

**Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Period:** \_\_\_\_\_

**Seat #:** \_\_\_\_\_

Show all work. Complete the following.

[1] Consider the reaction:  $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$

The following data were obtained from three experiments using the method of initial rates:

	Initial [NO] mol L <sup>-1</sup>	Initial [O <sub>2</sub> ] mol L <sup>-1</sup>	Initial Rate [NO] mol L <sup>-1</sup> s <sup>-1</sup>
Exp. 1	0.010	0.010	2.5 x 10 <sup>-5</sup>
Exp. 2	0.020	0.010	1.0 x 10 <sup>-4</sup>
Exp. 3	0.010	0.020	5.0 x 10 <sup>-5</sup>

a. Determine the order of the reaction for each reactant.

b. Write the rate equation for the reaction

c. Calculate the rate constant. (25 L<sup>2</sup>·mol<sup>-2</sup>·s<sup>-1</sup>)

d. Calculate the rate (in mol L<sup>-1</sup>s<sup>-1</sup>) at the instant when [NO] = 0.015 mol L<sup>-1</sup> and [O<sub>2</sub>] = 0.0050 mol L<sup>-1</sup>

e. At the instant when NO is reacting at the rate 1.0 x 10<sup>-4</sup> mol L<sup>-1</sup>s<sup>-1</sup>, what is the rate at which O<sub>2</sub> is reactant and NO<sub>2</sub> is forming? (Hint: Use coefficients)

[2] The reaction  $2 \text{NO}(\text{g}) + 2 \text{H}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$  was studied at 904 °C, and the data in the table were collected.

	Initial [NO] mol L <sup>-1</sup>	Initial [H <sub>2</sub> ] mol L <sup>-1</sup>	Initial Rate [N <sub>2</sub> ] mol L <sup>-1</sup> s <sup>-1</sup>
Exp. 1	0.420	0.122	0.136
Exp. 2	0.210	0.122	0.0339
Exp. 3	0.210	0.244	0.0678
Exp. 4	0.105	0.488	0.0339

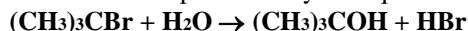
a. Determine the order of the reaction for each reactant.

b. Write the rate equation for the reaction

c. Calculate the rate constant at 904 °C. (6.32 L<sup>2</sup>·mol<sup>-2</sup>·s<sup>-1</sup>)

d. Find the rate of appearance of N<sub>2</sub> at the instant when [NO] = 0.350 M and [H<sub>2</sub>] = 0.205 M

[3] The reaction of tbutyl-bromide  $(\text{CH}_3)_3\text{CBr}$  with water is represented by the equation:

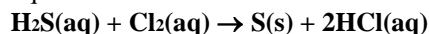


The following data were obtained from three experiments using the method of initial rates:

	Initial $[(\text{CH}_3)_3\text{CBr}]$ mol L <sup>-1</sup>	Initial $[\text{H}_2\text{O}]$ mol L <sup>-1</sup>	Initial Rate [NO] mol L <sup>-1</sup> s <sup>-1</sup>
Exp. 1	$5.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$2.0 \times 10^{-6}$
Exp. 2	$5.0 \times 10^{-2}$	$4.0 \times 10^{-2}$	$2.0 \times 10^{-6}$
Exp. 3	$1.0 \times 10^{-1}$	$4.0 \times 10^{-2}$	$4.0 \times 10^{-6}$

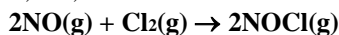
- a. What is the order with respect to  $(\text{CH}_3)_3\text{CBr}$ ?  
b. What is the order with respect to  $\text{H}_2\text{O}$ ?  
c. What is the overall order of the reaction?  
d. Write the rate equation  
e. Calculate the rate constant,  $k$ , for the reaction. ( $4.0\text{E-5 min}^{-1}$ )

[4] Hydrogen Sulfide is oxidized by chlorine in aqueous solution.



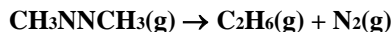
The experimental rate law is:  $\text{Rate} = k[\text{H}_2\text{S}][\text{Cl}_2]$ ; what is the reaction order with respect to  $\text{H}_2\text{S}$ ? with respect to  $\text{Cl}_2$ ? What is the overall order?

[5] For the reaction of nitric oxide, NO, with chlorine,  $\text{Cl}_2$ ,



The observed rate law is:  $\text{Rate} = k[\text{NO}]^2[\text{Cl}_2]$ ; what is the reaction order with respect to nitric oxide? With respect to  $\text{Cl}_2$ ? What is the overall order?

[6] In experiments on the decomposition of azomethane,  $k = 2.5\text{E-4s}^{-1}$



The following data were obtained:

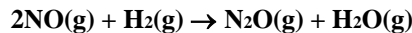
	Initial $[\text{CH}_3\text{NNCH}_3]$ mol L <sup>-1</sup>	Initial Rate mol L <sup>-1</sup> s <sup>-1</sup>
Exp. 1	$1.13 \times 10^{-2}$	$2.8 \times 10^{-6}$
Exp. 2	$2.26 \times 10^{-2}$	$5.6 \times 10^{-6}$

What is the rate law? What is the value of the rate constant?

Rate Law:

Rate constant:

[7] Nitric Oxide, NO, reacts with hydrogen to give nitrous oxide,  $\text{N}_2\text{O}$ , and water:  $k = 2.9\text{E}2 \text{ M}^{-2}\text{s}^{-1}$ )



In a series of experiments, the following initial rates of disappearance of NO were obtained:

	Initial $[\text{NO}(\text{g})]$ mol L <sup>-1</sup>	Initial $[\text{H}_2(\text{g})]$ mol L <sup>-1</sup>	Initial Rate [NO] mol L <sup>-1</sup> s <sup>-1</sup>
Exp. 1	$6.4 \times 10^{-3}$	$2.2 \times 10^{-3}$	$2.6 \times 10^{-5}$
Exp. 2	$12.8 \times 10^{-3}$	$2.2 \times 10^{-3}$	$1.0 \times 10^{-4}$
Exp. 3	$6.4 \times 10^{-3}$	$4.5 \times 10^{-3}$	$5.1 \times 10^{-5}$

Find the rate law and the value of the rate constant for the reaction of NO.

Rate Law:

Rate constant:

[8] Chlorine dioxide, ClO<sub>2</sub>, is a reddish-yellow gas that is soluble in water. In basic solution it gives ClO<sub>3</sub><sup>-</sup> and ClO<sub>2</sub><sup>-</sup> ions.



To obtain the rate law for this reaction, the following experiments were run and, for each, the initial rate of reaction of ClO<sub>2</sub> was determined. Obtain the rate law and the value of the rate constant.  $k = 2.3\text{E}2 \text{ (M}^{-2}\text{s}^{-1}\text{)}$

	Initial [ClO <sub>2</sub> ] mol L <sup>-1</sup>	Initial [OH <sup>-</sup> ] mol L <sup>-1</sup>	Initial Rate mol L <sup>-1</sup> s <sup>-1</sup>
Exp. 1	0.060	0.030	0.0248
Exp. 2	0.020	0.030	0.00276
Exp. 3	0.020	0.090	0.00828