Ankit Gupta Classes

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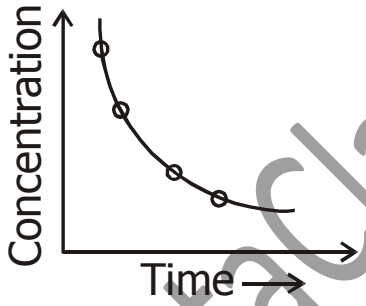
UNIT—4

CHEMICAL KINETICS

1 MARK QUESTIONS

Q. 1. In the reaction A ⟶ B, if the concentration of A is plotted against time, the nature of the curve obtained will be as shown. What is the order of the reaction ?



Ans. First Order

Q. 2. What is the effect of temperature on activation energy ?

Ans. There is no effect of temperature on activation energy.

Q. 3. Which will dissolve in water faster, powdered sugar or crystalline sugar and why ?

Ans. Powdered sugar will dissolve in water faster as it has more surface area.

Q. 4. Which reaction will take place faster and why ?

$$C(s) + \tfrac{1}{2} O_2(g) \xrightarrow{500\ ^\circ C} CO(g)$$

$$C(s) + \tfrac{1}{2} O_2(g) \xrightarrow{1000\ ^\circ C} CO(g)$$

Ans. The second reaction is faster because increase in temperature increases the number of effective collisions and hence increase in rate.

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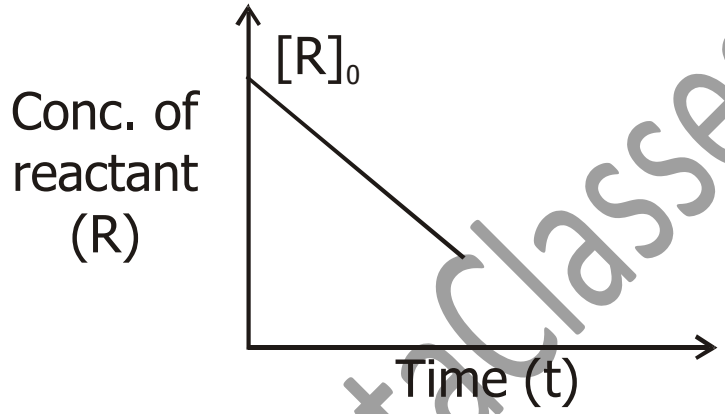
Q. 5. For a reaction $A + H_2O \longrightarrow B$; r = k [A]. What is its (i) Molecularity (ii) Order ?

Ans. Pseudo unimolecular rection order = 1

2 MARKS QUESTIONS

Q. 1. A reaction : Reactant $\longrightarrow$ Product is represented by :



(i) Predict the order of the reaction.

(ii) What does the slope of the graph represent ?

Ans. (i) Zero order

(ii) Slope = $-k = \frac{d[R]}{dt}$

Q. 2. For a reaction, the activation energy is zero. What is the value of rate constant at 300 K if K = 1.6×10^6 s^{-1} at 280 K.

Ans. $\log \frac{K_2}{K_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right] = \frac{0}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right] = 0$

$\frac{K_2}{K_1}$ = antilog (0) = 1 or $K_2 = K_1 = 1.6 \times 10^6$ s^{-1}

Q. 3. The slope of the line in the graph of log K is $\frac{1}{T}$ for a reaction is – 5841 K. Calculate E_a for the reaction.

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Ans. Slope $= -\frac{E_a}{2.303R}$

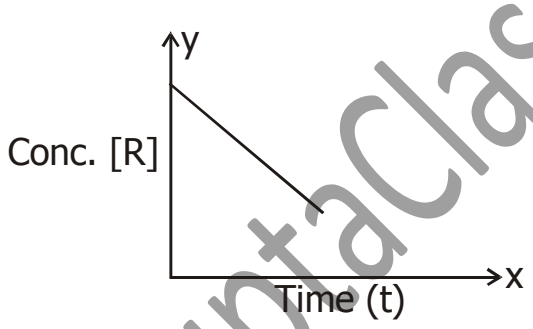
$E_a = -2.303\ R \times \text{Slope}$

$= -2.303 \times 8.314 \times -5841$

$= 1.118 \times 10^5$ g/mol

3 MARKS QUESTIONS K

Q. 1. Consider the reaction R ⟶ P. The change in concentration of A with time is shown in the given plot :



(i) Predict the order of the reaction.

(ii) Derive the expression for the time required for the completion of the reaction.

Ans. (i) Zero order

(ii) For the reaction R ⟶ P

$r = -\frac{d[R]}{dt} = K[R]^\circ$

$-d[R] = K\,dt$

On integration

$-[R] = Kt + C$

When $t = 0$ $[R] = [R]_0$

On substitution

$-[R] = Kt - [R]_0 \Rightarrow [R] = -Kt + [R]_0$

$Kt = [R]_0 - [R] \Rightarrow t = \frac{1}{K}\{[R]_0 - [R]\}$

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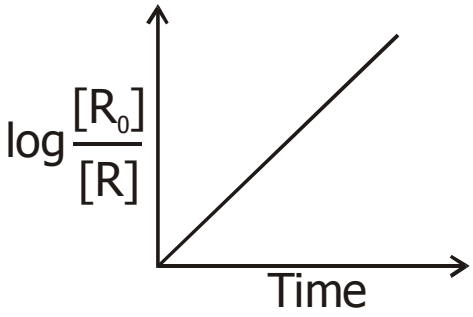
Q. 2. Answer the following questions on the basis of the given curve for a first order reaction :

A ⟶ P



(i) What is the relation between slope of this line and rate constant ?

(ii) Calculate the rate constant of the above reaction if the slope is $2 \times 10^{-4}\ s^{-1}$.

Ans. (i) $\text{Slope} = \frac{K}{2.303}$

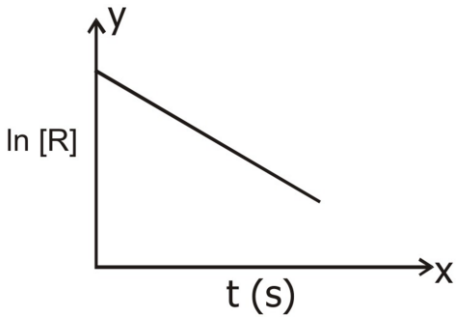
(ii) $\text{Slope} = 2 \times 10^{-4}\ s^{-1}$

$\therefore K = 2.303 \times \text{Slope}$

$= 2.303 \times 2 \times 10^{-4}\ s^{-1}$

$= 4.606 \times 10^{-4}\ s^{-1}$

Q. 3. For a certain chemical reaction variation in concentration in [R] VS time plot is given below. For this reaction write :



(i) What are the units of rate constant ?

(ii) Give the relationship between k and $t_{½}$.

(iii) What does the slope of the above line indicate ?

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Ans. (i) time^{-1} (s^{-1})

(ii) $K = \frac{0.693}{t_{1/2}}$

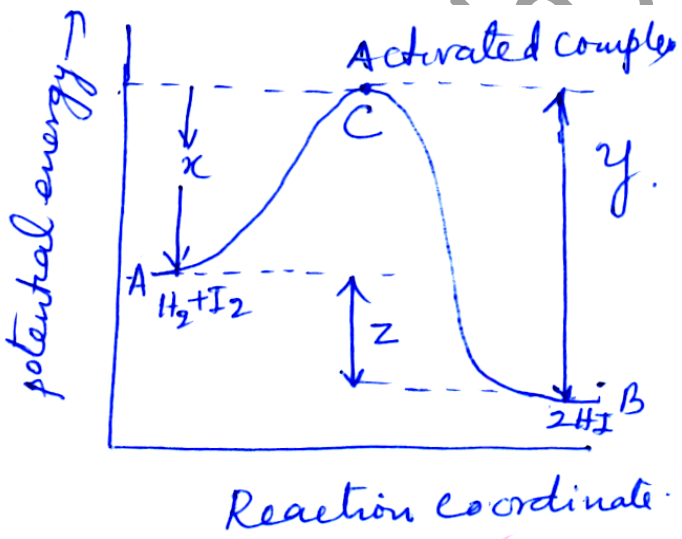
(iii) rate constant K of the reaction.

Q. 4. Consider the following diagram representing potential energy plot and answer the following questions :

(i) What do 'x' and 'y' represent ?

(ii) What does 'z' represent in this diagram ?

(iii) Is the reaction endothermic or exothermic ?



Ans. (i) 'x' represents E_a for forward reaction. 'y' represents E_a for backward reaction.

(ii) 'z' represents ΔH, the enthalpy change for the reaction.

(iii) Exothermic reaction.

Q. 5. Consider a plot between k vs $\frac{1}{T}$ where T is the temperature. On the basis of this plot, answer the following questions :

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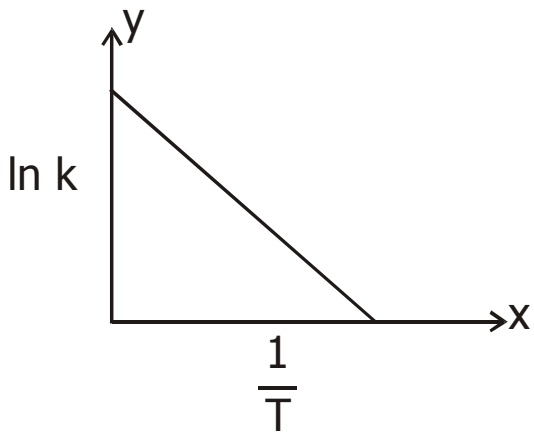

(i) What is the slope in this line ?

(ii) What is the intercept of this line on the y-axis ?

(iii) What is the relation between K and T ?

Ans. (i) Slope = $-\frac{E_a}{R}$

(ii) Intercept = ln A

(iii) $\ln k \alpha \frac{1}{T}$ or $K = A\, e^{-Ea/RT}$

Q. 6. Diagram given below shows a plot of potential energy Vs reaction co-ordination for a hypothetical reaction. Write answers to the following from the plot given :

(a) Represent reactant, product and activated complex in terms of A, B and C ?

(b) Is this reaction exothermic or endothermic ?

(c) What will be the effect of a catalyst on E_a of the reaction ?

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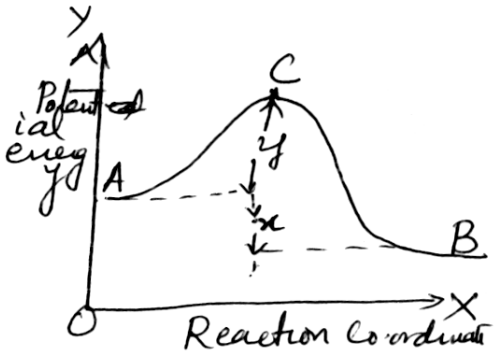

Ans. (a) A ⟶ Reactant

B ⟶ Product

C ⟶ Activated Complex

(b) Exothermic

(c) Catalyst will lower the activation energy for the reaction.

Q. 7. The rate of a first order reaction is 0.04 mol/h/s at 10 minutes and 0.03 mol/h/s at 20 minutes. Find the half life period of the reaction.

Ans. Rate = K C

r_1 = K C_1

r_2 = KC_2

$$\frac{r_1(10\ \text{min})}{r_2(20\ \text{min})} = \frac{C_1}{C_2} = \frac{0.04}{0.03}$$

$$K = \frac{2.303}{t} \log \frac{C_1}{C_2}$$

When t = 10 min

$$K = \frac{2.303}{t} \log \frac{0.04}{0.03} = \frac{2.303}{10} \log \frac{4}{3} \qquad = 0.0287\ \text{min}^{-1}$$

$$t_{½} = \frac{0.693}{K} = \frac{0.693}{0.0287} \qquad = 24.14\ \text{min.}$$