CHEMICAL KINETICS

Q.1 A flask contains a mixture of compound A and B both compounds decompose by first order kinetics. The half-lives are 27 min for A and 9 min for B. If the concentrations of A and B are equal initially, how long will it take for the concentration A to be four times that B.

(A) 27 min (B) 9 min (C) 18 min (D) 54 min

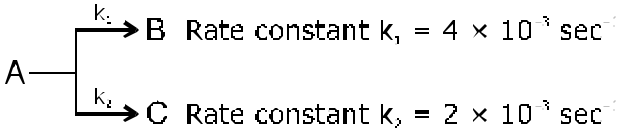
Q.2 For a homogeneous gaseous reaction
2A ? B + C + D the initial pressure was p_0 while pressure after time t, was p. The rate constant k in terms of p_0, p and t.

(A) $\frac{1}{t}\log\frac{p_0}{3p_0 ? p}$ (B) $\frac{1}{t}\log\frac{p_0}{3p_0 ? 2p}$

(C) $\frac{1}{t}\log\frac{p_0}{3p_0 ? 4p}$ (D) $\frac{1}{t}\log\frac{2p_0}{3p_0 ? 4p}$

Q.3 The ratio of the the time $t_{1/2}$ / $t_{3/4}$ for IInd order reaction is given by ..... where ($t_{3/4}$ is the time required for concentration to become $\frac{1}{4}$ of original concentration)

(A) $\frac{1}{2}$ (B) $\frac{1}{5}$ (C) 2 (D) 5

Q.4 

Activation energy For path A ? B; E_{aA-B} = 120 kJ
and Activation energy For path B ? C; E_{aB-C} = 60 kJ
the overall activation energy of the reaction is

(A) 100 kJ (B) 120 kJ (C) 80 kJ (D) 90 kJ

Q.5 The reaction X ? Product follows first order kinetics. In 40 minutes the concentration of X changes from 0.1 M to 0.025 M. Then the rate of reaction when concentration of X is 0.01 M.

(A) 1.73×10^{-4} M min^{-1} (B) 3.47×10^{-5} M min^{-1}
(C) 3.47×10^{-4} M min^{-1} (D) 1.73×10^{-5} M min^{-1}

Q.6 For the first order decomposition reaction of N_2O_5 written are

$2N_3O_5$??? $4NO_2 + O_2$ rate = $K[N_2O_5]$

N_2O_5 ??? $2NO_2 + O_2$ rate = $K'[N_2O_5]$

Which of the followring facts is true.

(A) K = K' (B) K > K' (C) K > 2K' (D) 2K = K'

Q.7 For a first order reaction, the ratio of times to complete 99.9% and halt of the reaction is

(A) 8 (B) 9 (C) 10 (D) 12

Q.8 The plot of in K and $\frac{1}{T}$ is linear with a slope of

(A) $\frac{Ea}{R}$ (B) $-\frac{Ea}{R}$ (C) $\frac{Ea}{2.303R}$ (D) $-\frac{Ea}{2.303R}$

Q.9 The rate constant for the reaction, $2N_2O_5$??? $4NO_2 + O_2$ is 3×10^{-5} sec^{-1} if the rate is 2.40×10^{-5} mol L^{-1} s^{-1} then the conc. of N_2O_5 is

(A) 1.4 (B) 1.2 (C) 0.4 (D) 0.8

Q.10 The rate of a certain reaction depends on concentration according to equation :

$$-\frac{dx}{dt} = \frac{mx^2}{1 ? nx^2}$$

the order of reaction when concentration of x is very-very low.

(A) 0 (B) Ist (C) IInd (D) None

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	A	A	C	D	C	B	D	C

SOLUTIONS (CHEMICAL KINETICS)

Ans.1 $N = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$ where N is conc. at any time t

& N_0 is conc. at t = 0.

? $N_A = N_0 \left(\frac{1}{2}\right)^{\frac{t}{27}}$ ..... (i)

? $N_B = N_0 \left(\frac{1}{2}\right)^{\frac{t}{9}}$ ..... (ii)

Devide eq. (ii) by eq. (i)

? $\frac{N_B}{N_B} = \left(\frac{1}{2}\right)^{\frac{t}{27}-\frac{t}{9}}$ $N_A = 4N_B$

? $4\frac{N_B}{N_B} = \left(\frac{1}{2}\right)^{-\frac{2t}{27}}$

? $4 = \left(\frac{1}{2}\right)^{-\frac{2t}{27}}$

? $(2)^2 = \left(\frac{1}{2}\right)^{-\frac{2t}{27}}$

? $2 = \frac{2t}{27}$

? t = 27 min. [A]

Ans.2

	2A	???	B	+	C	+	D
t = 0	p_0		0		0		0
t = t	p_0-2x		x		x		x

? $p_0 + x = p$

? $x = p - p_0$

? $K = \frac{2.303}{t} \log \frac{p_0}{p_0 - 2x}$

? $K = \frac{2.303}{t} \log \frac{p_0}{p_0 - 2(p - p_0)}$

? $K = \frac{2.303}{t} \log \frac{p_0}{3p_0 - 2p}$ [B]

Ans.3 $\frac{t_{1/2}}{t_{3/4}} = ?$ We know that $t_{½}$ for n^{th} order reaction is given by

$t_{½} \propto 2^{n-1}$ ..... (i)

similarly $t_{¾} \propto 4^{n-1}$ ..... (ii)

Devide eq. (ii) by eq. (i)

$$\therefore \quad \frac{t_{½}}{t_{¾}} = \frac{2^{n-1}}{4^{n-1}} \qquad n = 2 \text{ for II}^{nd} \text{ order reaction}$$

$$\therefore \quad \frac{t_{½}}{t_{¾}} = \frac{2^{2-1}}{4^{2-1}} = \frac{2}{4} = \frac{1}{2} \qquad [A]$$

Ans.4 A → B $k_1 = 4 \times 10^{-3}$ $E_{a(A\to B)} = 120$ kJ

A → C $k_2 = 2 \times 10^{-3}$ $E_{a(A\to C)} = 60$ kJ

$$\therefore \quad K = Ae^{-Ea/RT}$$

$$K_{overall} = K_1 + K_2$$

$$Ae^{-Ea/RT} = Ae^{-\frac{E_{aA\to B}}{RT}} + Ae^{-\frac{E_{aB\to C}}{RT}}$$

On diff. w.r.t. Temp.

$$\therefore \quad Ea = \frac{K_1 E_{aA\to B} + K_2 E_{aB\to C}}{K_1 + K_2}$$

$$\therefore \quad = \frac{4 \times 10^{-3} \times 120 + 2 \times 10^{-3} \times 60}{6 \times 10^{-3}}$$

$$\therefore \quad = \frac{480 + 120}{6}$$

$$\therefore \quad = \frac{600}{6} = 100 \text{ kJ} \qquad [A]$$

Ans.5

	X	??	P
t = 0	0.1		0
t = 40	0.025		

$$K = \frac{2.303}{t} \log \frac{0.1}{.025}$$

$$\therefore \quad \frac{2.303}{40} \log \frac{1000}{10 \times 25} \qquad \therefore \quad \frac{2.303}{40} \log 2^2$$

$$\therefore \quad \frac{2 \times 2.303}{40} \times .3010 \qquad \therefore \quad \frac{2}{40} \times .693$$

Rate = K(A)'

? $\frac{1}{20} \times 693 \times 1 \times 10^{-5}$? $\frac{1}{20} \times .693 \times .01$

? 34.7×10^{-5} M min^{-1} ? 3.47×10^{-4} M min^{-1} [C]

Ans.6 $2N_2O_5$??? $4NO_2 + O_2$ rate = K $[N_2O_5]$

N_2O_5 ??? $2NO_2 + \frac{1}{2}O_2$ rate = K' $[N_2O_5]$

$$-\frac{1}{2}\frac{d[N_2O_5]}{dt} = \frac{1}{4}\frac{d[NO_2]}{dt} = \frac{1}{1}\frac{d[O_2]}{dt} = K\,[N_2O_5]$$

$$-\frac{d[N_2O_5]}{dt} = \frac{1}{2}\frac{d[NO_2]}{dt} = 2\frac{d[O_2]}{dt} = K'\,[N_2O_5]$$

$K\,[N_2O_5] = K'\,[N_2O_5]$

$2K = K'$

Ans.7 $t_{99.9\%} = \frac{2.303}{K} \log \frac{a}{a ? \frac{99.9}{100}a}$

? $\frac{2.303}{K} \log \frac{a ? 100}{0.1a}$

? $\frac{2.303}{K} \log 1000$

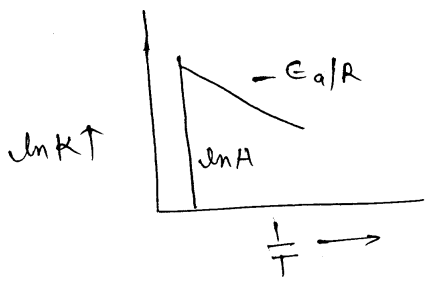
? $10\,[\frac{2.303}{K} \log 2]$? $10\ t_{½}$

$\frac{t_{99.9}}{t_{50\%}}$? 10

Ans.8 $K = Ae^{-Ea/RT}$

$\ln K = \ln A - \frac{Ea}{RT}$? $\ln K = -\frac{Ea}{R} \cdot \frac{1}{T} + \ln A$

$y = C - mx$? $y = -mx + C$



[B]

Ans.9 $2N_2O_5 \rightarrow 4NO_2 + O_2$

rate = $K[A]^n$ $\quad n = 1$

$2.40 \times 10^{-5} = 3 \times 10^{-5}\,[A]'$

$$[A] = \frac{2.40 \times 10^{-5}}{3 \times 10^{-5}} = 0.8 \qquad [D]$$

Ans.10 $\quad -\frac{dx}{dt} = \frac{mx^2}{1 - nx^2} \qquad x <<< 1 \qquad 1 + nx^2 \approx 1$

$\Rightarrow \quad -\frac{dx}{dt} = nx^2$

$\Rightarrow \quad$ rate $\propto x^2$

$\Rightarrow \quad n = 2$

Order of reaction is 2 (II^{nd}) [C]