BSc.
Physical chemistry

Chemical Kinetics

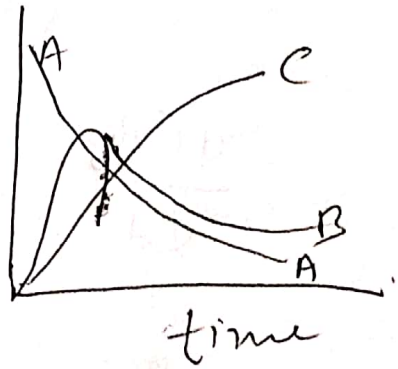
Consecutive reaction.

A Chemical or nuclear reaction in which the product further undergo reaction or decay to form another product is known as Consecutive reaction

Consider a consecutive Rxn

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

If order with respect to both B & C are one



Then

$$-\frac{d[A]}{dt} = k_1[A]$$

$$\frac{d[B]}{dt} = k_1[A] - k_2[B]$$

$$\frac{d[B]}{dt} + k_2[B] = k_1[A] = k_1[A]_0 e^{-k_1 t}$$

$$d(e^{k_2 t}[B]) = k_1[A]_0 e^{(k_2-k_1)t} dt$$

Integrating the above differential Equation, we have

$$[B] = \frac{k_1 [A]_0}{k_2 - k_1} \left[e^{-k_1 t} - e^{-k_2 t} \right]$$

$$[C] = \frac{[A]_0}{k_2 - k_1} \left[k_2 (1 - e^{-k_1 t}) - k_1 (1 - e^{-k_2 t}) \right]$$

for maximum intermediate concentration

$$\left(\frac{d[B]}{dt} \right)_{t = t_{max}} = 0$$

$$\frac{d[B]}{dt} = \frac{k_1}{k_2 - k_1} [A]_0 \left(-k_2 e^{-k_1 t} - (-k_2) e^{-k_2 t} \right) = 0$$

$$t_{max} = \frac{1}{k_1 - k_2} \ln \frac{k_1}{k_2}$$

$$(B)_{max} = [A]_0 \left(\frac{k_2}{k_1} \right)^{\frac{k_2}{k_1 - k_2}}$$