Exam One **CHM 205 (Dr. Mattson)** **24 January 2005**	***Academic Integrity Pledge:*** *In keeping with Creighton University's ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.* *Signature:*

Instructions: Show all work whenever a calculation is required! You will receive credit for <u>how</u> you worked each problem as well as for the correct answer. This exam is worth 50 points. BOX YOUR ANSWERS!

1. At 700 K, the reaction of HI to form H_2 and I_2 is second order in [HI] with a rate constant, k = 1.8 x 10^{-3} L/mol s. The reaction is:

$$2\ HI(g) \longrightarrow H_2(g) + I_2(g) \qquad \text{rate} = -\Delta[HI]/\Delta t = k[HI]^2$$

(a) (3 pts) If the original concentration of HI were 0.400 mol/L, how long would it take for [HI] = 0.250 mol/L?

(b) (3 pts) What is the rate of the reaction at 700 K when [HI] = 0.200 M?

(c) (3 pts) How would the rate of the reaction change if the concentration of HI were increased by a factor of 5.0 times?

(d) (3 pts) If, under certain conditions, the rate of the reaction, $-\Delta[HI]/\Delta t$ = 0.224 mol/L s, what is the rate of appearance of I_2, $\Delta[I_2]/\Delta t$?

2. The following initial concentration - initial rate data listed in the table were determined for the reaction:

$$NO_{2(g)} \longrightarrow NO_{(g)} + {}^1/_2\ O_{2(g)}$$

Expt.	$[NO_2]_0$ mol/L	Initial rate, $-\Delta[NO_2]/\Delta t$ (mol L^{-1} s^{-1})
1	0.020	1.35 x 10^{-2}
2	0.030	3.03 x 10^{-2}
3	0.050	8.43 x 10^{-2}
4	0.080	?

(a) (4 pts) What is the rate law and rate constant? *Show work or explain.*

(b) (3 pts) Determine the rate, $-\Delta[NO_2]/\Delta t$, for the conditions listed in Experiment 4.

3. (4 pts) A reaction known to be zero order has a half-life of 45 minutes. How long would it take for a 0.50 M solution of the reactant to decrease to 20% of its original concentration?

4. Consider data collected for the hydrolysis reaction of sucrose, $C_{12}H_{22}O_{11}$, to form glucose and fructose:

$$\text{sucrose(aq)} + H_2O \longrightarrow \text{glucose(aq)} + \text{fructose(aq)}$$

Time (h)	$[C_{12}H_{22}O_{11}]$ (mol/L)
0.0	0.900
2.0	0.594
4.0	0.392
6.0	0.258
8.0	0.170

(a) (5 pts) Determine the rate expression and the value of the rate constant for the reaction.

(b) (3 pts) Determine $[C_{12}H_{22}O_{11}]$ when t = 5.0 h.

5. Consider the following mechanism for the endothermic conversion of nitrogen dioxide to nitrogen monoxide and oxygen:

Step 1. $NO_2 + NO_2 \rightarrow NO + NO_3$ Slow

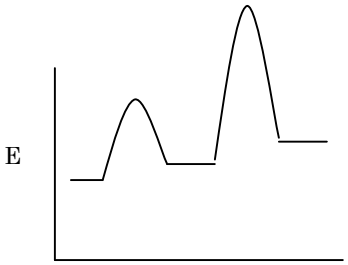
Step 2. $NO_3 \rightarrow NO + O_2$ Fast

(a) (2 pts) What is the overall reaction?

(b) (2 pts) Identify the intermediate.

(c) (3 pts) Write the rate law for mechanism.

(d) (3 pts) The following reaction profile for this reaction has two features that are correct and one error. List two correct features and the one error:



Correct features:

1.

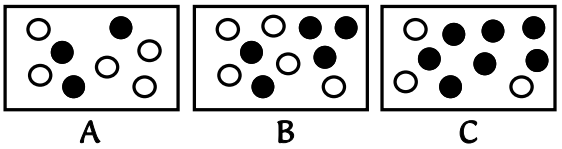
2.

Incorrect feature:

6. (2 pts) The value of the rate constant of a reaction can generally be expected to

(A) be independent of temperature.
(B) increase with increasing temperature.
(C) decrease with increasing temperature.
(D) equal the temperature for most reactions.

7. The following reaction is known to be second order in X (represented by ○) and zero order in Y (represented by ●).



(a) (2 pts) Write the rate law for the reaction.

(b) (2 pts) In which two containers will the rate of the reaction be equal?

8 (3 pts) In the space at right, sketch a reaction profile for an exothermic one-step mechanism. Label E_{act} in the forward and reverse directions and label ΔH_{rxn}.

9. (BONUS 1 point) Print your name here:

(For DocM's use)

Your exam score (50 possible): _____

Determine your grade:
A ≥ 46.5; B+ ≥ 43.5; B ≥ 41.0;
C+ ≥ 37.5; C ≥ 34.00; D ≥ 30.00

Answers:

1. (a) t = 833 s; (b) rate = 7.2×10^{-5} mol $L^{-1}s^{-1}$; (c) 25 times faster; (d) rate = $\Delta[I_2]/\Delta t = 0.112$ mol $L^{-1}s^{-1}$
2. (a) rate = $k[NO_2]^2$; k = 33.8 L mol^{-1} s^{-1}; (b) rate = 0.216 mol $L^{-1}s^{-1}$
3. t = 71.4 min
4. (a) first order, rate = $k[C_{12}H_{22}O_{11}]^1$; k = 0.208 hr^{-1}; (b) $[C_{12}H_{22}O_{11}]_{t = 5\ hr}$ = 0.318 mol L^{-1}
5. (a) $2\ NO_2 \rightarrow 2\ NO + O_2$; (b) NO_3; (c) rate = $k[NO_2]^2$; (d) Correct: products are higher in energy than reactants; intermediate shown; two humps for two steps; Incorrect: intermediate is usually higher in energy than products or reactants; first hump should be the largest one as that represents the slow step (other answers also possible)
6. B
7. (a) rate = $k[X]^2$; (b) A and B
8.