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14.2 The Dependence of Rate on Concentration

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:

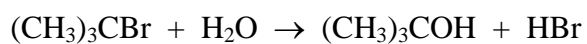|	Initial [NO] mol L^{-1}	Initial [O$_2$] mol L^{-1}	Initial rate NO mol L^{-1}s^{-1}
Experiment 1	0.010	0.010	2.5 x 10^{-5}
Experiment 2	0.020	0.010	1.0 x 10^{-4}
Experiment 3	0.010	0.020	5.0 x 10^{-5}

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

b. Write the rate equation for the reaction.

c. Calculate the rate constant.

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 x 10^{-4} mol L^{-1}s^{-1}, what is the rate at which O$_2$ is reactant and NO$_2$ is forming?

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}
Experiment 1	0.420	0.122	0.136
Experiment 2	0.210	0.122	0.0339
Experiment 3	0.210	0.244	0.0678
Experiment 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.

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 ^{t}butyl-bromide $(CH_3)_3CBr$ with water is represented by the equation:

$$(CH_3)_3CBr + H_2O \rightarrow (CH_3)_3COH + HBr$$

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 mol $L^{-1}min^{-1}$
Experiment 1	5.0×10^{-2}	2.0×10^{-2}	2.0×10^{-6}
Experiment 2	5.0×10^{-2}	4.0×10^{-2}	2.0×10^{-6}
Experiment 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.