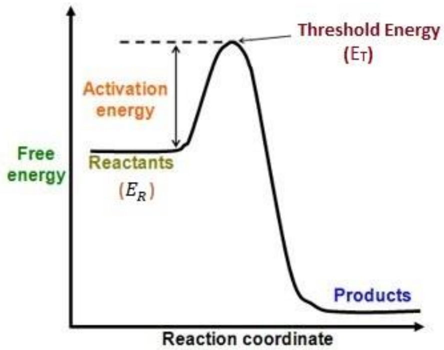
Activation Energy

The minimum amount of energy which must be supplied to the reactants to enable them to cross over the energy barrier is called activation energy.'

Rate of a reaction depends on activation energy. A reaction which has a lower value of its activation energy will proceed at a faster rate at a given temperature, while a reaction which has higher value of its activation energy proceed at low rate.

The difference between this barrier energy (i.e., threshold energy) E_T and the energy of normal molecules E_B called activation energy, E_a.

$\therefore E_a = E_T - E_R$



Arrhenius equation (Temperature dependence of rate constant):

Arrhenius suggested an equation which describes rate constant as a function of temperature i.e.

$$k = Ae^{-Ea/RT}$$

where A → frequency factor

E_a → Energy of activation.

R → the gas constant.

T → Temperature in Kelvin.

At two temperatures T_1 and T_2 their rate constant is given by k_1 and k_2.

Taking log of Arrhenius equation:

$$log_e\, k_1 = log\, A - \frac{E_a}{RT_1} \quad \text{...... (i)}$$

$$log_e\, k_2 = log\, A - \frac{E_a}{RT_2} \quad \text{..... (ii)}$$

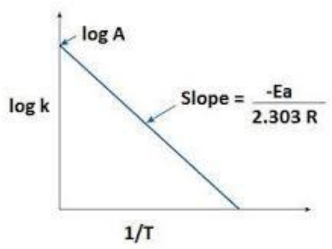
Subtracting equation (i) from equation (ii)

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

Graph (log k vs $\frac{1}{T}$):

Arrhenius Equation: $log\, k = log\, A - \frac{E_a}{2.303R}\frac{1}{T}$

From the above equation we can observe, the graph between log k and 1/T gives a straight line with slope equal to $-\frac{E_a}{2.303R}$



- As the value of E_a increases, the value of k decreases and, therefore reaction rate decreases.