

UNIT # 08 (PART - I)

CHEMICAL KINETICS

EXERCISE # 1

$$2. \quad r = \frac{-1}{3} \frac{d[H_2]}{dt}$$

$$\frac{-d[H_2]}{dt} = 3 \quad 2.5 \quad 10^{-4} = 7.5 \quad 10^{-4} \text{ mol L}^{-1} \text{ S}^{-1}$$

$$3. \quad \frac{-d[O_2]}{dt} = \frac{1}{2} \frac{d[SO_3]}{dt}$$

$$\frac{d[SO_3]}{dt} = 2 \quad 2.5 \quad 10^{-4} = 5 \quad 10^{-4} \text{ mol L}^{-1} \text{ S}^{-1}$$

$$4. \quad \frac{1}{3} \frac{d[H_2]}{dt} = \frac{1}{2} \frac{d[NH_3]}{dt}$$

$$\frac{d[NH_3]}{dt} = \frac{2}{3} \times 0.3 \times 10^{-4}$$

$$= 2 \quad 10^{-5} = 0.2 \quad 10^{-4}$$

$$6. \quad r = k[A]^2 [B]$$

$$r = k[x]^2 [y]$$

$$r' = k[3x]^2 [3y]$$

$$r' = 27 r$$

$$8. \quad r = \frac{1}{2} \frac{d[C]}{dt} = \frac{1}{2} \quad 1 = 0.5 \text{ mol L}^{-1} \text{ S}^{-1}$$

$$10. \quad K = \frac{2.303}{t} \log \left[\frac{a_0}{a} \right]$$

$$K = \frac{2.303}{500} \log \frac{10}{1}$$

$$= \frac{2.303}{500} \log 10 = 4.606 \quad 10^{-3} \text{ sec}^{-1}$$

$$12. \quad r = K[A] = 5 \quad 10^{-5} [1] = 5 \quad 10^{-5} \text{ M s}^{-1}$$

$$13. \quad r = K_2[N_2O_2] [O_2] \quad \dots(i)$$

$$\frac{K_1}{K_{-1}} = \frac{[N_2O_2]}{[NO]^2} \text{ or } [N_2O_2] = \frac{K_1}{K_{-1}} [NO]^2 \text{ from eq. (i)}$$

$$r = K_2 \frac{K_1}{K_{-1}} [NO]^2 [O_2]$$

$$\text{compair } r = K [NO]^2 [O_2]$$

$$K = K_2 \frac{K_1}{K_{-1}}$$

$$15. \quad r = -\frac{1}{2} \frac{d[N_2O_5]}{dt} = \frac{1}{4} \frac{d[NO_2]}{dt} = \frac{d[O_2]}{dt} = K[N_2O_5]$$

$$K_1 = 2K$$

$$K_2 = 4K = 2K_1$$

$$K_3 = K = K_1/2$$

$$16. \quad \frac{-d[a-x]}{dt} = K_1[a-x] + K_2[a-x]$$

$$20. \quad r = K[X][C]$$

$$K' = \frac{[X]}{[A][B]}$$

$$r = K'[A] [B] [C]$$

$$21. \quad r = K[NO]_2 [Cl_2]$$

$$K' = \frac{[NO]_2}{[NO]^2}$$

$$r = KK' [NO]^2 [Cl_2]$$

$$23. \quad K \quad 15 = \ln \left(\frac{35-0}{35-9} \right)$$

$$43. \quad K \quad 32 = \ln \left(\frac{100}{1} \right) \quad \dots (i)$$

$$K \quad t = \ln \left(\frac{100}{0.1} \right) \quad \dots (ii)$$

$$\text{eq. (ii)/(i)}$$

$$\frac{t}{32} = \frac{3 \ln 10}{2 \ln 10}$$

$$t = 48 \text{ min}$$

$$44. \quad \text{Given } t_1 \alpha \frac{1}{a^2}$$

$$\therefore t_1 \alpha \frac{1}{a^{n-1}}$$

$$n - 1 = 2$$

$$n = 3$$

$$45. \quad t_1 \alpha \frac{1}{a^{n-1}} \quad \frac{200}{100} = \left(\frac{1}{0.5} \right)^{n-1}$$

$$2 = 2^{n-1} \quad n - 1 = 1 \quad n = 2$$

$$51. \quad K = Ae^{-E_a/RT}$$

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

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

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

$$\text{slope } \frac{E_a}{2.303R} = 5000$$

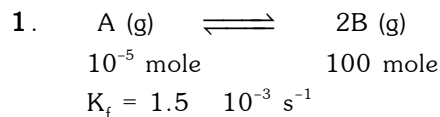
$$E_a = 5000 \quad 8.31 \quad 2.303 = 95.7 \text{ KJ k}^{-1} \text{ mol}^{-1}$$

$$52. \quad -\frac{E_a}{R} = -40000$$

$$E_a = 40000 \quad 2 = 8 \quad 10^4 \text{ cal}$$

$$53. \quad K = Ae^{-E_a/RT} \quad \therefore Ae^{-E_a/RT} = Ae^{\frac{-\epsilon_1 - \epsilon_3 + \epsilon_2}{RT}}$$

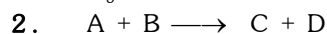
$$\epsilon_a = E_1 + E_3 - E_2 = 60 + 10 - 30 = 40 \text{ kJ}$$



$$K = \frac{[100]^2}{10^{-5} \times 10} = \frac{K_f}{K_b}$$

$$K_b = \frac{1.5 \times 10^{-3} \times 10^{-7}}{10^4}$$

$$K_b = 1.5 \quad 10^{-11} \text{ L mol}^{-1} \text{ s}^{-1}$$



$$\text{rate} = k [A]^{1/2} [B]^{1/2}$$

$$\frac{dx}{dt} = k \sqrt{(a-x)(a-x)}$$

$$\frac{dx}{dt} = k(a-x)$$

$$\Rightarrow t = \frac{2.303}{k} \log_{10} \left(\frac{a}{a-x} \right)$$

$$t = \frac{2.303}{2.31 \times 10^{-3}} \log_{10} \left(\frac{1}{0.25} \right)$$

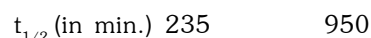
$$t = 600 \text{ sec.}$$



$$\frac{k_1}{k_2} = \frac{\log(2)}{\log(100/4)}$$

$$\frac{k_1}{k_2} = \frac{\log 2}{2 \log 10 - 2 \log 2}$$

$$\frac{k_1}{k_2} = 4.06$$



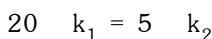
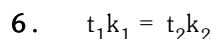
$$t_{1/2} \propto \frac{1}{a^{n-1}}$$

$$\frac{(t_{1/2})_1}{(t_{1/2})_2} = \left(\frac{a_2}{a_1} \right)^{n-1}$$

$$\frac{235}{950} = \left(\frac{250}{500} \right)^{n-1}$$

$$2^2 = (2)^{n-1}$$

$$n-1 = 2 \Rightarrow n = 3$$



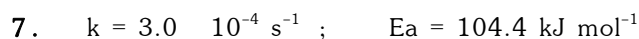
$$\frac{k_1}{k_2} = 4$$

Now Arrhenius equation

$$\log_{10} \left(\frac{k_2}{k_1} \right) = \frac{E_a}{2.30 \times R} \left(\frac{T_2 - T_1}{T_1 T_2} \right)$$

$$\log_{10}(4) = \frac{E_a}{8.314 \times 2.3} \left(\frac{20}{300 \times 320} \right)$$

$$E_a = 55.332 \text{ kJ/mole}$$



$$A = 6.0 \quad 10^{14} \text{ s}^{-1} \quad k_2 = A e^{-E_a/RT}$$

$$\text{But when } T \rightarrow \infty \quad e^{-0} \rightarrow 1$$

$$k = A \Rightarrow k = 6.0 \quad 10^{14} \text{ s}^{-1}$$

$$10. \quad k = \frac{1}{t(n-1)} \left[\frac{1}{C^{n-1}} - \frac{1}{C_0^{n-1}} \right]$$

$$t_{1/2} = \frac{1}{k(n-1)} \left[\frac{2^{n-1}}{C_0^{n-1}} - \frac{1}{C_0^{n-1}} \right] \dots (1)$$

$$t_{3/4} = \frac{1}{k(n-1)} \left[\frac{4^{n-1}}{C_0^{n-1}} - \frac{1}{C_0^{n-1}} \right] \dots (2)$$

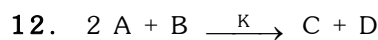
$$\text{equ. (2)} \div \text{equ. (1)}$$

$$\frac{t_{3/4}}{t_{1/2}} = \left[\frac{4^{n-1} - 1}{2^{n-1} - 1} \right] = \frac{2^{2(n-1)} - 1}{(2^{n-1} - 1)} = \frac{(2^{n-1} + 1)(2^{n-1} - 1)}{(2^{n-1} - 1)}$$

$$t_{3/4} = t_{1/2} [2^{n-1} + 1]$$

$$11. \quad \text{Fraction of reactant consumed} \quad f = \left(1 - \frac{C}{C_0} \right)$$

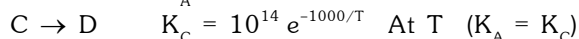
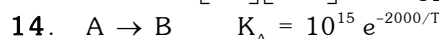
$$\text{for a reaction : } \frac{df}{dt} = k(1-f) \text{ (Remaining amount).}$$



$$\text{rate} = k [A] [B]^2 \quad t = 0 \quad C_0 \quad 2C_0$$

$$t = 30 \text{ min, } \frac{C_0}{2} \quad \frac{7C_0}{4} \quad \text{Rate at that time}$$

$$\text{Rate} = k \left[\frac{C_0}{2} \right] \left[\frac{7C_0}{4} \right]^2 = \frac{49C_0^3}{32}$$



$$C_0^{15} e^{-2000/T} = 10^{14} e^{-1000/T}$$

$$10 e^{-2000/T} = e^{-1000/T} \quad 10 = e^{1000/T}$$

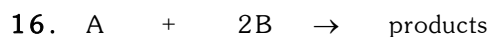
$$\log_e 10 = 1000/T \quad T = \frac{1000}{\log_e 10} \quad T = \left(\frac{1000}{2.303} \right) k$$

$$15. \quad \log_{10} \frac{k_2}{k_1} = \frac{2.303 E_a}{R} \left(\frac{T_2 - T_1}{T_1 T_2} \right)$$

$$\frac{R \log 2 \times 280 \times 290}{2.303 \times 10} = E_a$$

$$\log \frac{k_4}{k_3} = \frac{2.303 \times R \log 2 \times 280 \times 290}{2.303 \times 10 \times R} \left(\frac{10}{290 \times 300} \right)$$

$$\log_{10} \left(\frac{k_4}{k_3} \right) = \frac{280}{300} \log 2 \quad \frac{k_4}{k_3} = 1.91$$

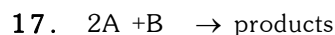


$$-\frac{d[A]}{dt} = k \sqrt{[A]} \sqrt{[B]}$$

Reactant are in their stoichiometric proportion

$$\Rightarrow -\frac{d(a-x)}{dt} = k\sqrt{(a-x)}\sqrt{2(a-x)}$$

$$\frac{dx}{dt} = \sqrt{2} k(a-x) \quad t_{1/2} = \frac{0.693}{\sqrt{2}k}$$



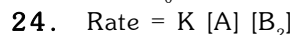
$$A = A_0 e^{-kt}$$

$$A = A_0 e^{-1}$$

$$\frac{-d[A]}{dt} = k[A]$$

$$\text{when } t_2 = 1/k$$

$$A = A_0/e$$



$$K = \frac{[A]^2}{[A_2]} \Rightarrow [A] = \{K[A_2]\}^{1/2}$$

$$r = K' [A_2]^{1/2} [B_2] \quad \text{order} = 1\frac{1}{2}$$

26. For A $K_1 \quad t = \ln \frac{100}{100-94} \quad \dots(1)$

For B $K_2 \quad t = \ln \frac{100}{100-50} \quad \dots(1)$

Eq. (1) and (2)

$$\frac{K_1}{K_2} = \frac{\ln \frac{100}{6}}{\ln \frac{100}{50}} \Rightarrow \frac{K_1}{K_2} = 4.058$$

27. % B = $\frac{K_1}{K_1 + K_2} \times 100 = 76.83\%$

$$\%C = 100 - B\% = 23.17\%$$

28. $\frac{dt}{dt} = \alpha - \lambda N,$

For max. no of nuclei $\frac{dN}{dt} = 0$

$$\alpha = \lambda N \Rightarrow N = \alpha/\lambda$$

29. Let n is the moles of reagent 'R' when R is reacted with A at time t = 0

	A	→	B	+	C
t = 0	n		0		0
at t	n - x		2x		3x
at t → ∞	0		2n		3n

$$\therefore 5n = n_2 \Rightarrow n = \frac{n_2}{5}$$

$$n + 4x = n_1 \Rightarrow x = \frac{n_1 - n}{4}$$

$$k = \frac{2.303}{t} \log \left(\frac{n}{n-x} \right)$$

$$\text{so } k = \frac{1}{t} \ln \left(\frac{4n_2}{5(n_2 - n_1)} \right)$$

30. Overall rate constant = $k = k_1 + k_2 + k_3 = 6.93 \times 10^{-3}$

$$t_{1/2} = \frac{0.693}{6.93 \times 10^{-3}} = 100 \text{ sec;}$$

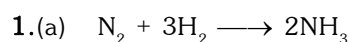
After half-life, $P_B + P_C + P_D = 4 \text{ atm}$

$$\frac{P_B}{P_B + P_C + P_D} = \frac{k_1}{k_1 + k_2 + k_3} = \frac{200}{693}$$

$$P_B = 4 \times \frac{200}{693} = 1.154 \text{ atm}$$

CHEMICAL KINETICS

EXERCISE # 4[A]

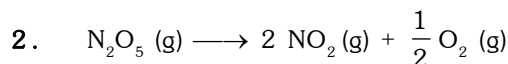


$$\text{Rate} = \frac{\Delta[NH_3]}{\Delta t} = 2 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

$$-\frac{dH_2}{dt} = -\frac{1}{3} \frac{dH_2}{dt} = \frac{1}{2} \frac{dNH_3}{dt}$$

$$\frac{dN_2}{dt} = 1 \times 10^{-4}$$

(b) $-\frac{dH_2}{dt} = -\frac{3}{2} \times 2 \times 10^{-1}$
 $= -3 \times 10^{-4}$



$$-d[N_2O_5] / dt = k_1[N_2O_5]$$

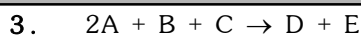
$$d[NO_2] / dt = k_2[N_2O_5]$$

$$d[O_2] / dt = k_3[N_2O_5]$$

$$-\frac{dN_2O_5}{dt} = \frac{1}{2} \frac{dNO_2}{dt} = 2 \frac{dO_2}{dt}$$

$$K_1 = \frac{K_2}{2} = 2K_3$$

$$2K_1 = K_2 = 4K_3$$

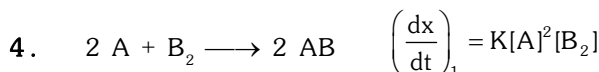


$$\left(\frac{dx}{dt} \right)_1 = K_1 [A] [B]^2 [C]^0$$

if increases conc. 2 time

$$\left(\frac{dx}{dt} \right)_2 = K_1 [2A] [2B]^2 [2C]^0 = 8 \left(\frac{dx}{dt} \right)_1$$

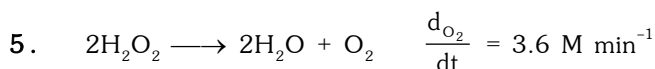
⇒ rate increase by 8 time



if V is decrease to $\frac{V}{3}$

$$\Rightarrow \left(\frac{dx}{dt} \right)_2 = [3A]^2 [3B_2] \quad \left(\frac{dx}{dt} \right)_2 = 27 \left(\frac{dx}{dt} \right)_1$$

reaction increase by 27 times



(a) Rate of formation of H_2O

$$\frac{dH_2O}{dt} = 2 \times 3.6 = 7.2 \text{ M min}^{-1}$$

$$\frac{dH_2O_2}{dt} = 7.2 \text{ M min}^{-1}$$

6. $A \longrightarrow B$ $K = 1.2 \times 10^{-2} \text{ M s}^{-1}$
 initially = 10 M
 from the unit of rate constant we find that reaction
 is of zero order $X_1 = kt$
 remaining
 $= 10 - 1.2 \times 10^{-2} \times 10 \times 60 = 10 - 7.2$
 [Remaining mole = 2.8 M]
 If $10 = 1.2 \times 10^{-2} t$ $\frac{1000}{1.2} = t$
 $t = \frac{1000}{60 \times 1.2}$ ddd $t = 13.88 \text{ min}$

28. $\text{H}_2\text{O} + \text{O} \xrightleftharpoons[\text{Eb}]{\text{Ea}} 2 \text{HO}$ $\Delta H = 72 \text{ kJ}$
 $T = 500 \text{ K}$
 $E_a = 77 \text{ kJ/mole} \Rightarrow \Delta H = E_a - E_b$
 $72 = 77 - E_b$
 $E_b = 77 - 72$
 $E_b = 5 \text{ kJ}$

33. $2 \text{NO} + \text{Br}_2 \longrightarrow 2 \text{NOBr}$
 (i) $\text{NO} + \text{Br}_2 \rightleftharpoons \text{NOBr}_2$ (East)
 (ii) $\text{NOBr}_2 + \text{NO} \xrightleftharpoons[\text{Slow}]{\text{Fast}} 2 \text{NOBr}$
 Rate is determined by the slowest step
 $\Rightarrow \text{Rate} = k [\text{NOBr}_2] [\text{NO}]$
 But NOBr_2 is a visible intermediate
 $k_2 = \frac{[\text{NOBr}_2]}{[\text{NO}][\text{Br}_2]} \Rightarrow \text{Rate} = k_1 [\text{NO}]^2 [\text{Br}_2]$
 \Rightarrow 3rd order RxN
 45. $A \longrightarrow B$ $E_a = 70 \text{ kJ/mole}$ $t_{1/2} = 40 \text{ min}$
 $k = \left(\frac{0.693}{40 \text{ min}} \right)$ $k = 2.8875 \times 10^{-4}$

$$\log_{10} \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left(\frac{T_2 - T_1}{T_1 T_2} \right)$$

$$= \frac{70 \times 10^3}{2.303 \times 8.314} \left[\frac{15}{298 \times 313} \right]$$

$$\frac{k_2}{k_1} = 5.88 \times 10^{-4} \times 10^3 = 10^{0.588}$$

$$\frac{k_2}{k_1} = 3.87$$

$$\frac{k_2}{k_1} = \frac{\log(a/a-x)}{\log_{10}(a/3ka)}$$

$$3.87 = \frac{\log(a/a-x)}{\log(4/3)}$$

$$10^{4.835} = \left(\frac{a}{a-x} \right)$$

$$\left(\frac{a}{a-x} \right) = 10^{4.835} \quad \left(\frac{a}{a-x} \right) 100 = 32.84\%$$

$$\Rightarrow \% \text{ decomposition} = 100 - 32.84 = 67.16\%$$

46. (i) $A \longrightarrow \text{product}$
 (ii) $B \longrightarrow \text{product}$

$$\log \left(\frac{k_2}{k_1} \right) = \frac{E_a}{2.303R} \left[\frac{10}{310 \times 300} \right]$$

$$\log 2 \quad 2.303 \quad 8.314 \quad 31 \quad 300 = E_a$$

$$E_a = 53.6 \text{ kJ/mole}$$

$$k_{A_2} = \left(\frac{0.693}{30} \right)$$

$$k_{B_2} = \left(\frac{0.693}{15} \right)^{\text{min}^{-1}}$$

$$E_a = 26.8 \text{ kJ/mole}$$

$$\log \frac{k_2}{k_B} = \frac{E_a}{2.303} \left[\frac{-10}{310 \times 300} \right]$$

$$\log \left(\frac{k_2}{k_B} \right) = \frac{-26.8 \times 1000}{2.303 \times 8.314 \times 30 \times 3.10}$$

$$\log_{10} \left(\frac{k_2}{k_B} \right) = -0.151$$

$$k_2 = \left(\frac{0.706 \times 0.693}{15 \times 60} \right)^{\text{sec}^{-1}}$$

$$k_2 = 0.0327 \text{ min}^{-1}$$

47. $2 \text{H}_2\text{O}_2 \longrightarrow 2 \text{H}_2\text{O} + \text{O}_2$
 ml. eq of H_2O_2 in 10 ml diluted
 $= M_1 \text{ eq. of } \text{KMnO}_4 \text{ titrated} = 25 \times 0.025 \times 5 = 3.125$
 ml. eq in 100 ml solu. = 31.25
 but 22400 ml $\text{O}_2 = 68 \text{ gm } \text{H}_2\text{O}_2$

$$1 \text{ ml} = \frac{68}{22400}$$

$$20 \text{ ml} = \frac{68 \times 20}{22400} \text{ in } 1 \text{ ml } \text{H}_2\text{O}_2$$

$$= \frac{68 \times 20 \times 10}{22400} \text{ in } 10 \text{ ml } \text{H}_2\text{O}_2$$

$$\text{No. of Meq. in } 10 \text{ ml of } 20\% \text{ kg ml } \text{H}_2\text{O}_2$$

$$\text{Initially} = \frac{68 \times 20 \times 10 \times 1000}{17 \times 22400} = 35.71$$

$$\Rightarrow k = \frac{2.303}{6} \log \left(\frac{35.71}{31.25} \right)$$

$$k = 0.022 \text{ hr}^{-1}$$

1. Initial m mol of cyclobutene (साइक्लोब्यूटीन के प्रारम्भिक m मोल) = 10

Let after 20 min, x m mol cyclobutene isomerized.
(माना 20 मिनट पश्चात्, x m mol साइक्लोब्यूटीन समावयवीकृत हुआ।)

m mol of cyclobutene left = 10 - x and m mol of diene formed = x

(साइक्लोब्यूटीन के शेष m mol = 10 - x व निर्मित डाईन के m mol = x)

m mol of Br₂ required after 20 min = 10 - x + 2x = 10 + x = 16

(20 मिनट पश्चात् आवश्यक Br₂ के m mol = 10 - x + 2x = 10 + x = 16)

$$\Rightarrow x = 6 \Rightarrow 20K = \ln \frac{10}{4} \quad \dots\dots(i)$$

If y m mol of cyclobutene isomerized after 30 min.
(यदि 30 मिनट पश्चात् साइक्लोब्यूटीन के y m mol समावयवीकृत होते हैं।)

$$30 K = \ln \frac{10}{10-y} \quad \dots\dots(ii)$$

From Eqs. (i) and (ii) (समीकरण (i) व (ii) से) y = 7.47

$$\Rightarrow \text{m mol of Br}_2 \text{ required (Br}_2 \text{ के आवश्यक m mol)} = 10 + y = 17.47$$

$$\Rightarrow \text{Vol. of bromine solution required (ब्रोमीन विलयन का आवश्यक आयतन)} = 17.47 \text{ mL}$$

$$2. 10^2 e^{\frac{14000}{RT}} = 10^3 e^{\frac{20000}{RT}} \quad \text{Solving (हल करने पर),}$$

$$T = 313.42 \text{ K}$$

$$\Rightarrow \text{Rate constant (दर नियतांक)} K_1 = K_2 = 0.464 \text{ hr}^{-1}$$

$$\Rightarrow K_1 t = \ln \frac{n_0(A_2)}{n_0(A_2) - n_1} \Rightarrow n_1 = 0.37$$

$$K_2 t = \ln \frac{n_0(B_3)}{n_0(B_3) - n_2} \Rightarrow n_2 = 0.37$$

$$\Rightarrow \text{Total moles of gases after 1.0 hr. (1.0 घंटे पश्चात् गैसों के कुल मोल)} = 1.37 + 1.74 = 2.11$$

$$P = 5.42 \text{ atm}$$

3. Let rate constant in absence of catalyst is k₁
(माना उत्प्रेरक की अनुपस्थिति में दर नियतांक k₁)

Let rate constant in presence of first catalyst is k₂
(प्रथम उत्प्रेरक की उपस्थिति में दर नियतांक k₂)

Let rate constant in presence of second catalyst is k₃
(द्वितीय उत्प्रेरक की उपस्थिति में दर नियतांक k₃)

$$k_1 \quad 1 = \ln \Rightarrow k_1 = 0.2231 \text{ hr}^{-1} \quad \dots\dots(i)$$

$$k_2 \quad 0.5 = \ln \frac{80}{40} \Rightarrow k_2 = 1.3862 \quad \dots\dots(ii)$$

$$\frac{k_3 \times 1}{6} = \ln \frac{40}{10} \Rightarrow k_3 = 8.317 \quad \dots\dots(iii)$$

$$k_1 = A e^{-80,000/RT}$$

$k_2 = A e^{-E_{a1}/RT}$ $E_{a1} \rightarrow$ Activation energy in presence of 1st catalyst

(1st उत्प्रेरक की उपस्थिति में सक्रियण ऊर्जा)

$$\ln \frac{k_2}{k_1} = \frac{80,000 - E_{a1}}{RT} = \ln \frac{1.3862}{0.2231}$$

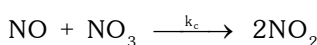
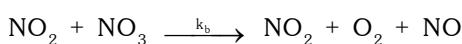
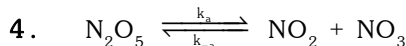
$$E_{a1} = 75443.8 \text{ J} = 75.44 \text{ kJ}$$

$k_3 = A e^{-E_{a2}/RT}$ $E_{a2} \rightarrow$ Activation energy in presence of 2nd catalyst

(2nd उत्प्रेरक की उपस्थिति में सक्रियण ऊर्जा)

$$\ln \frac{k_3}{k_1} = \frac{80,000 - E_{a2}}{RT} = \ln \frac{8.317}{0.2231}$$

$$E_{a2} = 70974.9 \text{ J} = 70.975 \text{ J}$$



$$\frac{-d[\text{N}_2\text{O}_5]}{dt} = k_a [\text{N}_2\text{O}_5] - k_{-a} [\text{NO}_2] [\text{NO}_3] \quad \dots\dots(i)$$

$$\frac{d[\text{NO}_3]}{dt} = k_a [\text{N}_2\text{O}_5] - k_{-a} [\text{NO}_2] [\text{NO}_3] - k_b [\text{NO}_2] [\text{NO}_3] - k_c [\text{NO}] [\text{NO}_3] = 0 \quad \dots\dots(ii)$$

$$\frac{d[\text{NO}]}{dt} = k_b [\text{NO}_2] [\text{NO}_3] - k_c [\text{NO}] [\text{NO}_3] = 0 \quad \dots\dots(iii)$$

From equation (iii) (समीकरण (iii) से)

$$[\text{NO}] = \frac{k_b}{k_c} [\text{NO}_2]$$

putting this in equation(ii) (इसे समीकरण (ii) में रखने पर)

$$k_a [\text{N}_2\text{O}_5] = [\text{NO}_3] \{k_{-a} [\text{NO}_2] + 2k_b [\text{NO}_2]\}$$

$$[\text{NO}_3] = \frac{k_a [\text{N}_2\text{O}_5]}{k_{-a} [\text{NO}_2] + 2k_b [\text{NO}_2]}$$

putting this in equation (i) (इसे समीकरण (i) में रखने पर)

$$\frac{-d[\text{N}_2\text{O}_5]}{dt} = k_a [\text{N}_2\text{O}_5] - \frac{k_a k_{-a} [\text{N}_2\text{O}_5]}{k_{-a} + 2k_b}$$

$$\frac{-d[\text{N}_2\text{O}_5]}{dt} = \frac{2k_a k_b [\text{N}_2\text{O}_5]}{k_{-a} + 2k_b}$$

$$r = \frac{-1}{2} \frac{d[\text{N}_2\text{O}_5]}{dt} = \frac{k_a k_b [\text{N}_2\text{O}_5]}{k_{-a} + 2k_b}$$

$$5. \quad \tau^2 = \alpha t + \beta$$

$$2\tau \frac{d\tau}{dt} = \alpha \Rightarrow \frac{d\tau}{dt} = \frac{\alpha}{2\tau} = \frac{\alpha}{2} (\tau)^{-1}$$

$$\text{order (कोटि)} = -1$$

6. Given (दिया है) : $r = k' [\text{complex}]^a [[\text{सकुंल}]]^a$

& since (व चूंकि) $t_{3/4} = 2t_{1/2}$

so (अतः) $a = 1$

$$t_{1/2} = \frac{\ln 2}{k'} = \frac{\ln 2}{k[H^+]^b}$$

On doubling concentration of $[H^+]$ ion $t_{1/2}$ gets half
so $b = 1$

($[H^+]$ आयन की सान्द्रता दुगुनी करने पर $t_{1/2}$ आधा हो जाता है, अतः $b = 1$)

7. Let at 20 C rate constant (माना 20 C पर दर नियतांक) $= k$
then at 3 C rate constant (तो 3 C पर दर नियतांक) $= k/3$

$$\ln \frac{k}{k/3} = \frac{E_a}{R} \left[\frac{1}{276} - \frac{1}{293} \right] \Rightarrow E_a = 43.45 \text{ kJ}$$

Let at 40 C rate constant is k_1 then

$$\ln \frac{k_1}{k} = \frac{43.45 \times 10^3}{8.314} \left[\frac{1}{293} - \frac{1}{313} \right]$$

(माना 40 C पर दर नियतांक k_1 है तो)

$$k_1 = 3.125 k$$

so time required for juice to get spoil at 40 C =

$$\frac{64}{3.125} = 20.47 \text{ hr.}$$

(अतः 40 C पर जूस के खराब होने में लगा समय)

8. Given :

$$\frac{k_1}{k_2} = \frac{1}{9}, \quad k_1 = 1.3 \times 10^{-5}$$

$$k_2 = 9k_1$$

$$[A] = [A]_0 e^{-(k_1+k_2)t}$$

$$[C] = \frac{k_2[A]_0}{k_1+k_2} [1 - e^{-(k_1+k_2)t}]$$

$$\frac{[C]}{[A]} = \frac{k_2}{k_1+k_2} [e^{(k_1+k_2)t} - 1] = \frac{9k_1}{10k_1} [e^{10k_1 t} - 1] = 0.537$$

9. $k = 0.16, k_1 = 3.3 \times 10^{-4}$

so $k_2 = k_1/k = 2.0625 \times 10^{-3}$

$$k_1 + k_2 = 0.0023925$$

$$[B]_{\text{eq.}} = \frac{k_1}{k_2} [A]_{\text{eq.}} = \frac{k_1[A]_0}{k_1+k_2}$$

$$\text{given } [B] = \frac{[B]_{\text{eq.}}}{2} = \frac{k_1[A]_0}{2(k_1+k_2)}$$

$$\& [B] = \frac{k_1[A]_0}{k_1+k_2} [1 - e^{-(k_1+k_2)t}]$$

$$\text{so } \frac{1}{2} = 1 - e^{-(k_1+k_2)t} \quad (k_1+k_2)t = \ln 2$$

$$t = 289.71 \text{ sec.} = 4.82 \text{ min.}$$

10. $A \longrightarrow B + C$

$t = 0$ a

$t = 20$ min. $a-x$ x x

$t = \infty$ $-$ a a

$$60(a-x) + 40x - 80x = 5$$

$$40a - 80a = -20$$

on solving (हल करने पर) $a = 0.5, x = 0.25$

so $t_{1/2} = 20 \text{ min.}$

$$\text{Average life} = 1/k = 1.443 t_{1/2} = 28.86 \text{ min.}$$

11. At $t = \infty$ when equilibrium is established

($t = \infty$ पर जब साम्य स्थापित होता है।)

$$k = \frac{[P]}{[A]} = \frac{7}{3} = 2.33$$

$$\& \frac{k_1}{k_{-1}} = 2.33 \Rightarrow k_1 = 2.33 k_{-1}$$

$$[A] = \frac{k_2[A]_0}{k_1+k_2} [1 - e^{-(k_1+k_2)t}]$$

$$0.725 = \frac{1}{3.33} [1 + 2.33 e^{-3.33 k_{-1} \times 3600}]$$

$$k_{-1} = 4.16 \times 10^{-5} \text{ sec}^{-1}$$

$$k_1 = 2.33 k_{-1} = 9.7 \times 10^{-5} \text{ sec}^{-1}$$

13. $\text{CH}_3\text{OCH}_3 \longrightarrow \text{CH}_4 + \text{CO} + \text{H}_2$

$t = 0$ 0.4

$t = 4.5 \text{ hr.}$ 0.11 0.29 0.29 0.29

$$kt = \ln \frac{P_0}{P} \Rightarrow 4.78 \times 10^{-3} \times 4.5 \times 60 = \ln \frac{0.4}{P}$$

$$P = 0.11 \text{ atm}$$

at $t = 0$ $P_0 = 0.4$

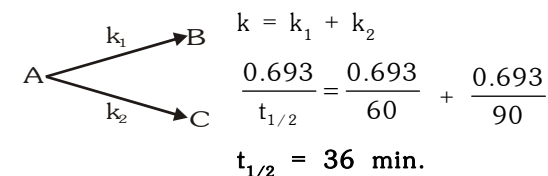
$$M_0 = 46$$

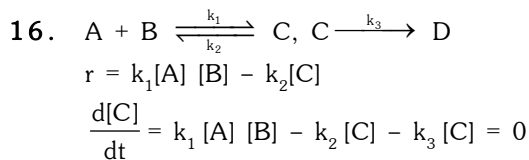
at $t = 4.5 \text{ hr.}$ $P = 0.11 + 0.29 \times 3 = 0.98 \text{ atm}$

$$M = \frac{0.11 \times 46 + 0.29(16 + 28 + 2)}{0.98} = 18.77$$

$$\frac{r_0}{r} = \frac{P_0}{P} \sqrt{\frac{M}{M_0}} = \frac{0.4}{0.98} \sqrt{\frac{18.77}{46}} = 0.26$$

14.





$$[C] = \frac{k_1[A][B]}{k_2 + k_3}$$

$$\frac{d[D]}{dt} = r = k_1[A][B] - k_2 \frac{k_1[A][B]}{k_2 + k_3}$$

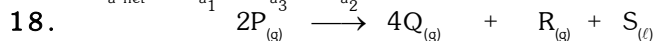
$$r = \frac{k_1 k_3 [A][B]}{k_2 + k_3}$$

$$\text{since } k_2 \gg k_3$$

$$k_{\text{net}} = \frac{k_1 k_3}{k_2}$$

so $A_{\text{net}} = \frac{A_1 A_3}{A_2}$

$$(E)_{a_{\text{net}}} = E_{a_1} + E_{a_3} - E_{a_2}$$



$$\begin{array}{l} t = 0 \quad P_0 \\ t = 30 \text{ min. } P_0 - P \quad 2P \quad P/2 \\ t = \infty \quad - \quad 2P_0 \quad P_0/2 \end{array}$$

so $P_0 - P + 2P + P/2 = 317 - 32.5$

i.e. $P_0 + 1.5 P = 284.5 \dots\dots\dots(i)$

& $2.5 P_0 = 617 - 32.5 = 584.5$

so $P_0 = 233.8$

$$P = 33.8$$

$$k_{30} = \ln \frac{233.8}{200} \Rightarrow k = 0.0052$$

At $t = 75 \text{ min}$

$$0.0052 \quad 75 = \ln \frac{233.8}{P_0 - P}$$

$$P - P = 158.23 \Rightarrow P = 75.57$$

$$P_T = 32.5 + P_0 + 1.5 P = 347.155 + 32.5$$

$$P_T = 379.65 \text{ mm Hg}$$

(ii) $0.0052 \quad t = \ln 8$

$$t = 399.89 \text{ min.}$$



$$t = 0 \quad a$$

$$t = 10 \text{ min. } a - x$$

$$\text{v.f. of } B^{n+} = 2$$

$$\text{v.f. of } B^{(n+4)+} = 5$$

Let normality of reducing agent (माना अपचायक की नॉर्मलता) = N

so $2a = 25 N$

$$2(a - x) + 5x = 32 N$$

$$2a + 3x = 32 N \quad x = \frac{7}{3} N$$

$$k_{10} = \ln \frac{a}{a-x} = \ln \frac{12.5N}{12.5N - \frac{7}{3}N}$$

$$k = 0.02 \text{ min}^{-1}.$$

20. For reaction 1 (अभिक्रिया 1 के लिए)

$$k_2 = k_1 e^{+E_a/R \left(\frac{1}{T_1} - \frac{1}{T} \right)} = 2.79 \cdot 10^{-3} e^{6000 \left(\frac{1}{509} - \frac{1}{T} \right)}$$

For reaction 2 (अभिक्रिया 2 के लिए)

$$k_2 = 1.52 \cdot 10^{-4} e^{12250 \left(\frac{1}{510} - \frac{1}{T} \right)}$$

For given condition (दी गयी परिस्थिति के लिए)

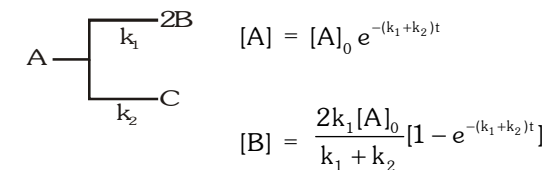
$$2.79 \cdot 10^{-3} e^{6000 \left(\frac{1}{509} - \frac{1}{T} \right)} = 1.52 \cdot 10^{-4} e^{12250 \left(\frac{1}{510} - \frac{1}{T} \right)}$$

$$18.355 = e^{12250 \left(\frac{1}{510} - \frac{1}{T} \right) - 6000 \left(\frac{1}{509} - \frac{1}{T} \right)}$$

$$\ln 18.355 = 12.33 - \frac{6250}{T} = 2.9$$

$$T = 670.6 \text{ K} = 397.6 \text{ } ^\circ\text{C}$$

21.



since V & T are constant (चूंकि V व T नियत हैं) P α moles

$$\text{at } t = 0, P = 1 \text{ atm so}$$

$$[A]_0 = 1$$

$$t = 10 \text{ sec. } P = 1.4 \text{ atm so}$$

$$\text{at } t = 10, [A] + [B] + [C] = 1.4 \dots(2)$$

$$t = \infty P = 1.5 \text{ atm} \dots(3)$$

at $t = \infty, [B] + [C] = 1.5$

from equation (समीकरण (3) से) (3)

$$\frac{2k_1}{k_1+k_2} + \frac{k_2}{k_1+k_2} = 1.5$$

$$\frac{2k_1+k_2}{k_1+k_2} = 1.5$$

$$1 + \frac{k_1}{k_1+k_2} = 1.5$$

$$k_1 = k_2 \dots (4)$$

from equation (समीकरण से) (2) & (4)

$$e^{-(k_1+k_2)t} + \frac{2k_1}{k_1+k_2} (1 - e^{-(k_1+k_2)t}) + \frac{k_2}{k_1+k_2} (1 - e^{-(k_1+k_2)t}) = 1.4$$

$$t = 10 \text{ sec} \text{ \& } k_1 = k_2 \text{ so}$$

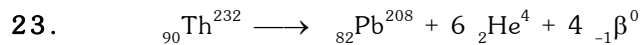
$$e^{-20k_1} + 1 - e^{-20k_1} + 0.5 - 0.5e^{-20k_1} = 1.4$$

$$0.1 = 0.5 e^{-20k_1}$$

$$0.2 = e^{-20k_1}$$

$$20k_1 = 1.6094$$

$$k_1 = 0.0804 = k_2$$



$$t = 0 \text{ a}$$

$$\text{time } t \quad a - x \quad 6x$$

given :

$$a - x = \frac{5 \times 10^{-7}}{232} = 2.155 \times 10^{-9} \text{ mole}$$

$$6x = \frac{8 \times 10^{-5}}{22400} \Rightarrow x = 5.9523 \times 10^{-10} \text{ mole}$$

so $a = 2.75 \times 10^{-9}$

$$k = \frac{0.693}{1.39 \times 10^{10}}$$

$$k \quad t = \ln \frac{a}{a-x}$$

$$\frac{0.693}{1.39 \times 10^{10}} = \ln \frac{2.75 \times 10^{-9}}{2.155 \times 10^{-9}} = 0.2438$$

$$t = 4.89 \times 10^9 \text{ year}$$

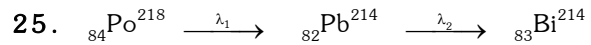
24. $k = \frac{0.693}{8}$

$$kt = \ln \frac{A_0}{A} = \frac{0.693}{8} \times 4 = \ln \frac{A_0}{A}$$

$$\frac{A}{A_0} = 0.707$$

Total activity is 70.7% of the original activity but only 67.7% found in the thysoid so mass of stable iodide ion had migrated to the thyroid gland is (कुल सक्रियता वास्तविक सक्रियता की 70.7% है लेकिन केवल 67.7% थाइरॉइड में पाया गया। अतः थाइरॉइड में प्रवेशित होने वाले स्थायी आयोडाइड का द्रव्यमान)

$$= \frac{67.7}{70.7} \times 0.1 = 0.09575 \text{ mg}$$



Number of nuclei of Pb^{214} at time t are N_2

$$= \frac{\lambda_1 N_0}{(\lambda_2 - \lambda_1)} [e^{-\lambda_1 t} - e^{-\lambda_2 t}]$$

(समय t पर Pb^{214} के नाभिकों की संख्या N_2)

For max. value of N_2 (N_2 के अधिकतम मान कि लिए)

$$\frac{dN_2}{dt} = 0$$

so $t = \frac{1}{(\lambda_2 - \lambda_1)} \ln \frac{\lambda_2}{\lambda_1}$

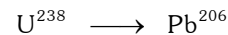
$$\text{when } \lambda_2 = \frac{0.693}{2.68}, \lambda_1 = \frac{0.693}{3.05},$$

on putting these values (यह मान रखने पर)

$$t = 31.87 \ln \frac{3.05}{2.68} = 4.12 \text{ min}$$

26. Let the mass of sample in a g & initial mass of U^{238} is w g the

(माना नमूने का द्रव्यमान g में है व U^{238} का प्रारम्भिक द्रव्यमान w g है।)



$$t = 0 \quad w$$

$$t \quad w-x \quad \frac{206x}{2.68}$$

given $w - x = 0.5 \text{ a}$

$$\frac{206x}{238} = \frac{2.425 \text{ a}}{100} \times 0.93 = 0.0225525 \text{ a}$$

$$x = 0.026 \text{ a}$$

so $w = 0.526 \text{ a}$

$$\lambda t = \ln \frac{w}{w-x}$$

$$1.52 \times 10^{-10} \quad t = \ln \frac{0.526 \text{ a}}{0.5 \text{ a}}$$

$$t = 3.33 \times 10^8 \text{ year.}$$

- rate of appearance of HI = $\frac{1}{2} \frac{d[\text{HI}]}{dt}$
 rate of formation of $\text{H}_2 = \frac{-d[\text{H}_2]}{dt}$
 rate of formation of $\text{I}_2 = \frac{-d[\text{I}_2]}{dt}$
 hence $\frac{-d[\text{H}_2]}{dt} = -\frac{d[\text{I}_2]}{dt} = \frac{1}{2} \frac{d[\text{HI}]}{dt}$
 or $-\frac{2d[\text{H}_2]}{dt} = -\frac{2d[\text{I}_2]}{dt} = \frac{d[\text{HI}]}{dt}$
- Order is the sum of the power of the concentrations terms in rate law expression.
 hence the order of reaction is = 1 + 2 = 3
- For a zero order reaction.
 rate = k [A] i.e., rate = k
 hence unit of k = M.sec⁻¹
 For a first order reaction
 rate = k [A]
 k = M.sec⁻¹ / M = sec⁻¹
- $Rt = \log C_0 - \log C_t$
 It is clear from the equation that if we plot a graph between $\log C_t$ and time, a straight line with a slope equal to $-\frac{k}{2.303}$ and intercept equal to $\log[A_0]$ will be obtained.
- It is zero order reaction
 Note : Adsorption of gas on metal surface is of zero order.
- In equation $K = Ae^{-E_a/RT}$; A = Frequency factor
 K = velocity constant,
 R = gas constant and E_a = energy of activation
- $r = k[\text{O}_2][\text{NO}]^2$. When the volume is reduced to 1/2, the conc. will double.
 \therefore New rate = $k[2\text{O}_2][2\text{NO}]^2 = 8 k [\text{O}_2] [\text{NO}]^2$
 The new rate increases to eight times of its initial.
- $\therefore \frac{\text{Rate}_2}{\text{Rate}_1} = \frac{k[2\text{A}]^n [\frac{1}{2}\text{B}]^m}{k[\text{A}]^n [\text{B}]^m} = [2]^n [\frac{1}{2}]^m = 2^n \cdot 2^{-m} = 2^{n-m}$
- As the concentration of reactant decreases from 0.8 to 0.4 in minutes hence the $t_{1/2}$ is 15 minutes. To fall the concentration from 0.1 to 0.025 we need two half lives i.e., 30 minutes.
- The velocity constant depends on temperature only. It is independent of concentration of reactants.
- $N_t = N_0 \left(\frac{1}{2}\right)^n$ where n is number of half life periods.
 $n = \frac{\text{total time}}{\text{half life}} = \frac{24}{4} = 6$
 $\therefore N_t = 200 \left(\frac{1}{2}\right)^6 = 3.125\text{g}$
- Enthalpy of reaction (ΔH) = $E_{a(f)} - E_{a(b)}$
 for an endothermic reaction $\Delta H = +\text{ve}$ hence for ΔH to be negative.
 $E_{a(b)} < E_{a(f)}$
- The molecularity of a reaction is the number of reactant molecules taking part in a single step of the reaction.
 Note : The reaction involving two different reactant can never be unimolecular.
- $t_{1/4} = \frac{2.303}{K} \log \frac{1}{3/4} = \frac{2.303}{K} \log \frac{4}{3}$
 $= \frac{2.303}{K} (\log 4 - \log 3) = \frac{2.303}{K} (2 \log 2 - \log 3)$
 $= \frac{2.303}{K} (2 \times 0.301 - 0.4771) = \frac{0.29}{K}$
- Since the reaction is 2nd order w.r.t. CO. Thus, rate law is given as
 $r = k [\text{CO}]^2$
 Let initial concentration of CO is a i.e. $[\text{CO}] = a$
 $\therefore r_1 = k(a)^2 = ka^2$
 when concentration becomes doubled, i.e.,
 $[\text{CO}] = 2a$
 $\therefore r_2 = k(2a)^2 = 4ka^2 \quad \therefore r_2 = 4r_1$
 So, the rate of reaction becomes 4 times.
- In Arrhenius equation $K = Ae^{-E/RT}$, E is the energy of activation, which is required by the colliding molecules to react resulting in the formation of products.
- (i) $\text{NO(g)} + \text{Br}_2(\text{g}) \rightleftharpoons \text{NOBr}_2(\text{g})$
 (ii) $\text{NOBr}_2(\text{g}) + \text{NO(g)} \longrightarrow 2\text{NOBr(g)}$
 Rate law equation = $K[\text{NOBr}_2] [\text{NO}]$
 But NOBr_2 is intermediate and must not appear in the rate law equation
 from 1st step $K_c = \frac{[\text{NOBr}_2]}{[\text{NO}][\text{Br}_2]}$
 $\therefore [\text{NOBr}_2] = K_c [\text{NO}] [\text{Br}_2]$
 \therefore Rate law equation = $k \cdot K_c [\text{NO}]^2 [\text{Br}_2]$
 hence order of reaction is 2 w.r.t. NO.

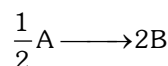
19. $\Delta H_R = E_f - E_b = 180 - 200 = -20 \text{ kJ/mol}$

The nearest correct answer given in choices may be obtained by neglecting sign.

20. For a first order reaction $t_{1/2} = \frac{0.693}{K}$ i.e., for a first order reaction $t_{1/2}$ does not depend up on the concentration. From the given data, we can say that order of reaction with respect to B = 1 because change in concentration of B does not change half life.

Order of reaction with respect to A = 1 because rate of reaction doubles when concentration of B is double keeping concentration of A constant.
 \therefore Order of reaction = 1 + 1 = 2 and units of second order reaction are $\text{L mol}^{-1} \text{sec}^{-1}$.

21. The rates of reactions for the reaction



can be written either as

$$-2 \frac{d}{dt}[A] \text{ with respect to 'A'}$$

or $\frac{1}{2} \frac{d}{dt}[B] \text{ with respect to 'B'}$

from the above, we have

$$-2 \frac{d}{dt}[A] = \frac{1}{2} \frac{d}{dt}[B]$$

or $-\frac{d[A]}{dt} = \frac{1}{4} \frac{d[B]}{dt}$

22. For first order reaction

$$k = \frac{2.303}{t} \log \frac{100}{100 - 99}$$

$$\frac{0.693}{693} = \frac{2.303}{t} \log \frac{100}{1}$$

$$\frac{0.693}{693} = \frac{2.303 \times 2}{t}$$

$$t = 46.06 \text{ minutes}$$

23. Since the slow step is the rate determining step hence if we consider option (1) we find

$$\text{Rate} = k[\text{Cl}_2][\text{H}_2\text{S}]$$

Now if we consider option (2) we find

$$\text{Rate} = k[\text{Cl}_2][\text{HS}^-] \dots\dots\dots(i)$$

From equation (i)

$$k = \frac{[\text{H}^+][\text{HS}^-]}{\text{H}_2\text{S}} \text{ or } [\text{HS}^-] = \frac{k[\text{H}_2\text{S}]}{\text{H}^+}$$

Substituting this value in equation (i) we find

$$\text{Rate} = k[\text{Cl}_2] K \frac{k[\text{H}_2\text{S}]}{\text{H}^+} = k' \frac{[\text{Cl}_2][\text{H}_2\text{S}]}{[\text{H}^+]}$$

hence only, mechanism (i) is consistent with the given rate equation.

24. For the reaction



given $t_{1/2} = 1 \text{ hour}$

for a zero order reaction

$$t_{\text{completion}} = \frac{[A_0]}{k} = \frac{\text{initial conc.}}{\text{rate constant}}$$

$$\therefore t_{1/2} = \frac{[A_0]}{2k}$$

or $k = \frac{[A_0]}{2t_{1/2}} = \frac{2}{2 \times 1} = 1 \text{ mol lit}^{-1} \text{ hr}^{-1}$

Further for a zero order reaction

$$k = \frac{dx}{dt} = \frac{\text{change in concentration}}{\text{time}}$$

$$1 = \frac{0.50 - 0.25}{\text{time}}$$

$$\therefore \text{time} = 0.25 \text{ hr.}$$

25. Since for every 10 C rise in temperature rate doubles for 50 C rise in temp increase in reaction rate = $2^5 = 32$ times.

26. $k_1 = A_1 e^{-E_{a1}/RT} \dots\dots\dots(i)$

$$k_2 = A_2 e^{-E_{a2}/RT} \dots\dots\dots(ii)$$

On dividing eq. (i) from eq. (ii)

$$\frac{k_1}{k_2} = \frac{A_1}{A_2} (E_{a2} - E_{a1}) / RT \dots\dots\dots(iii)$$

Given $E_{a2} = 2E_{a1}$,

On substituting this value in eqn. (iii)

$$k_1 = k_2 A e^{E_{a1}/RT}$$

27. For a first order reaction

$$k = \frac{2.303}{t} \log \frac{a}{a-x} = \frac{2.303}{40} \log \frac{0.1}{0.025}$$

$$= \frac{2.303}{40} \log 4 = \frac{2.303 \times 0.6020}{40} = 3.47 \times 10^{-7}$$

$$R = K(A)^1 = 3.47 \times 10^{-2} \times 0.01 = 3.47 \times 10^{-4}$$