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Arrhenius Equation :-

$$k = A \cdot e^{-E_a/RT}$$

Here :- A → Arrhenius Constant / pre-exponential factor / Frequency factor.

E_a → Activation energy, R :- Gas Constant

$= 0.0821 \frac{ltr\text{-}atm}{k \cdot mol}$

$= 8.314\ J/k\text{-}mol = 2\ Cal/k\text{-}mol$

T :- Temp. in kelvin

k ⇒ Rate Constant.

k increase with increase Temp.

Arrhenius Equation :-

$$k = A \cdot e^{-E_a/RT}$$

$\log_{10} 10 = 1$
$\ln_e e = 1$

$\ln \xrightarrow{\times 2.303} \log$

Take ln Both side -

$$\ln k = \ln\left(A \cdot e^{-E_a/RT}\right)$$

$$\ln k = \ln A + \ln\left(e^{-E_a/RT}\right)$$

$$\ln k = \ln A - \frac{E_a}{RT} \cdot \ln e$$

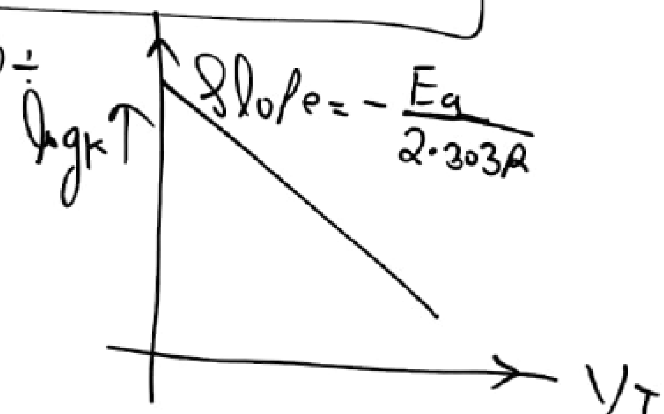
$$\ln k = -\frac{E_a}{RT} + \ln A$$

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

$$\log k = -\frac{E_a}{2.303 R} \cdot \frac{1}{T} + \log A \quad \text{- (1)}$$

** imp.

Graph :-



$T \rightarrow T_1$; $k \rightarrow k_1$

Put these data in eq. ①

$$\log k_1 = -\frac{E_a}{2.303RT_1} + \log A \quad \text{--- (2)}$$

$T \rightarrow T_2$; $k \rightarrow k_2$

Put again in eq. ①

$$\log k_2 = -\frac{E_a}{2.303RT_2} + \log A \quad \text{--- (3)}$$

eq.(3) − eq.(2)

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

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

imp.

Absence of catalyst:-

$E_a \rightarrow E_{a_1}$; $k \rightarrow k_1$

Presence of catalyst (+ve/-ve)

$E_a \rightarrow E_{a_2}$; $k \rightarrow k_2$

Put these data in eq. ①

$$\log k_1 = -\frac{E_{a_1}}{2.303RT} + \log A \quad -(1)$$

$$\log k_2 = -\frac{E_{a_2}}{2.303RT} + \log A \quad -(2)$$

eq. (2) - (1)

$$\log k_2 - \log k_1 = \frac{1}{2.303RT}\left[E_{a_1} - E_{a_2}\right]$$

***

$$\log\left(\frac{k_2}{k_1}\right) = \frac{1}{2.303RT}\left[E_{a_1} - E_{a_2}\right]$$

$k = A \cdot e^{-E_a/RT}$

imp.

$T \rightarrow \infty$

$$k = A \cdot e^{-\frac{E_a}{R \cdot T} \times 0}$$

$$k = A \cdot e^{-0} \Rightarrow k = A \cdot \frac{1}{e^0}$$

$$\boxed{k = A}$$ **

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Q.1. A reaction whose Temp. is increased from 10°c to 50°c then increase in rate of reaction will be.

(a) 2r (b) 4r (c) 8r ~~(d)~~ ✓ 16r

Sol. I[st]

$$10 \xrightarrow{2r} 20 \xrightarrow{4r} 30 \xrightarrow{8r} 40 \xrightarrow{16r} 50 \quad (\times 2 \text{ each step})$$

II $\frac{r_2}{r_1} = \mu^{\Delta T/10} \Rightarrow \frac{r_2}{r} = (2)^{\frac{50-10}{10}} \Rightarrow \frac{r_2}{r} = 2^4$

$$\boxed{r_2 = 2^4 \cdot r}$$

** Q.2 An exothermic reaction $A \longrightarrow B$ has an Activation energy of 17 kj/mol of A. The Heat of rexn is 40 kj. Cal. the Activation energy for the reverse rexn, $B \longrightarrow A$

(a) 23 kj/mol
(b) −23 kj/mol
✓(c) 57 kj/mol
(d) −57 kj/mol

given: $(E_a)_f = 17$ kj/mol ; $(E_a)_b = ?$

$\Delta H = -40$ kJ/mol ;

$\Delta H = (E_a)_f - (E_a)_b \Rightarrow -40 = 17 - (E_a)_b$

$$\boxed{(E_a)_b = 17 + 40 = 57 \text{ kj/mol}}$$

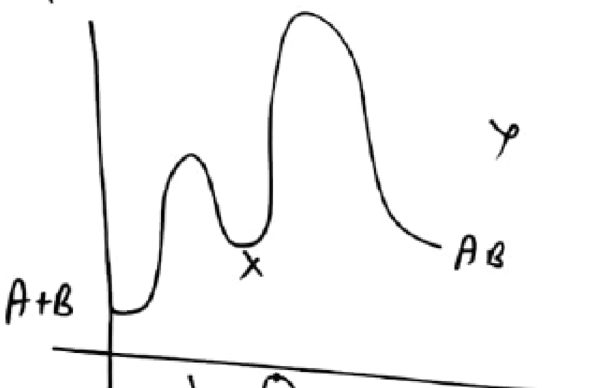
Q.3. An exothermic reaction is occuring in two steps as follow

(i) $A + B \longrightarrow X$ (slow)

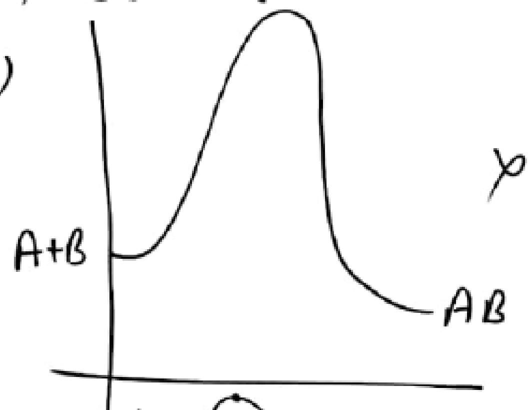
(ii) $X \longrightarrow AB$ (fast)

the process of reaction can be best described by –

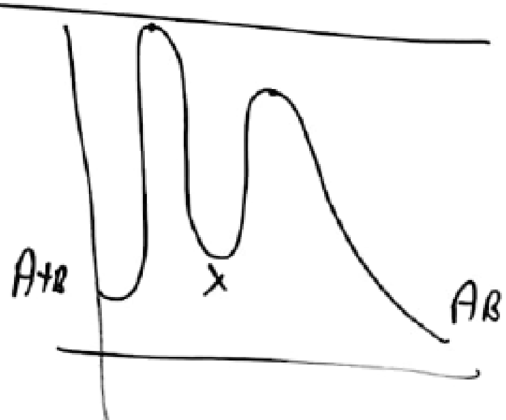
(a)



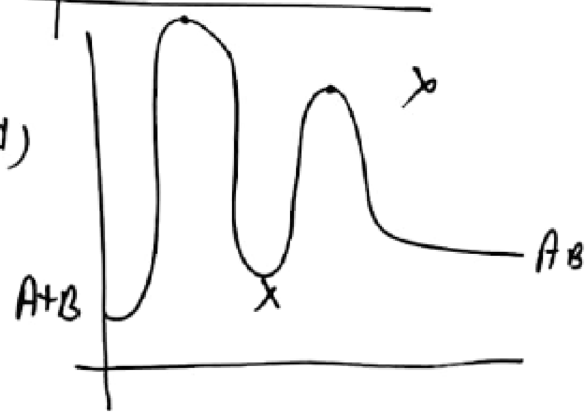
(b)



(c)



(d)



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Q.4. For Ist order gaseous reaction log k when plotted against $\frac{1}{T}$, give a straight line with a slope of -8000. Cal the Activation energy in k cal.

Sol. we know

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

$$\text{slope} = -\frac{E_a}{2.303R}$$

$$+8000 = +\frac{E_a}{2.303R}$$

$$E_a = \frac{2.303 \times 2 \times 8000}{1000}$$

$$E_a = 36.84 \text{ k Cal}$$ Ans.

Q.5. At 300k rate Const. of rexn is 9×10^{-5} sec^{-1} & at 500k rate constant is 4.5×10^{-4} sec^{-1} Cal. Activation energy in kj.

Sol. $T_1 \rightarrow 300$; $k_1 \rightarrow 9\times10^{-5}$

$T_2 \rightarrow 500$; $k_2 \rightarrow 4.5\times10^{-4}$

$$\log\left(\frac{4.5\times10^{-4}}{9\times10^{-5}}\right) = \frac{E_a}{2.303R}\left[\frac{500-300}{300\times500}\right]$$

$$\log\left(\frac{10}{2}\right) = \frac{E_a}{2.303\times8.314}\left[\frac{200}{300\times500}\right]$$

$$E_a = \frac{0.70\times20\times3\times500}{2\times1000} \text{ kj} = 10.5 \text{ kj}$$ Ans.