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Deg - I (H/s) Physical Chemistry (Paper-II)
Chapter - Chemical - Kinetics
Topics — Order of Reaction.

Order of Reaction :- The sum of the powers through which the Concentration must be raised in the experimentally verified rate law expression.

It is an important for every Chemical Reaction. It is always determined experimentally and cannot be determined from the balanced Chemical equation.

In general for a hypothetical Reaction.

$$aA + bB \longrightarrow \text{Product}$$

Its rate law expressed as

~~Rate = $K[A]^{m}[B]^{n}$~~

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K = Rate Const.

The O.R is equal to (m+n)

Remember :- The exponent / Powers m

& b have no relation to the stoichiometric Coefficient a & b of the balanced Chemical Equation.

only the order with respect to A is m & B is n. But $a+b = m+n$, in that case order of Reaction is equal to Molecularity of that Chemical Rxn.

The order of Rxn may be one, two, three, zero & fractional also and -ve value also.

The order of Reaction never greater than three & infinite and imaginary value are not possible.

In general Type of Rxn.

$A \rightarrow$ Product — O.R. = 1 — First Order Rxn

Rate $\propto [A]^1$

$2A \rightarrow$ Product — Rate $\propto [A]^2$ — O.R = 2

$A + B \rightarrow$ Product — Rate $\propto [A]^1 [B]^1$ — Second Order Rxn

$3A \rightarrow$ Product — Rate $\propto [A]^3$

$2A + B \rightarrow$ Product — Rate $\propto [A]^2 [B]^1$

$A + B + C \rightarrow$ Product — Rate $\propto [A]^1 [B]^1 [C]^1$

O.R = 3 — Third Order Rxn

Again $A \rightarrow$ Product OR,
Rate $\propto [A]^0$ $= 1$
Zero order Rxn.
In that Rxn, Rate is independent upon Concentration but depends upon other factor like Temp, Press & Catalyst

Examples of Reaction having Different Order.

Examples	Rate Law	Order
① Zero Order Rxn		
$2NH_3 \xrightarrow{Pt} N_2 + 3H_2$	Rate $\propto [NH_3]^0$	0
$N_2O \xrightarrow{Pt} N_2 + \frac{1}{2}O_2$	Rate $\propto [N_2O]^0$	0
② First Order Rxn.		
$2H_2O_2 \rightarrow 2H_2O + O_2$	Rate $\propto [H_2O_2]^1$	1
$SO_2Cl_2 \rightarrow SO_2 + Cl_2$	Rate $\propto [SO_2Cl_2]^1$	1
③ Second Order Rxn.		
$H_2 + I_2 \rightarrow 2HI$	Rate $\propto [H_2]^1 [I_2]^1$	2
④ Third Order Rxn		
$2NO + O_2 \rightarrow 2NO_2$	Rate $\propto [NO]^2 [O_2]$	3

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⑤ Fractional-Order Rxn

$CH_3CHO \rightarrow CH_4 + CO$	$Rate \propto [CH_3CHO]^{3/2}$	$3/2 = 1.5$
$CO + Cl_2 \rightarrow COCl_2$	$Rate \propto [CO]^{1} [Cl_2]^{1/2}$	$= 3/2 = 2.5$

Pseudo-order Reaction:

Those reaction whose actual-order is different from the expected using rate law expressions are called pseudo-order Rxn.

Example —

$$RCl + H_2O \rightarrow ROH + HCl$$

Expected Rate law

$$Rate = K[RCl]^1[H_2O]^1$$

O.R = 2

Actual Rate-law

$$Rate = K[RCl]^1$$

Actual O.R = 1

Water is taken as excess. Thus its conc^n is taken to be constant. Thus Rxn is pseudo first-order. Another example

$$CH_3COOC_2H_5 + H_2O \rightleftharpoons CH_3COOH + C_2H_5OH$$

$$Rate = K[CH_3COOC_2H_5]^1$$