

Arrhenius Equation :-

From Van't Hoff's equation -

We know that -

$$\frac{d \ln k}{dt} = \frac{E_a}{RT^2} \quad \text{--- (1)}$$

Where k is the rate constant of temperature T & E_a is activation energy.

On rearranging and integrating eqⁿ (1) --- (1)

$$\int d \ln k = \frac{E_a}{R} \int \frac{dt}{T^2}$$

$$\therefore \ln k = -\frac{E_a}{RT} + \ln A \quad \text{--- (2)}$$

Where, $\ln A$ = Integration Constant.

$$\text{or } \ln k - \ln A = -\frac{E_a}{RT}$$

$$\text{or } \ln \frac{k}{A} = e^{-E_a/RT}$$

$$\boxed{k = A e^{-E_a/RT}} \quad \text{--- (3)}$$

The above eqⁿ - (3) is called Arrhenius eqⁿ.

Where, 'A' is called frequency factor or pre-exponential factor.

Again,
from eqⁿ - (2)

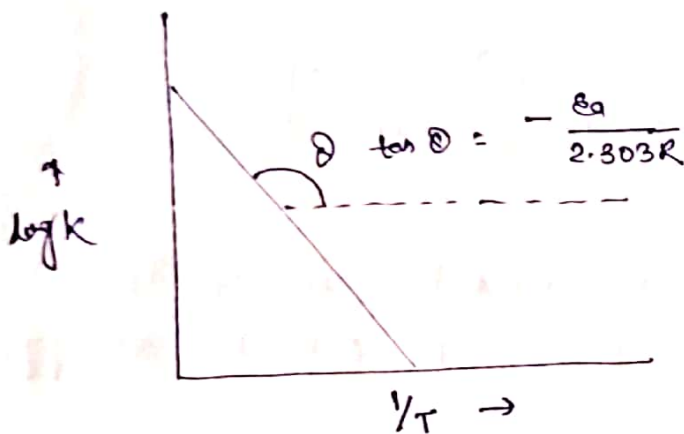
$$\ln K = -\frac{E_a}{RT} + \ln A$$

$$\therefore 2.303 \log K = -\frac{E_a}{RT} + 2.303 \log A$$

$$\therefore \log K = -\frac{E_a}{2.303 RT} + \log A$$

A plot of $\log K$ vs $1/T$ will give a straight line.

The slope of which is $-\frac{E_a}{2.303 R}$



* Calculation of Activation energy (E_a)

Let K_1 and K_2 are the rate constants at temperature T_1 & T_2 . Let ' E_a ' is the activation energy of that reaction then from eqⁿ - (2)

$$\ln K_1 = -\frac{E_a}{RT_1} + \ln A \quad \text{--- (4)}$$

$$\& \ln K_2 = -\frac{E_a}{RT_2} + \ln A \quad \text{--- (5)}$$

On subtracting eqⁿ - (5) from eqⁿ - (4)

$$\ln(k_1 - k_2) = \frac{E_a}{R} \left[\frac{1}{T_2} - \frac{1}{T_1} \right]$$

$$\ln \frac{k_1}{k_2} = \frac{E_a}{R} \left[\frac{1}{T_2} - \frac{1}{T_1} \right]$$

$$\therefore 2.303 \log \frac{k_1}{k_2} = \frac{E_a}{R} \left[\frac{1}{T_2} - \frac{1}{T_1} \right]$$

$$\therefore \log \frac{k_1}{k_2} = \frac{E_a}{2.303 R} \left[\frac{1}{T_2} - \frac{1}{T_1} \right]$$

$$\therefore \log \frac{k_1}{k_2} = \frac{E_a}{2.303 R} \left[\frac{T_1 - T_2}{T_2 T_1} \right]$$

∴ knowing the values of k_1 , k_2 and T_1, T_2 . We can easily calculate the value of Activation energy (E_a).

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