

15 • Chemical Kinetics

RATE LAWS

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

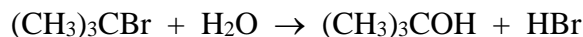
The following data were obtained from three experiments using the method of initial rates:

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

- Determine the order of the reaction for each reactant.
 - Write the rate equation for the reaction.
 - Calculate the rate constant.
 - Calculate the rate (in mol L⁻¹s⁻¹) at the instant when [NO] = 0.015 mol L⁻¹ and [O₂] = 0.0050 mol L⁻¹
 - At the instant when NO is reacting at the rate 1.0×10^{-4} mol L⁻¹s⁻¹, what is the rate at which O₂ is reactant and NO₂ is forming?
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 ⁻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

- Determine the order of the reaction for each reactant.
 - Write the rate equation for the reaction.
 - Calculate the rate constant at 904 °C.
 - Find the rate of appearance of N₂ at the instant when [NO] = 0.350 M and [H₂] = 0.205 M.
3. The reaction of ^tbutyl-bromide (CH₃)₃CBr with water is represented by the equation:

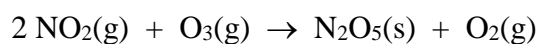


The following data were obtained from three experiments using the method of initial rates:

	Initial [(CH ₃) ₃ CBr] mol L ⁻¹	Initial [H ₂ O] mol L ⁻¹	Initial rate HBr 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}

- What is the order with respect to (CH₃)₃CBr?
- What is the order with respect to H₂O?
- What is the overall order of the reaction?
- Write the rate equation.
- Calculate the rate constant, k, for the reaction.

4. The reaction:



$$\text{Rate Law: Rate} = k [\text{NO}_2]^a [\text{O}_3]^b$$

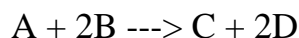
Write your values for “a” (0, 1, 2), “b” (0, 1, 2), and “k”

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

	Initial $[\text{NO}_2]$ mol L^{-1}	Initial $[\text{O}_3]$ mol L^{-1}	Initial rate N_2O_5 $\text{mol L}^{-1}\text{min}^{-1}$
Experiment 1	0.100	0.200	
Experiment 2	0.100	0.100	
Experiment 3	0.200	0.400	

- What is the order with respect to NO_2 ?
- What is the order with respect to O_3 ?
- Write the rate equation.
- Calculate the rate constant, k , for the reaction.

5. Rate data were obtained for following reaction:



	Initial $[\text{A}]$ mol L^{-1}	Initial $[\text{B}]$ mol L^{-1}	Initial rate C $\text{mol L}^{-1}\text{s}^{-1}$
Experiment 1	0.10	0.10	3.0×10^{-4}
Experiment 2	0.30	0.30	9.0×10^{-4}
Experiment 3	0.10	0.30	3.0×10^{-4}
Experiment 4	0.20	0.40	6.0×10^{-4}

- What is the rate law expression for this reaction?
- What is the value of k ?
- What would be the Rate of formation if the value of A was 0.50 and B was 0.40?