# Zero Order Reactions

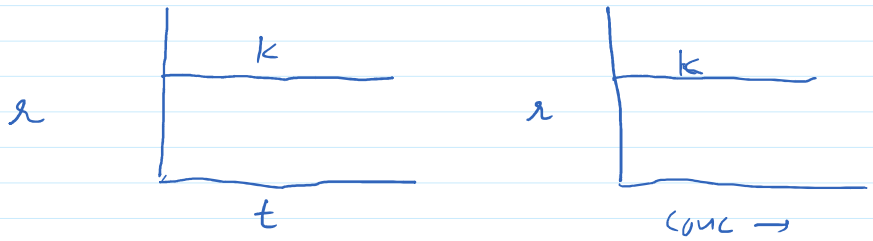
Consider a zero order reaction $A \rightarrow B$. Let $a_0$ be initial concentration of A. $a_t$ and $b_t$ be the concentrations of A and B at time t. Let x be the change in concentration of A in time t.

| | A | ⟶ | B |
|---|---|---|---|
| t = 0 | $a_0$ | | 0 |
| t = t | $a_t = a_0 - x$ | | $b_t = x$ |

For zero order reaction rate law expression is given as:

$$r = k [A]^0 = k \quad \text{— I}$$

For zero order reaction, rate of reaction is independent of time and concentration of reactants




For any general reaction $A \rightarrow B$, $r = -\frac{dA}{dt} = \frac{dB}{dt}$

$$-\frac{dA}{dt} = -\frac{d(a_t - a_0)}{dt} = -\frac{d(a_0 - x - a_0)}{dt} = \frac{dx}{dt}$$

$$\frac{dB}{dt} = \frac{d(b_t - 0)}{dt} = \frac{d(x-0)}{dt} = \frac{dx}{dt}$$

Thus $r = \frac{dx}{dt}$ — II

Equate I and II

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

$$dx = k\,dt$$

Integrate both sides

$$\int_0^x \qquad \int_0^t$$

Integrate both sides

$$\int_0^x dx = k\int_0^t dt$$

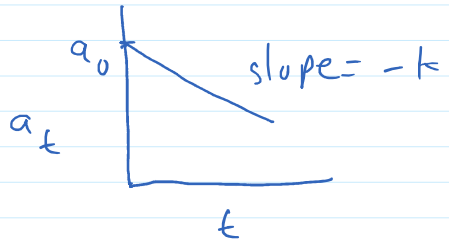
$$x\Big|_0^x = k\,t\Big|_0^t$$

$$(x-0) = k(t-0)$$

$$x = kt$$

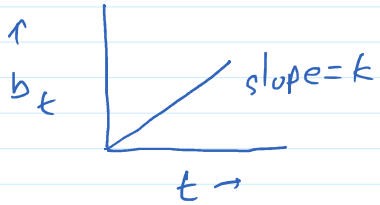
Concentration of reactant at time t

$$a_t = a_0 - x = a_0 - kt$$




Concentration of products at time t

$$b_t = x = kt$$




## Life time of reaction

Time of completion of reaction is called life time ($t_{LT}$) of reaction. when reaction is completed $a_t = 0$

$$a_0 - kt_{LT} = 0$$

$$t_{LT} = \frac{a_0}{k}$$

## Half life time of reaction

Time in which 50% reaction is completed is called half life time ($t_{1/2}$) of reaction. when reaction is half complete

$$a_t = \frac{a_0}{2}$$

$$a_0 - kt_{1/2} = \frac{a_0}{2}$$

$$t_{1/2} = \frac{a_0}{2k}$$

Examples of zero order reactions

i) Some enzyme catalyzed reactions.

ii) Reactions with occur on metal surfaces.

iii) The decomposition of gaseous ammonia on a hot platinum surface at high pressure.

iv) The thermal decomposition of $HI$ on gold surface.