## Arrhenius equation and Calculation of activation energy.

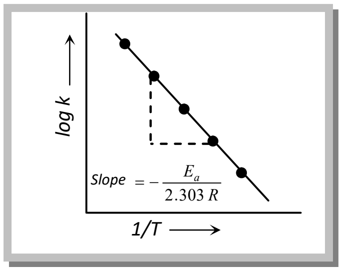
Arrhenius proposed a quantitative relationship between rate constant and temperature as,

$$k = A\, e^{-E_a / RT} \qquad \text{.....(i)}$$

The equation is called ***Arrhenius equation*** in which constant A is known as ***frequency factor***. This factor is related to number of binary molecular collision per second per liter. $E_a$ Is the activation energy. *T* is the absolute temperature and *R* is the gas constant. Both A and $E_a$ are collectively known as ***Arrhenius parameters***. Taking logarithm equation (i) may be written as,

$$\boxed{\log k = \log A - \frac{E_a}{2.303\, RT}} \qquad \text{.....(ii)}$$

The value of activation energy $(E_a)$ increases, the value of *k* decreases and therefore, the reaction rate decreases. When log *k* plotted against $\frac{1}{T}$, we get a straight line. The intercept of this line is equal to log *A* and slope equal to $\frac{-E_a}{2.303\, R}$. Therefore $E_a = -2.303\, R \times \text{slope}$ .




Rate constants for the reaction at two different temperatures $T_1$ and $T_2$ ,

$$\boxed{\log \frac{k_2}{k_1} = \frac{E_a}{2.303\, R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]} \qquad \text{.....(iii)}$$

Where $k_1$ and $k_2$ are rate constant at temperatures $T_1$ and $T_2$ respectively $(T_2 > T_1)$.

Note: Generally rate of reaction increases with increase in temperature but remember for the reaction $2NO + O_2 \rightarrow 2NO_2$; the rate decreases slightly with increase in temperature because it has small negative temperature coefficient.

When $E_a$= 0, the rate of reaction becomes independent of temperature ($E_a$= activation energy)