

Question Number –1

An organic compound undergoes first -order decomposition. The time taken for its decomposition to $1/8$ and $1/10$ of its initial concentration are $t_{1/8}$ and $t_{1/10}$ respectively. What is the value of $\left[\frac{t_{1/8}}{t_{1/10}} \right] \times 10$? ($\log_{10} 2 = 0.3$) $k = \frac{2.303}{t} \log \frac{[A_0]}{[A]}$

Answer: (9)

Solution

$$t_{1/8} \Rightarrow \text{Let } [A_0] = 1$$

$$[A] = \frac{1}{8} \times 1$$

$$t_{1/8} = \frac{2.303}{k} \log \frac{1}{1/8}$$

$$t_{1/8} = \frac{2.303}{k} \log 8$$

$$t_{1/8} = \frac{2.303}{k} \log 2^3$$

$$t_{1/8} = 3 \times \frac{2.303}{k} \log 2$$

$$t_{1/10} \Rightarrow [A_0] = 1$$

$$[A] = \frac{1}{10} \times 1 = 1/10$$

$$t_{1/10} = \frac{2.303}{k} \log \frac{1}{1/10}$$

$$t_{1/10} = \frac{2.303}{k} \log 10$$

$$\left[\frac{t_{1/8}}{t_{1/10}} \right] \times 10 = \frac{\left(\frac{2.303 \times 3 \log 2}{k} \right)}{\left(\frac{2.303}{k} \right)} \times 10 = 9$$

Question Number –2

A drop of solution of volume 0.05 ml contains 3×10^{-6} mole of H^+ . If the rate constant for the disappearance of H^+ is $10^7 \text{ mol L}^{-1}\text{s}^{-1}$. How many nanoseconds it required for H^+ in drop to disappear?

Answer: (6)

Solution

The given reaction is zero order reaction

For zero order reaction

$$t = \frac{\text{concentration used}}{\text{rate constant}}$$

$$\text{or } t = \frac{\frac{3 \times 10^{-6}}{0.05} \times 10^3}{10^7} = 6 \times 10^{-9} \text{ seconds} = 6 \text{ nanoseconds}$$

Question Number –3

For the reaction, $A(g) + 2B(g) \rightarrow C(g) + D(g)$

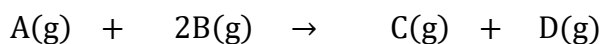
$$\frac{dx}{dt} = k[A][B]^2$$

Initial pressure of A and B are respectively 0.60 atm and 0.80 atm. At a time when pressure of C is 0.20 atm, ratio of initial rate and final rate is y. What is the value of y?

Answer: (6)

Solution

$$\left(\frac{dx}{dt}\right)_{\text{initial}} = k p_A p_B^2 = k(0.60)(0.80)^2$$



$$0.60 \qquad 0.80 \qquad 0 \qquad 0$$

$$(0.60 - x) \quad (0.80 - 2x) \qquad x \qquad x$$

$$p_C = X = 0.20 \text{ atm}$$

$$\therefore p_A = 0.60 - 0.20 = 0.40 \text{ atm}$$

$$p_B = 0.80 - 0.40 = 0.40 \text{ atm}$$

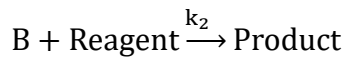
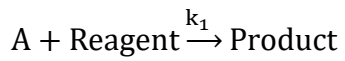
$$\therefore \left(\frac{dx}{dt}\right)_{\text{final}} = k p_A p_B^2 = k(0.40)(0.40)^2$$

$$\therefore \frac{\left(\frac{dx}{dt}\right)_{\text{initial}}}{\left(\frac{dx}{dt}\right)_{\text{final}}} = \frac{k(0.60)(0.80)^2}{k(0.40)(0.40)^2} = 6$$

Thus, $y=6$

Question Number –4

In the following first order competing reactions



The ratio of k_1/k_2 if only 50% of B will have been reacted when 94% of A has been reacted is

Answer: (4)

Solution

$$t = \frac{2.303}{k_2} \log \frac{100}{50}$$

$$\text{and } t = \frac{2.303}{k_1} \log \frac{100}{6}$$

$$\frac{k_1}{k_2} = \frac{\log 100 - \log 6}{\log 2} = 4$$

Question Number –5

If the rate of reaction is $2.6 \times 10^{-3} \text{ mol L}^{-1}\text{s}^{-1}$ at 50°C and

$7.02 \times 10^{-2} \text{ mol L}^{-1}\text{s}^{-1}$ at 80°C , then what will be the temperature coefficient of the reaction?

Answer: (3)

Solution

$$\frac{r_2}{r_1} = (\mu)^{\Delta T/10}$$

$$\frac{7.02 \times 10^{-2}}{2.6 \times 10^{-3}} = (\mu)^{30/10}$$

$$\Rightarrow 27 = \mu^3$$

$$\therefore \mu = 3$$

Question Number – 6

In an enzymatic solution of the fermentation of sugar, it is observed that on doubling the time the fractional reduction of the reactant concentration also doubles. In an experiment, initially 0.12 M the concentration of the sugar is reduced to 0.06 M in 10 h and to 0.03 M in 20h. Rate constant of the reaction is $x \times 10^{-5} \text{s}^{-1}$. The value of x is

Answer: (1.92)

Solution:

Since, doubling the time doubles the fractional reduction of the reactant concentration, the reaction must be of first order,

$$0.12\text{M} \xrightarrow{t=10 \text{ h} = t_{50}} 0.06\text{M}$$

$$\xrightarrow{t=20 \text{ h} = 2 \times t_{50}} 0.03\text{M}$$

$$\Rightarrow k = \frac{0.693}{10\text{h}} = \frac{0.693}{10 \times 3600\text{s}}$$

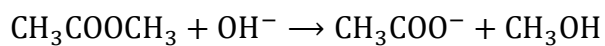
$$= 1.92 \times 10^{-5} \text{s}^{-1}$$

$$= x \times 10^{-5} \text{s}^{-1}$$

$$\therefore x = 1.92$$

Question Number – 7

The hydrolysis of methyl acetate in alkaline solution,



followed rate = $[\text{CH}_3\text{COOCH}_3][\text{OH}^-]$, with $k = 0.137 \text{ L mol}^{-1}\text{s}^{-1}$ at 25°C . A reaction mixture was prepared to have initial concentrations of methyl acetate and OH^- of 0.05M each. Initial rate of the reaction is found to be $a \times 10^{-4}\text{Ms}^{-1}$. The value of 'a' will be

Answer: (3.42)

Solution:

$$\text{Rate} = k[\text{CH}_3\text{COOCH}_3][\text{OH}^-]$$

$$= (0.137 \text{ L mol}^{-1}\text{s}^{-1}) \times (0.05 \text{ mol L}^{-1})^2$$

$$= 3.42 \times 10^{-4} \text{ mol l}^{-1}\text{s}^{-1}$$

$$= a \times 10^{-4} \text{ M s}^{-1}$$

$$\therefore a = 3.42$$

Question Number – 8

The following data were obtained at a certain temperature for decomposition of ammonia in contact with tungsten:

$\rho(\text{mm Hg})$	50	100	200
Relative $t_{1/2}$	3.64	1.82	0.91

The order of reaction is

Answer: (2)

Solution:

We know,

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

$$\frac{3.64}{1.82} = \left(\frac{100}{50}\right)^{n-1}$$

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

$$\text{or } (2)^1 = (2)^{n-1}$$

$$\Rightarrow 1 = n - 1$$

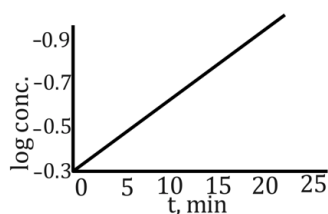
$$n = 2$$

\therefore Order of reaction = 2

Question Number – 9

Using the data sheet and its plot, rate constant (in min^{-1}) of the concerned reaction will be.....

t min	conc. M	log conc.
0.00	0.500	-0.301
5.00	0.389	-0.410
10.00	0.303	-0.519
15.00	0.236	-0.627
20.00	0.184	-0.735
25.00	0.143	-0.845



Answer: (0.05)

Solution:

$$\text{Slope} = \frac{0.845 - 0.310}{25.00 - 0.00}$$

$$= -0.0214 \text{ min}^{-1}$$

$$\Rightarrow k = -2.303 \times \text{slope}$$

$$= -2.303 \times (-0.0214 \text{ min}^{-1})$$

$$= 0.05 \text{ min}^{-1}$$

\therefore The reaction follows the first order kinetics.

Question Number – 10

The decomposition of N_2O into N_2 and O in presence of gaseous argon follows the second order kinetics with, $k = (5 \times 10^{11} \text{ L mol}^{-1} \text{ s}^{-1}) \times e^{-29000\text{K}/T}$ The activation energy (in kJ mol^{-1}) of the reaction will be.....

Answer: (241)

Solution:

Comparing,

$k = (5 \times 10^{11} \text{ L mol}^{-1} \text{ s}^{-1}) \times e^{29000\text{K}/T}$ with Arrhenius equation, $k = A. e^{-E_a/Rt}$

$$\Rightarrow \frac{E_a}{RT} = \frac{29000\text{K}}{T}$$

$$\Rightarrow E_a = (29000 \text{ K}) \times R$$

$$= 29000\text{K} \times 8.314 \text{ J mol}^{-1}\text{K}^{-1}$$

$$= 241106 \text{ J mol}^{-1}$$

$$= 241.10 \text{ kJ mol}^{-1}$$

$$= 241 \text{ kJ mol}^{-1}$$