



CHEMISTRY • CLASS 12

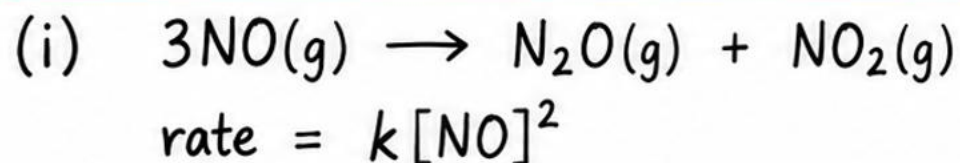
CHAPTER 3

Chemical Kinetics

NCERT SOLUTIONS

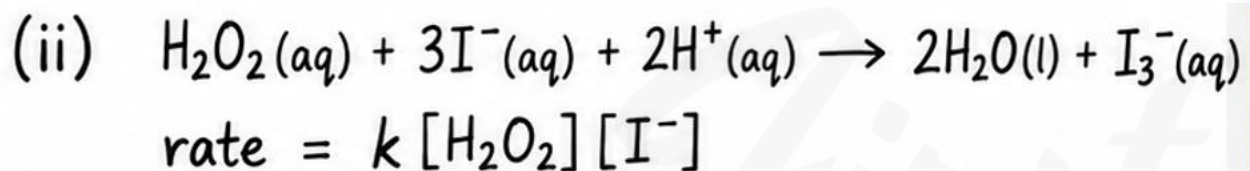
RATE LAW: ORDER AND k UNITS

3.1 From these rate laws, find each reaction order and the dimensions/units of its rate constant.



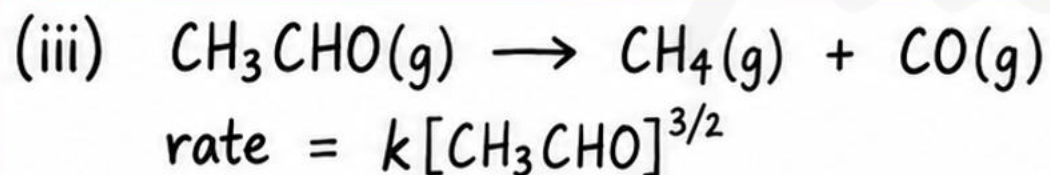
Solution:
Order = 2

$$[k] = (\text{mol L}^{-1})^{(1-2)} \text{s}^{-1} \\ = \text{L mol}^{-1} \text{s}^{-1}$$



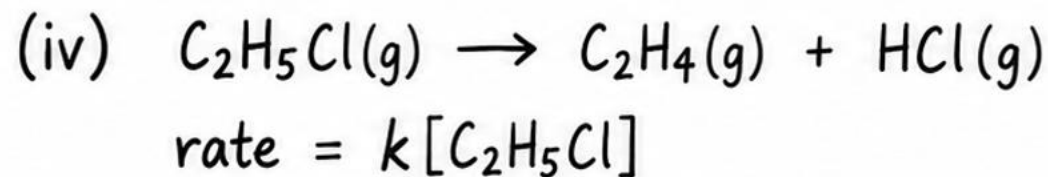
Solution:
Order = 2

$$[k] = (\text{mol L}^{-1})^{(1-2)} \text{s}^{-1} \\ = \text{L mol}^{-1} \text{s}^{-1}$$



Solution:
Order = $3/2$

$$[k] = (\text{mol L}^{-1})^{(1-3/2)} \text{s}^{-1} \\ = \text{L}^{1/2} \text{mol}^{-1/2} \text{s}^{-1}$$



Solution:
Order = 1

$$[k] = (\text{mol L}^{-1})^{(1-1)} \text{s}^{-1} \\ = \text{s}^{-1}$$

Method: $[k] = (\text{mol L}^{-1})^{(1-n)} \text{s}^{-1}$.

Add only the powers in the experimental rate law; do not use equation coefficients to infer order.

RATE FROM CHANGING CONCENTRATIONS

3.2 For $2A + B \rightarrow A_2B$, $\text{rate} = k[A][B]^2$, $k = 2.0 \times 10^{-6} \text{ L}^2 \text{ mol}^{-2} \text{ s}^{-1}$.
Find initial rate at $[A] = 0.10 \text{ M}$, $[B] = 0.20 \text{ M}$; then find rate when $[A]$ falls to 0.06 M .

Solution:

Initial rate (at $[A] = 0.10 \text{ M}$, $[B] = 0.20 \text{ M}$):

$$r_0 = 2.0 \times 10^{-6} \times 0.10 \times (0.20)^2 = 8.0 \times 10^{-9} \text{ mol L}^{-1} \text{ s}^{-1}.$$

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When A loses 0.04 M , B loses only half as much because $2 \text{ mol } A$ react with $1 \text{ mol } B$.

$$\text{Decrease in } [B] = \frac{0.04}{2} = 0.02 \text{ M}; \quad [B]_{\text{new}} = 0.20 - 0.02 = 0.18 \text{ M}.$$

Rate when $[A] = 0.06 \text{ M}$ and $[B] = 0.18 \text{ M}$:

$$r = 2.0 \times 10^{-6} \times 0.06 \times (0.18)^2 = 3.888 \times 10^{-9} \text{ mol L}^{-1} \text{ s}^{-1} \approx 3.9 \times 10^{-9} \text{ mol L}^{-1} \text{ s}^{-1}.$$

$$r = 3.9 \times 10^{-9} \text{ mol L}^{-1} \text{ s}^{-1}$$

ZERO ORDER AMMONIA: PRODUCT RATES

3.3 Decomposition of NH_3 on Pt is zero order. If $k = 2.5 \times 10^{-4}$, find rates of N_2 and H_2 production.

For a zero-order rate, k unit = $\text{mol L}^{-1} \text{s}^{-1}$ (the printed $\text{mol}^{-1} \text{L s}^{-1}$ is a unit error).

Solution:

The decomposition of ammonia on Pt is represented by



The rate of reaction (zero order) is

$$\text{rate} = -\frac{1}{2} \frac{d[\text{NH}_3]}{dt} = \frac{d[\text{N}_2]}{dt} = \frac{1}{3} \frac{d[\text{H}_2]}{dt} = k[\text{NH}_3]^0 = k$$

Rate of N_2 production:

$$\frac{d[\text{N}_2]}{dt} = k = 2.5 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

Rate of H_2 production:

$$\frac{d[\text{H}_2]}{dt} = 3k = 7.5 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

The product ratio follows the balanced coefficients.

GAS PRESSURE RATE: UNITS

3.4 Dimethyl ether decomposes to CH_4 , H_2 and CO . $\text{Rate} = k[\text{CH}_3\text{OCH}_3]^{3/2}$; when measured by partial pressure, $\text{rate} = k(p_{\text{CH}_3\text{OCH}_3})^{3/2}$. Pressure is in bar and time in minutes. Find units of rate and k .

Solution:

Pressure replaces concentration only in this form of the rate equation; keep its stated units.

Units of rate: $[\text{rate}] = \boxed{\text{bar min}^{-1}}$.

Units of k : $[k] = \frac{[\text{rate}]}{[p]^{3/2}} = \frac{\text{bar min}^{-1}}{\text{bar}^{3/2}} = \boxed{\text{bar}^{-1/2} \text{ min}^{-1}}$.

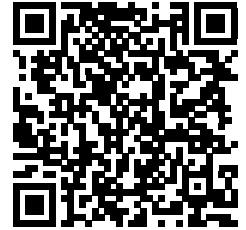


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