$$\frac{d[A]}{dt} = -k[A]^n$$

$$\int_{[A]_0}^{[A]} \frac{d[A]}{[A]^n} = -k\int_0^t dt$$

$$\frac{1}{(-n+1)}\frac{1}{[A]^{n-1}}\Bigg|_{[A]_0}^{[A]} = \frac{1}{-n+1}\left(\frac{1}{[A]^{n-1}} - \frac{1}{[A]_0^{n-1}}\right) = -kt$$

$$\boxed{\frac{1}{n-1}\left(\frac{1}{[A]^{n-1}} - \frac{1}{[A]_0^{n-1}}\right) = kt} \quad \Big| \quad n \neq 1$$

$t = t_{1/2}$, $[A] = [A]_0/2$

$$\frac{1}{n-1}\left(\frac{2^{n-1}}{[A]_0^{n-1}} - \frac{1}{[A]_0^{n-1}}\right) = kt_{1/2}$$

$$\frac{1}{[A]_0^{n-1}} \times \frac{2^{n-1}-1}{n-1} = kt_{1/2}$$

$$\frac{d[A]}{dt} = -k[A]^2 \Rightarrow \boxed{\left(\frac{1}{[A]} - \frac{1}{[A]_0}\right) = kt}$$

(1)

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

$\nu_A A + \nu_B B \longrightarrow$ Products

$t=0$	$[A]_0$	$[B]_0$
$t=t$	$[A]$	$[B]$

$[A] = [A]_0 - x$

$[B] = [B]_0 - x$

$[A] = [A]_0 - \nu_A x$

$[B] = [B]_0 - \nu_B x$

$$-\frac{dx}{dt} = -k([A]_0 - x) \times ([B]_0 - x)$$

$$\frac{dx}{dt} = k([A]_0 - x)([B]_0 - x)$$

$$\frac{dx}{([A]_0 - x)([B]_0 - x)} = k\,dt$$

$$\frac{1}{([A]_0 - [B]_0)} \frac{([A]_0 - x) - ([B]_0 - x)}{([A]_0 - x)([B]_0 - x)}\,dx = k\,dt$$

$$\frac{1}{([A]_0 - [B]_0)}\left[\int_0^x \frac{dx}{[B]_0 - x} - \int_0^x \frac{dx}{[A]_0 - x}\right] = k\int_0^t dt$$

$$\frac{1}{[A]_0 - [B]_0}\left(-\ln\frac{[B]_0 - x}{[B]_0} + \ln\frac{[A]_0 - x}{[A]_0}\right) = kt$$

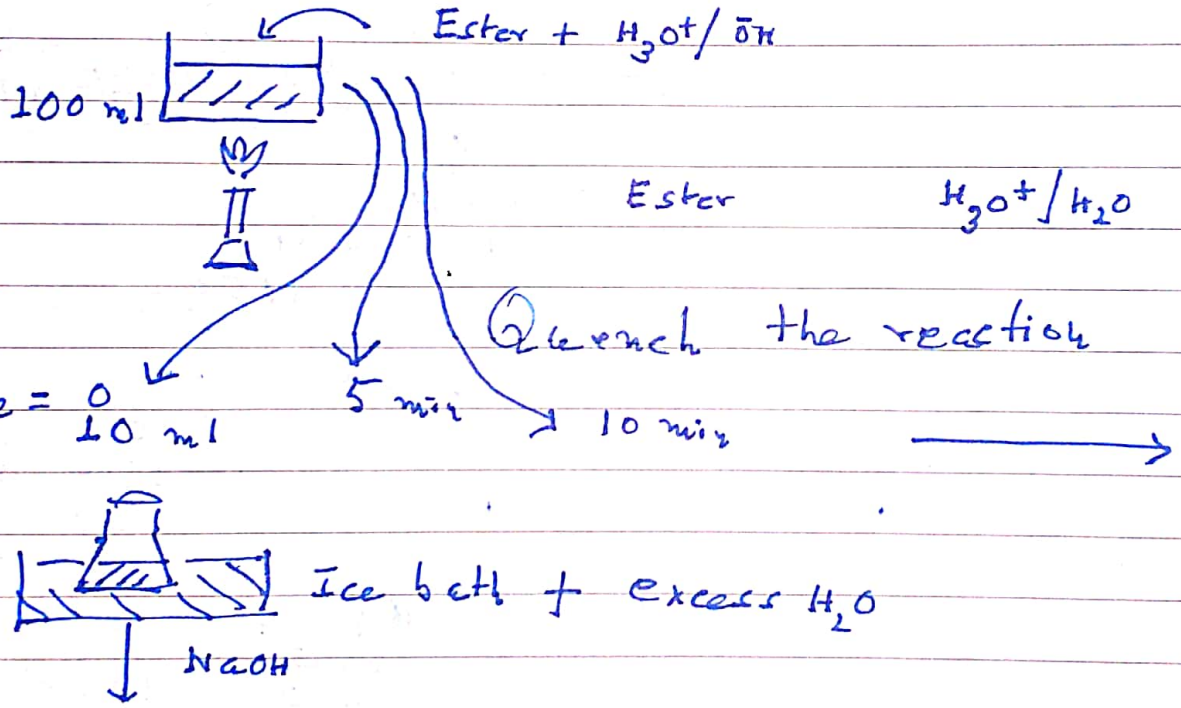
$$\frac{1}{[A]_0 - [B]_0}\left(-\ln\frac{[B]}{[B]_0} + \ln\frac{[A]}{[A]_0}\right) = kt$$

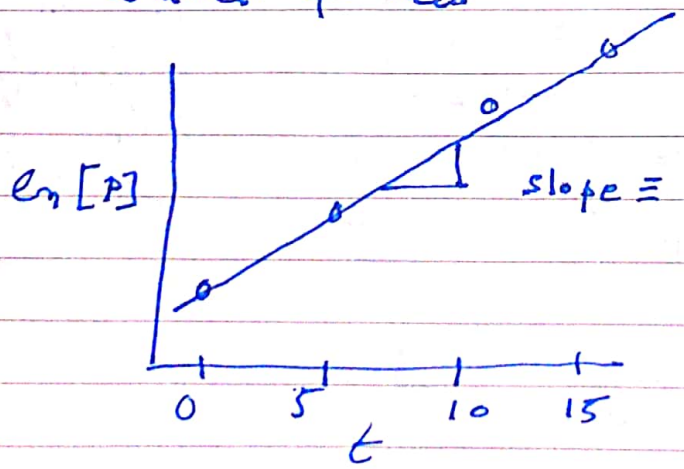
$$\boxed{\frac{1}{[A]_0 - [B]_0} \ln\frac{[A]/[A]_0}{[B]/[B]_0} = kt}$$

Hydrolysis of esters

$$R-\underset{\underset{O}{\|}}{C}-O-R' \xrightarrow[H_3O^+/\,OH^-]{H_2O} R-\underset{\underset{O}{\|}}{C}-OH + HO-R'$$

$$\text{Rate} = k\,[\text{Ester}]\,[H_2O] \simeq k'\,[\text{Ester}]$$





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

$$\frac{d[P]}{dt} = k'[P]$$

$$\frac{d[A]}{dt} = -k[A][B][C] \cdots$$

$A + B \rightarrow X$
$X + C \rightarrow P$
$X \rightarrow P$

?

Composite reaction
(Multi-step process)
↓
Elementary reaction
(Single step process)

Mechanism

① $A \rightleftharpoons P$ Equilibrium

② $A \rightleftharpoons P$, $A \rightleftharpoons Q$ Branching

③ $A \rightarrow P \rightarrow Q$

$H_2 + Br_2 \rightarrow 2HBr$

Rate $\propto [H_2][Br_2]$ ✗

① $Br_2 + M \rightarrow 2Br + M$

② $Br + H_2 \rightarrow HBr + H$

③ $H + Br_2 \rightarrow HBr + Br$

⋮

Rate $= k_2[Br][H_2]$

k rate constant

A, B → P

$k = k(T)$?

$k = A e^{-E_a/kT}$

$\ln k$ vs $1/T$

Arrhenius

A + B → P