one step? If so, how many?



Reaction Diagram

8. What is the rate law equation for each of the following *elementary* reactions?
   a. $Cl(g) + ICl(g) \rightarrow I(g) + Cl_2(g)$
   b. $O(g) + O_3(g) \rightarrow 2\ O_2(g)$
   c. $2\ NO_2(g) \rightarrow N_2O_4(g)$

9. The reaction of $NO_2(g)$ and $CO(g)$ is thought to occur in two steps:

   Step 1 (slow) $NO_2(g) + NO_2(g) \rightarrow NO(g) + NO_3(g)$

   Step 2 (fast) $NO_3(g) + CO(g) \rightarrow NO_2(g) + CO_2(g)$

   a. Add the elementary steps to find the overall, stoichiometric equation.
   b. What is the molecularity of each step? Which step is rate determining?
   c. For this mechanism to be consistent with kinetic data, what must be the experimental rate law equation?
   d. Identify any intermediates and/or catalysts in this reaction.

10. The data in the table below shows the temperature dependence of the rate constant for the reaction as follows: $N_2O_5(g) \rightarrow 2\ NO_2(g) + {}^1/_2\ O_2(g)$. **Plot** these data using the **Arrhenius equation** to derive the **activation energy** and **frequency factor** for the reaction.

T(K)	***k*(s^{-1})**
338	4.87×10^{-3}
328	1.50×10^{-3}
318	4.98×10^{-4}
308	1.35×10^{-4}
298	3.46×10^{-5}
273	7.87×10^{-7}

11. Complete the following nuclear equations. Write the mass number, atomic number and symbol for the remaining particle(s).
    a. $^{9}_{4}\text{Be} + ? \rightarrow {}^{6}_{3}\text{Li} + {}^{4}_{2}\text{He}$
    b. $^{241}_{95}\text{Am} + {}^{4}_{2}\text{He} \rightarrow {}^{243}_{97}\text{Bk} + ?$
    c. $^{238}_{92}\text{U} + ? \rightarrow {}^{249}_{100}\text{Fm} + 5\ {}^{1}_{0}\text{n}$
    d. Gallium-67 decays by electron capture.
    e. Potassium-38 decays with positron decay.
    f. Technetium-99m decays with γ emission.

12. Calculate the binding energy in kilojoules per mole of nucleons of P for the formation of ^{30}P and ^{31}P. The required masses (in grams per mole) are $^{1}_{1}\text{H} = 1.00783$, $^{1}_{0}\text{n} = 1.00867$, $^{30}_{15}\text{P} = 29.97832$ and $^{31}_{15}\text{P} = 30.97376$.

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