

Chemical Kinetics

→ branch of chemistry that deals with rate of reaction, factors affecting rate of reaction, mechanism of reaction and order of reaction.

Types Of Reaction:

- Slow: if reaction has high Activation Energy
 - ↳ Rusting of Iron
- Fast: (low E_a)
 - ↳ Acid + Base
- Moderate: (moderate E_a)
 - ↳ Reactions in lab ↳ Hydrolysis of ester

Rate:

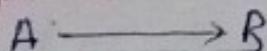
Rate = $\frac{\text{Change in conc. (R \& P)}}{\text{Change in time}}$

↳ depends on both reactants & products

$$= \frac{\Delta C}{\Delta t}$$

$$\text{Rate} \propto C \propto \frac{1}{t}$$

General Expression:



With respect to reactant:

$$\text{Rate} = - \frac{\Delta [A]}{\Delta t} \rightarrow \text{decrease in conc.}$$

With respect to Product:

$$\text{Rate} = + \frac{\Delta [B]}{\Delta t} \rightarrow \text{Increase in conc.}$$

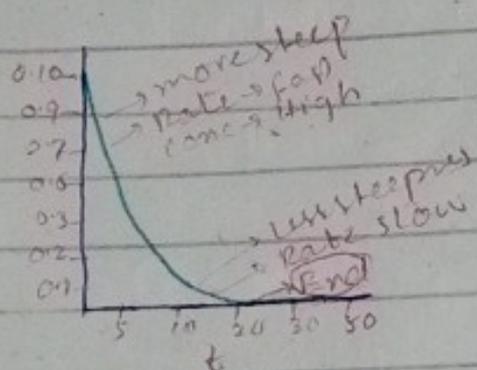
- ↳ Rate is always positive
 - ↳ Rate is never uniform
 - ↳ Rate change at every moment
- start $q_i \rightarrow$ fast
End \rightarrow slow

Units:

$$\text{Rate} = \frac{\Delta P}{\Delta t} \Rightarrow \frac{\text{mol dm}^{-3}}{\text{s}} \Rightarrow (\text{mol dm}^{-3})^{-1} \text{ or } \text{M s}^{-1}$$

Gaseous: atm s^{-1} (\therefore b/c partial pressure will be given)

Graph:



Instant Rate	Average Rate
\rightarrow at any instant	\rightarrow b/w two points
\rightarrow start \rightarrow fast	\rightarrow start \rightarrow slow
\rightarrow end \rightarrow slow	\rightarrow end \rightarrow fast

$$\text{Rate} = \frac{\Delta C}{t}$$

$$\frac{\Delta C}{\Delta t} = \frac{C_2 - C_1}{t_2 - t_1}$$

$\Delta t = 0$, Instant = Average.

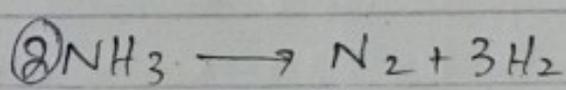
Rate Law: | Rate Eq | Rate Exp

\hookrightarrow Equation that gives relation b/w rate of reaction & concentration of reactants.

\hookrightarrow Obtained experimentally

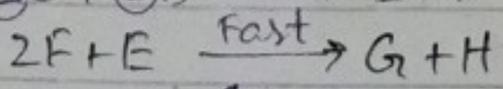
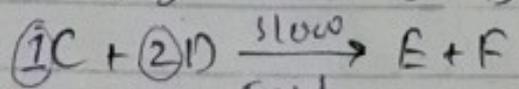
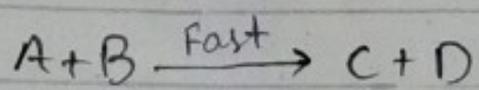
\hookrightarrow Can't write from balance chemical equation

\hookrightarrow can write if slow step is given.



$$\text{Rate} \propto [\text{NH}_3]^0$$

\therefore we can't write power for balance equation b/c slow step is not given.

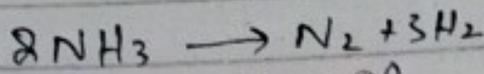


$$\text{R} \propto [\text{C}]^1 [\text{D}]^2$$

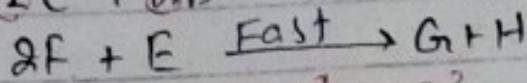
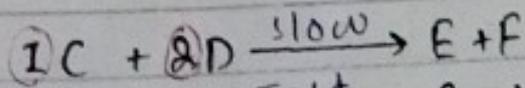
\therefore Now we can write exponents because slow step is given.

Order Of Reaction:

- Sum of exponents in rate law
- Only experimentally obtained
- Can't write from balance chemical equation
- Can write if slow step is given.



Rate $\propto [\text{NH}_3]^0$ zero order



Rate $\propto [C]^1 [D]^2$ Third order \therefore sum of exponents

Zero <small>→ does not depend on concentration</small>	First	Second	Third	Pseudo first <small>→ depends on conc.</small>
$A \xrightarrow{\text{slow}} \text{Product}$	$A \rightarrow \text{Product}$	$2A \rightarrow \text{Product}$	$3A \rightarrow \text{Product}$	$A + B \xrightarrow{\text{slow}} D$
Rate = $k[A]^0$	Rate = $k[A]^1$	Rate = $k[A]^2$	Rate = $k[A]^3$	Rate = $k[A]^1[B]^0$
Rate $[A]^0$	Rate $[A]^1$	Rate $[A]^2$	Rate $[A]^3$	
1 1	1 1	1 1	1 1	
1 2	2 2	4 2	8 2	
1 3	3 3	9 3	27 3	
1 4	4 4	16 4	64 4	

Rate = $k[A][B]$. When the conc. of A & B both doubled the rate will be?

a: doubled

b: 4 times

c: 8 times

d: None

\therefore Rate = $k[A]^1[B]^2$

Add exponent if we become 2.

[A]	[B]	Rate
0.1	0.1	1×10^{-2}
0.2	0.1	2×10^{-2}
0.2	0.2	4×10^{-2}

a: Rate = $k[A]^1[B]^1$

b: Rate = $k[A]^0[B]^2$

c: Rate = $k[A]^2[B]^0$

d: Rate = $k[A]^2[B]^0$

Factors:

1: Nature of Reactants:

→ Electronic Configuration

$$\frac{IA}{1s^1} > \frac{IIA}{1s^2}$$

→ Homo > Hetero

→ Ionic > Molecular & Covalent

→ Gas > Liquids > Solids

2: Surface Area: -

Rate \propto surface area

↳ by increasing surface area number of interacting molecules increases?

Coal (powder) > Coal (pieces)

3: Concentration of Reactant:

Rate \propto [conc] → except zero order.

↳ by increasing conc number of molecules will increase and hence effective collisions will increase.

4: Light:

Rate \propto light (Photochemical reactions)

↳ Intensity of Rate ↑

5: Catalyst:

Rate \propto Catalyst

↳ $E_a(f) \downarrow$, $E_a(r) \downarrow$ ↳ mechanism of Rxn alter.

6: Temperature:

Rate \propto T

↳ by increasing temperature effective collisions will increase because of increase in K.E.

↳ Temp. has no relation with E_a (activation E_a)

→ Rate will double if $T \uparrow 10^\circ C / 10K$.

↳ 2^n

$$\therefore n = \frac{T_2 - T_1}{10}$$

50
10
00
50x
500

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