

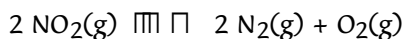
EXAM ONE
CHM 205
(DR. MATTSON)
27 JANUARY 2004

Quiz: _____ / 50
 A ≥ 46.5; B+ ≥ 43.5; B ≥ 41.0;
 C+ ≥ 37.5; C ≥ 34.00; D ≥ 30.00

Name:
(Answers at the end)

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

1. This reaction is known to be second order in NO₂(g):



(a) (3 points) Write the rate law:

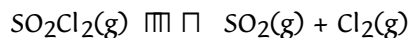
(b) (3 pts) At 300 °C and with [NO₂] = 0.40 mol L⁻¹, the rate of the reaction, $\frac{\Delta[\text{NO}_2]}{\Delta t}$, is 8.64 × 10⁻² mol L⁻¹ s⁻¹. What is the value of the rate constant, including units?

(c) (3 pts) What is the rate of the reaction in terms of $\frac{\Delta[\text{O}_2]}{\Delta t}$?

2. (5 pts) True/False

- T F The rate of any reaction increases if the concentration of the reactant(s) increases.
- T F The rate of a second order reaction will increase by 9 X if the concentration of the reactant is increased by 3 times.
- T F First order reactions are always faster than second order reactions.
- T F Second order reactions are always faster than first order reactions.
- T F The rate of any reaction increases if the temperature is increased.

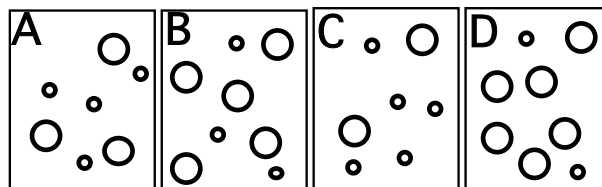
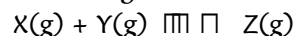
3. (4 pts) Consider the data for the reaction of SO₂Cl₂(g) to produce SO₂(g) and Cl₂(g):



Initial SO ₂ Cl ₂	Initial rate (mol/L s)
0.015	0.0110
0.024	0.0176
0.041	0.0301

What is the rate law?

4. (3 pts) The following reaction is known to be second order in [X] (shown as ●) and first order in [Y] (○). Which of the reaction mixtures, A - D, would have the largest reaction rate?

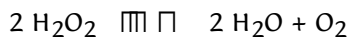


Show work

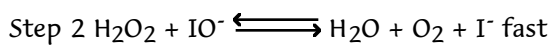
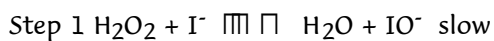
5. (4 pts) The reaction R \rightleftharpoons P follows first order kinetics. Suppose it was determined that the [R] decreased from 0.150 M to 0.110 M in a 15.0 minute period. What is the half-life for this reaction?

6. (4 pts) The reaction below is first order with k = 1.33 × 10⁻² min⁻¹. If the initial concentration

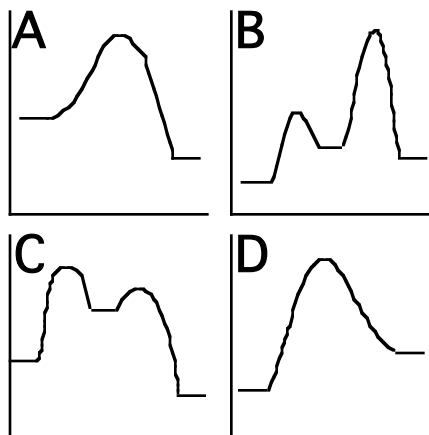
of H_2O_2 is 0.0805 M, how long will it take for 30% of the H_2O_2 to react?



7. (4 pts) The reaction mechanism for the exothermic decomposition of H_2O_2 is:



Which reaction profile shown below matches this? Circle one: A B C D None of these



Explain:

8. (4 pts) The following reaction proceeds by a one-step mechanism:

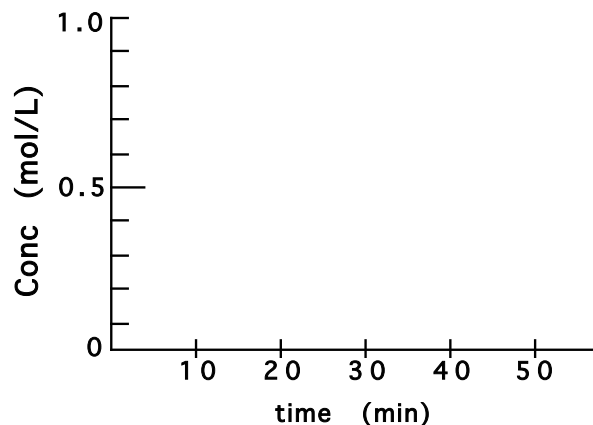


If the activation energy in the forward direction is 85 kJ/mol, what is the activation in the reverse direction?

9. (5 pts) Consider the following data for the reaction $\text{Q} \rightleftharpoons 2 \text{P} + \text{S}$. Determine the order of the reaction and the rate constant.

time (min)	[Q]
0	0.500
12	0.391
20	0.319
28	0.247
45	0.093

10. (4 pts) Considering what you know about the reaction in Question 9, plot [Q], [P] and [S] as a function of time:



11. (4 pts) Given the rate of a reaction doubles with an increase in temperature of 10 degrees (from 298 K to 308 K), estimate the activation energy for the reaction. Convert answer to kJ/mol.

This Table of Kinetics Equations will be given on the exam:

	Zero Order	First Order	Second Order
Rate Expression	rate = k	rate = k[A]	rate = k[A] ²
Time-Conc. Expression	[A] _t = [A] _o - kt	ln([A] _o /[A] _t) = kt	1/[A] _t = kt + 1/[A] _o
Linear Plot	[A] vs t	ln[A] vs t	1/[A] vs t
Half-life, t _{1/2}	t _{1/2} = [A] _o /2k	t _{1/2} = 0.693/k	t _{1/2} = 1/k[A] _o

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_{act}}{8.314 \text{ J mol}^{-1} \text{ K}^{-1}} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Answers:

1(a) rate = k[NO₂]²

(b) k = 0.54 L/mol s

(c) 4.32 x 10⁻² mol/L s

2. F T F F T

3. rate = k[SO₂Cl₂]¹

4. C

5. 33.5 min

6. 26.8 min

7. C

8. 215 kJ

9. zero order

10. The slopes of [S] and [P] will both be positive. The slope of [S] will be the same value as the slope of [Q], however opposite in sign. The slope of [P] will be twice the value as the slope of [Q], and opposite in sign.

11. 52.9 kJ