Dougherty Valley HS AP Chemistry
Kinetics – Method of Initial Rates

WORKSHEET #1

Name: **Date:** **Period:** **Seat #:**

Show all work. Complete the following.

[1] Consider the reaction: **$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$**
The following data were obtained from three experiments using the method of initial rates:

	Initial [NO] mol L^{-1}	Initial [O_2] mol L^{-1}	Initial Rate [NO] mol $L^{-1}\ s^{-1}$
Exp. 1	0.010	0.010	2.5×10^{-5}
Exp. 2	0.020	0.010	1.0×10^{-4}
Exp. 3	0.010	0.020	5.0×10^{-5}

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

b. Write the rate equation for the reaction

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c. Calculate the rate constant. ($25\ L_2 \cdot mol^{-2} \cdot s^{-1}$)

d. Calculate the rate (in mol $L^{-1}s^{-1}$) at the instant when [NO] = 0.015 mol L^{-1} and [O_2] = 0.0050 mol L^{-1}

e. At the instant when NO is reacting at the rate 1.0×10^{-4} mol $L^{-1}s^{-1}$, what is the rate at which O_2 is reactant and NO_2 is forming? (Hint: Use coefficients)

[2] 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 were collected.

	Initial [NO] mol L^{-1}	Initial [H_2] mol L^{-1}	Initial Rate [N_2] mol $L^{-1}\ s^{-1}$
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. ($6.32\ L_2 \cdot mol^{-2} \cdot s^{-1}$)

d. Find the rate of appearance of N_2 at the instant when [NO] = 0.350 M and [H_2] = 0.205 M

[3] The reaction of tbutyl-bromide $(CH_3)_3CBr$ with water is represented by the equation:

$$\mathbf{(CH_3)_3CBr + H_2O \rightarrow (CH_3)_3COH + HBr}$$

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

	Initial $[(CH_3)_3CBr]$ mol L^{-1}	Initial $[H_2O]$ mol L^{-1}	Initial Rate [NO] mol L^{-1} s^{-1}
Exp. 1	5.0×10^{-2}	2.0×10^{-2}	2.0×10^{-6}
Exp. 2	5.0×10^{-2}	4.0×10^{-2}	2.0×10^{-6}
Exp. 3	1.0×10^{-1}	4.0×10^{-2}	4.0×10^{-6}

a. What is the order with respect to $(CH_3)_3CBr$?

b. What is the order with respect to H_2O?

c. What is the overall order of the reaction?

d. Write the rate equation

e. Calculate the rate constant, k, for the reaction. ($4.0E^{-5}$ min^{-1})

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

$$\mathbf{H_2S(aq) + Cl_2(aq) \rightarrow S(s) + 2HCl(aq)}$$

The experimental rate law is: Rate = $k[H_2S][Cl_2]$; what is the reaction order with respect to H_2S? with respect to Cl_2? What is the overall order?

[5] For the reaction of nitric oxide, NO, with chlorine, Cl_2,

$$\mathbf{2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)}$$

The observed rate law is: Rate = $k[NO]_2[Cl_2]$; what is the reaction order with respect to nitric oxide? With respect to Cl_2? What is the overall order?

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

$$\mathbf{CH_3NNCH_3(g) \rightarrow C_2H_6(g) + N_2(g)}$$

The following data were obtained:

	Initial $[\mathbf{CH_3NNCH_3}]$ mol L^{-1}	Initial Rate mol L^{-1} s^{-1}
Exp. 1	1.13×10^{-2}	2.8×10^{-6}
Exp. 2	2.26×10^{-2}	5.6×10^{-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, N_2O, and water: $k = 2.9E^2$ $M^{-2}s^{-1}$)

$$\mathbf{2NO(g) + H_2(g) \rightarrow N_2O(g) + H_2O(g)}$$

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

	Initial $[\mathbf{NO(g)}]$ mol L^{-1}	Initial $[\mathbf{H_2(g)}]$ mol L^{-1}	Initial Rate [NO] mol L^{-1} s^{-1}
Exp. 1	6.4×10^{-3}	2.2×10^{-3}	2.6×10^{-5}
Exp. 2	12.8×10^{-3}	2.2×10^{-3}	1.0×10^{-4}
Exp. 3	6.4×10^{-3}	4.5×10^{-3}	5.1×10^{-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_2, is a reddish-yellow gas that is soluble in water. In basic solution it gives ClO_3^- and ClO_2^- ions.

$$\mathbf{2ClO_2(aq) + 2OH^-(aq) \rightarrow ClO_3^-(aq) + ClO_2^-(aq) + H_2O}$$

To obtain the rate law for this reaction, the following experiments were run and, for each, the initial rate of reaction of ClO2 was determined. Obtain the rate law and the value of the rate constant. k = 2.3E2 ($M^{-2}s^{-1}$)

	Initial [$\mathbf{ClO_2}$] mol L^{-1}	Initial [$\mathbf{OH^-}$] mol L^{-1}	Initial Rate mol L^{-1} s^{-1}
Exp. 1	0.060	0.030	0.0248
Exp. 2	0.020	0.030	0.00276
Exp. 3	0.020	0.090	0.00828