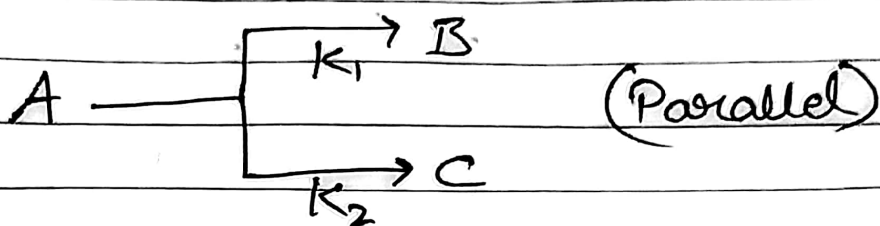


Special Cases of First Order Reactions

① Parallel or Side Reactions



$$\text{rate} = -\frac{dA}{dt} = k_1[A] + k_2[A] = (k_1 + k_2)[A]$$

$$\text{rate} = -\frac{dA}{dt} = (k_1 + k_2)[A] = k_{\text{eff}}[A]$$

effective order = 1

$$\boxed{k_{\text{eff}} = k_1 + k_2}$$

$$(t_{1/2})_{\text{eff}} = \frac{0.693}{k_{\text{eff}}} = \frac{0.693}{k_1 + k_2} = \frac{0.693}{\frac{0.693}{(t_{1/2})_1} + \frac{0.693}{(t_{1/2})_2}}$$

$$\boxed{\frac{1}{(t_{1/2})_{\text{eff}}} = \frac{1}{(t_{1/2})_1} + \frac{1}{(t_{1/2})_2}} \quad \text{Effective Half Life}$$

Effective Activation Energy. \therefore

$$k_{eff} = k_1 + k_2$$

$$A_{eff} \cdot e^{-(Ea)_{eff}/RT} = A_1 \cdot e^{-(Ea)_1/RT} + A_2 \cdot e^{-(Ea)_2/RT}$$

differentiate w.r.t Temperature 'T'

$$A_{eff} \cdot e^{-(Ea)_{eff}/RT} \left(\frac{-(Ea)_{eff}}{RT} \right) = A_1 \cdot e^{-(Ea)_1/RT} \left(\frac{-(Ea)_1}{RT} \right) + A_2 \cdot e^{-(Ea)_2/RT} \left(\frac{-(Ea)_2}{RT} \right)$$

$$-k_{eff} (Ea)_{eff} = -k_1 (Ea)_1 - k_2 (Ea)_2$$

$$(Ea)_{eff} = \frac{k_1 Ea_1 + k_2 Ea_2}{k_{eff}}$$

$$\boxed{Ea_{eff} = \frac{k_1 Ea_1 + k_2 Ea_2}{k_1 + k_2}}$$

Finding Concentration of [A] & [B] & [C]

$$[A] = A_0 e^{-k_{eff}t} = A_0 \cdot e^{-(k_1 + k_2)t}$$

First order kinetics

$$\frac{d[B]}{dt} = k_1[A] \Rightarrow \frac{d[B]}{dt} = k_1 A_0 \cdot e^{-(k_1+k_2)t}$$

$$\int_0^B \frac{d[B]}{dt} = \int_0^t k_1 A_0 \cdot e^{-(k_1+k_2)t}$$

$$[B]_B = k_1 A_0 \left[\frac{e^{-(k_1+k_2)t}}{-(k_1+k_2)} \right]_0^t$$

$$[B] = \frac{k_1 A_0}{-(k_1+k_2)} (e^{-(k_1+k_2)t} - 1)$$

$$[B] = \frac{k_1 A_0}{k_1+k_2} (1 - e^{-(k_1+k_2)t})$$

Similarly

$$[C] = \frac{k_2 A_0}{k_1+k_2} (1 - e^{-(k_1+k_2)t})$$

$$\boxed{\frac{[B]}{[C]} = \frac{k_1}{k_2}}$$

$$\% \text{ of B in product} = \frac{[B]}{[B]+[C]} \times 100 = \frac{k_1}{k_1+k_2} \times 100$$

$$\% \text{ of C in product} = \frac{[C]}{[B]+[C]} \times 100 = \frac{k_2}{k_1+k_2} \times 100$$