***Chemistry***

**12: Kinetics**

**12.6: Reaction Mechanisms**

69. In general, can we predict the effect of doubling the concentration of *A* on the rate of the overall reaction ? Can we predict the effect if the reaction is known to be an elementary reaction?

Solution

No. In general, for the overall reaction, we cannot predict the effect of changing the concentration without knowing the rate equation. Yes if the reaction is an elementary reaction, then doubling the concentration of *A* doubles the rate.

71. What is the rate equation for the elementary termolecular reaction ? For ?

Solution

In an elementary reaction, the rate constant is multiplied by the concentration of the reactant raised to the power of its stoichiometric coefficient. Rate = *k*[*A*][*B*]2; Rate = *k*[*A*]3

73. Write the rate equation for each of the following elementary reactions:

(a) 

(b) 

(c) 

(d) 

(e) 

Solution

(a) Rate1 = *k*[O3]; (b) Rate2 = *k*[O3][Cl]; (c) Rate3 = *k*[ClO][O]; (d) Rate2 = *k*[O3][NO]; (e) Rate3 = *k*[NO2][O]

75. Experiments were conducted to study the rate of the reaction represented by this equation.[[1]](#footnote-1)



Initial concentrations and rates of reaction are given here.

|  |  |  |  |
| --- | --- | --- | --- |
| Experiment | Initial Concentration [NO] (mol/L) | Initial Concentration, [H2] (mol/L) | Initial Rate of Formation of N2 (mol/L min) |
| 1 | 0.0060 | 0.0010 | 1.8  10–4 |
| 2 | 0.0060 | 0.0020 | 3.6  10–4 |
| 3 | 0.0010 | 0.0060 | 0.30  10–4 |
| 4 | 0.0020 | 0.0060 | 1.2  10–4 |

Consider the following questions:

(a) Determine the order for each of the reactants, NO and H2, from the data given and show your reasoning.

(b) Write the overall rate law for the reaction.

(c) Calculate the value of the rate constant, *k*, for the reaction. Include units.

(d) For experiment 2, calculate the concentration of NO remaining when exactly one-half of the original amount of H2 had been consumed.

(e) The following sequence of elementary steps is a proposed mechanism for the reaction.

Step 1: 

Step 2: 

Step 3: 

Based on the data presented, which of these is the rate determining step? Show that the mechanism is consistent with the observed rate law for the reaction and the overall stoichiometry of the reaction.

Solution

(a) Doubling [H2] doubles the rate. [H2] must enter the rate equation to the first power. Doubling [NO] increases the rate by a factor of 4. [NO] must enter the rate law to the second power. (b) The rate law is Rate = *k*[NO]2[H2]. (c) 1.8  10−4 mol/L/ min = *k*[0.0060 mol/L]2[0.0010 mol/L], *k* = 5.0  103 mol−2 L−2 min−1; (d) The reaction has consumed 0.0010 mol/L of H2. The amount of NO consumed is the same, 0.0010 mol/L of NO. Thus 0.0060 – 0.0010 = 0.0050 mol/L remains. (e) Step II is the rate-determining step. If step I gives N2O2 in adequate amount, steps 1 and 2 combine to give . This reaction corresponds to the observed rate law. Combine steps 1 and 2 with step 3, which occurs by supposition in a rapid fashion, to give the appropriate stoichiometry.

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1. .This question is taken from the Chemistry Advanced Placement Examination and is used with the permission of the Educational Testing Service. [↑](#footnote-ref-1)