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Chemical Kinites Numerical

The following rate data were obtained at 303K for the reaction $2A + B \longrightarrow C + D$

Experiment	[A] molL^{-1}	[B] molL^{-1}	Initial rate of formation of [D] molL^{-1} min^{-1}
1	0.1	0.1	6.0×10^{-3}
2	0.3	0.2	7.2×10^{-2}
3	0.3	0.4	2.88×10^{-1}
4	0.4	0.1	2.4×10^{-2}

i) What is the rate law?

ii) Write the order with respect to each reactant and overall order.

iii) Find the unit of the overall reaction.

Ans: Rate = $K[A]^p [B]^q$ —— (1)

p = Order with respect to A

q = order with respect to B.

Now substituting the values from tabe in equation (1) we get

$6.0 \times 10^{-3} = K[0.1]^p [0.1]^q$ —— (ii)

$7.2 \times 10^{-2} = K[0.3]^p [0.2]^q$ —— (iii)

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$2.88 \times 10^{-4} = K[0.3]^p [0.4]^q$ —— (IV)

$2.4 \times 10^{-2} = K[0.4]^p [0.1]^q$ —— (V)

Now,
Dividing (III) by (V) we get

$$\frac{6 \times 10^{-3}}{2.4 \times 10^{-2}} = \frac{K[0.1]^p [0.1]^q}{K[0.4]^p [0.1]^q}$$

$$(0.25)^1 = (0.25)^p$$

$$p = 1$$

Again dividing (II) by (IV), we get

$$\frac{7.2 \times 10^{-2}}{2.88 \times 10^{-1}} = \frac{K[0.3]^p [0.2]^q}{K[0.3]^p [0.4]^q}$$

$$(0.25) = (0.5)^q$$

$$(0.5)^2 = [0.5]^q$$

$$q = 2$$

Question

overall order of reaction = p + q
= 1 + 2
= 3

So it is third order reaction.

For rate constant

Rate = $K[0.1]^p[0.1]^2$

$6.0 \times 10 = K[0.1]^1[0.1]^2$

$K = 6 \text{ mol}^{-2} L^2 \text{min}^{-1}$

(X) for unit of rate constant, we have,

Rate = $K[A]^1[B]^2$

$$K = \frac{\text{Rate}}{[A][B]^2}$$

$$= \frac{\text{mol L}^{-1} \text{min}^{-1}}{(\text{mol L}^{-1})(\text{mol L}^{-1})^2}$$

$= \text{mol}^{-2} L^2 \text{min}^{-1}$

Question Q. 2. The rate of first order reaction is $1.5 \times 10^2 \text{ mol}^{-1} \text{min}^{-1}$ at 0.5 M concentration of the reaction. What is the half life of the reaction.

Ans ⟹

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M

For first order reaction

$$\text{Rate} = K[A] \quad -(1)$$

where, [A] = 0.5 M.

Rate = $1.5\ mol^{-1}\ min^{-1}$

∴ Putting this value in eqn (1)

$$1.5 \times 10^{2} = K[0.5]$$

$$K = \frac{1.5 \times 10^{2}}{0.5}$$

$$K = 3 \times 10^{2}\ min.$$

For half life for first order reaction

$$t_{1/2} = \frac{0.693}{K}$$

$$= \frac{0.693}{3 \times 10^{2}}$$

$$t_{1/2} = 0.002\overline{31}\ \text{minute}.$$