

THE RATE LAW

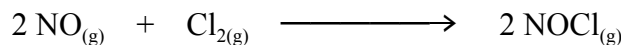
SCH4U_08-09

1. Explain what is meant by the rate law of a reaction.
2. What is meant by the order of a reaction?
3. What are the units for the rate constants of zero-order, first-order, and second-order reactions?
4. On which of the following properties does the rate constant of a reaction depend ?
 - a. Reactant concentration, (b) nature of reactants, (c) temperature.
5. Determine the overall orders of the reactions to which the following rate laws apply:
 - (a) $\text{rate} = k [\text{NO}_2]^2$, (b) $\text{rate} = k$, (c) $\text{rate} = k [\text{NO}]^2 [\text{O}_2]$

6. Consider the reaction: $\text{A} \longrightarrow \text{B}$

The rate of the reaction is $1.6 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1}$ when the concentration of A is 0.35 mol L^{-1} . Calculate the rate constant if the reaction is (a) first order in A and (b) second order in A.

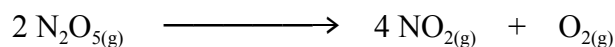
7. Consider the following data for the given reaction carried out at 300K.



Experiment	[NO] (mol/L)	[Cl ₂] (mol/L)	Rate (mol/L•s)
1	0.01	0.01	1.2×10^{-4}
2	0.01	0.02	2.4×10^{-4}
3	0.02	0.02	9.6×10^{-4}

- a) Analyze the data to determine the values of the orders for this expression.
- b) What is the overall order of this reaction?
- c) What is the molecularity of this reaction?
- d) Use the data to determine the value of the rate constant, and state its units.
- e) Based on your findings, write the rate law expression with the correct value for k substituted into the equation.
- f) Use the rate law established above to determine the rate of the reaction at 300K, if the $[\text{NO}] = 0.03 \text{ mol/L}$ and the $[\text{Cl}_2] = 0.04 \text{ mol/L}$.
- g) What would be the overall rate of this reaction if the concentration of $\text{NO}_{(g)}$ was doubled and the concentration of $\text{Cl}_{2(g)}$ was halved ? (note: no calculation required !!!)

8. The following data were collected for the decomposition of dinitrogen pentoxide, $\text{N}_2\text{O}_{5(\text{g})}$, at a fixed temperature.



Experiment	$[\text{N}_2\text{O}_5]$ (mol/L)	Rate (mol/L•min)
1	0.0014	0.4×10^{-4}
2	0.0028	0.8×10^{-4}
3	0.0046	1.3×10^{-4}

- Analyze the data provided to determine the order of the reaction.
 - Determine the value of the rate constant for the reaction at this temperature.
 - State the units of the rate constant for the reaction at this temperature.
 - What would the reaction rate be for this reaction when the concentration of the dinitrogen pentoxide, $\text{N}_2\text{O}_{5(\text{g})}$, is:
 - 0.0019 mol/L
 - 0.0113 mol/L
9. The following data were obtained by studying the reaction between compounds A, B and C at a constant temperature.

Experiment	[A] (mol dm ⁻³)	[B] (mol dm ⁻³)	[C] (mol dm ⁻³)	Initial rate (mol dm ⁻³ s ⁻¹)
1	0.20	0.10	0.40	0.80×10^{-3}
2	0.20	0.40	0.40	3.20×10^{-3}
3	0.10	0.80	0.40	1.60×10^{-3}
4	0.10	0.30	0.20	0.60×10^{-3}

- Deduce the order of the reaction with respect to A.
 - Deduce the order of the reaction with respect to B.
 - Deduce the order of the reaction with respect to C.
 - What is the rate law for the reaction?
 - Calculate a value for the rate constant, k , and state its units.
10. The rate equation for the reaction between compounds D and E at a given temperature is :

$$\text{Rate} = k [\text{D}]^2 [\text{E}]$$

The initial rate of reaction is $8.36 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}$ when the initial concentration of D is 0.84 mol dm^{-3} and the initial concentration of E is 1.16 mol dm^{-3} . Calculate a value for the rate constant, k , at this temperature and deduce its units.