

# CHEMICAL KINETICS

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# Content

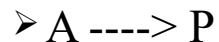
- Rate of Reaction
- Order of Reaction
- Arrhenius Equation

# Introduction

- In chemical Kinetic, Reaction occurs in single step are Simple or Elementary reaction & those which take two or more steps are complex reaction.
- For elementary reaction order of reaction & molecularity are *generally* same.

# Rate of Reaction

- Change in concentration of Reactant or Product per unit time called rate of Reac<sup>n</sup>.



➤  $t=0 \quad \quad a \quad \quad 0$

➤  $t=t \quad \quad a-x \quad \quad x$

➤  $\text{rate} \propto [\text{Reactant}]$

$$\text{Rate} = \frac{dx}{dt}$$

➤  $\Rightarrow r = k[a-x]$

➤  $|$

➤ Rate Constant

$$\text{rate} = \frac{a-x-a}{dt} = \frac{-x}{t} = \frac{dx}{dt} (\text{for } A)$$

$$\text{rate} = \frac{x-0}{dt} (\text{for } P)$$

# Rate of Reaction



$$\text{Rate of Reaction}(r) = -\frac{d(A)}{dt} = -\frac{d(B)}{dt} = \frac{d(C)}{dt} = \frac{d(D)}{dt} = \frac{dx}{dt}$$

- Rate of disappearance of reactant = Rate of appearance of Product
- eg.  $2A + 3B \longrightarrow C + 4D$

$$\text{rate} = -\frac{1}{2} \frac{d[A]}{dt} = -\frac{1}{3} \frac{d[B]}{dt} = \frac{d[C]}{dt} = \frac{1}{4} \frac{d[D]}{dt}$$

- $\text{Conc}^n = P^r$  at Temp<sup>r</sup> constant

# Order of Reaction

- No of molecules of reactant whose  $\text{conc}^n$  determines the rate of reaction.
- It is experimental value. It may be zero or fraction, -ve also.
- It is derive from rate expression.



$$\text{➤ } R = K[A]^x$$

$x$  = order of Reaction

# 1<sup>st</sup> order of Reaction

➤  $R = K[A]^x$   $x = 1$

$$kt = 2.303 \log \frac{a}{a-x}$$

➤  $a = \text{initial conc}^n$  ;  $a-x = \text{left conc}^n$  ;  $k = \text{time}^{-1}$

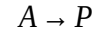
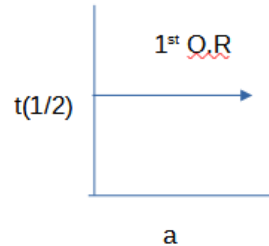
➤  $t(1/2) = \frac{0.693}{K}$  : Independent of initial concentration

$$t = t/2$$

$$a = a; \quad a - x = a/2$$

$$k = \frac{2.303}{t(1/2)} \log \frac{a}{a/2} = \frac{0.693}{t(1/2)}$$

$$t(1/2) = \frac{0.693}{K}$$



$$r = k[a-x]$$

$$\frac{dx}{dt} = k[a-x]$$

$$\frac{dx}{a-x} = k dt$$

$$kt = 2.303 \log \frac{a}{a-x}$$

# Zero order of Reaction



➤  $t=0 \quad a \quad 0$

➤  $t=t \quad a-x \quad x$

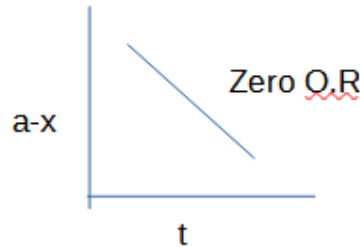
➤  $R = K[A]^x \quad \text{at } x = 0$

•  $x = kt \quad ; k = \text{mole L}^{-1} \text{ time}^{-1}$

➤ If  $t=t/2 \Rightarrow x=a/2$

➤  $t(1/2) = \frac{a}{2k} : t_{1/2} \propto a$

✓ **Rate const.  $\Rightarrow$  depends only Temp'**



$$r = k[a-x]^0$$

$$r = k$$

$$\frac{dx}{dt} = k$$

$$dx = k \cdot dt$$

$$x = kt$$



# Arrhenius Eqn

- Relation between rate constant & Temperature

- $K = Ae^{-E_a/RT}$

$$\log K = \log A - \frac{E_a}{2.303 RT}$$

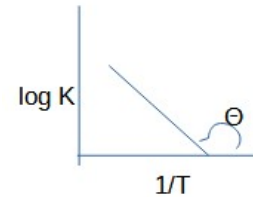
- A = Arrhenius Constant or Pre-exponential factor
- $E_a$  = activation energy; R = gas const.; T = temp. In Kelvin

$$K = Ae^{-(E_a/RT)}$$

$$\ln K = \ln A - \frac{E_a}{RT}$$

$$2.303 \log K = 2.303 \log A - \frac{E_a}{RT}$$

$$\log K = \log A - \frac{E_a}{2.303 RT}$$



$$\text{slope} = \tan \Theta = \frac{-E_a}{2.303 R}$$

$$y\text{-intercept} = \log A$$

# Conclusion

Thank you!

