Chemical Kinetics

Weightage = 08 Marks 1 Mark – 1Q 2Mark -1Q 5 Marks – 1Q

ONE MARK QUESTIONS :

1. For the reaction $2HI \rightarrow H_2+I_2$ Write its molecularity.
   Ans : Two
2. Give an example of zero order reaction .
   Ans : Decomposition of hydrogen iodide on gold surface
   $$2HI_{(g)} \xrightarrow{Au} H_2 + I_2$$
3. What happens to the half life period of a first order reaction, if the initial concentration of reactant is increased?
   Ans : No Change
4. Rate constant of a reaction is $K = 3.4\times10^{-4}$ $Lmol^{-1}S^{-1}$. What is the order of reaction?
   Ans : Second order
5. Rate of a reaction $A\rightarrow B$ increases two times by increasing the concentration 'A' By four times, What is the order of reaction?
   Ans : ½ (or) 0.5
6. A chemical reaction has rate expression Rate = $[A]^2$ [B]. What is its overall order?
   Ans : 3
7. Unit of rate constant of reaction is same as that of its rate. What is order of the reaction?
   Ans : 0 (zero)
8. What is the order for the reaction?
   $$2NH_3\,(g) \xrightarrow[Platinum\ \ catalyst]{1130K} N_2(g) + 3H_2(g)$$
   Ans : zero
9. What is the unit of rate of a reaction ?
   Ans : mol $L^{-1}S^{-1}$
10. What is the SI unit of zero order reaction?
    Ans: mol $L^{-1}S^{-1}$
11. What is the unit of first order reaction?
    Ans : S^{-1}
12. Which step of reaction mechanism decides the order?
    Ans : Slowest step (or) rate determining step.
13. In a reaction $A\rightarrow$ products the rate of reaction is doubled when the concentration of reactant is doubled. What is order of reaction?
    Ans : One (or) 1
14. Define average rate of a reaction.
    Ans: Average rate = $\frac{change\ \ in\ concentration of\ \ \ reactant\ \ (or)product}{time\ \ interval}$
15. In a reaction $2A\rightarrow$ product, the concentration of 'A' decreases from 0.5mol L^{-1} to 0.4 mol L^{-1} in 10 minutes calculate the rate during this interval.
    Ans : Average rate = $\frac{\Delta[A]}{\Delta t}$

$$= \frac{(0.5-0.4)mol\, l^{-1}}{10min}$$

$= 0.01$ mol L^{-1} min^{-1}

16. Mention any 2 factors which influence the rate of reaction?
    Ans : (i) Concentration of reactant
    (ii) Temperature
    (iii)Catalyst.
17. The conversion of molecules X to Y follows second order kinetics, if the concentration of X is increased by three times, how will it affect the rate of formation of Y?
    Ans: Rate $= K \cdot [X]^2$ $X \longrightarrow Y$
    $= K \cdot (3)^2$
    $= 9$ times.
18. What is zero order reaction? Give an example.
    Ans : A reaction in which rate is independent of concentration of reactant is Called zero order reaction.
    Ex : $2NH_3(g) \xrightarrow[1130K]{Pt.catalyst} N_2(g) + 3H_2(g)$
19. What is the first order reaction? Give an example.
    Ans : A reaction in which rate is directly proportional to first power of concentration term is called first order reaction.
    Ex : $2N_2O_5 \longrightarrow 2N_2O_4 + O_2$
20. Explain pseudo first order reaction with an example.
    Ans : Higher order reactions can be converted into first order by changing the experimental conditions such a reaction is called Psuedo first order reaction
    Ex : Inversion of sucrose.

    $$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose.}}{C_6H_{12}O_6}$$

21. Give any two differences between order and molecularity

Molecularity	Order
1. It is defined as the number of reactant molecules taking part in elementary reaction.	1. It is defined as the sum of powers of concentration terms in an experimentally determined rate equation,
2. It is always a whole number	2. Order may be zero, fraction(or) whole Number.

22. Define half life period of a reaction.
    Ans : The time requird to convert half of the reactant into product is called half life period of reaction.
23. Derive integrated rate equation for a first order reaction.
    Ans: Consider first order reaction
    $R \longrightarrow P$
    Rate $\propto [R]$

$$\text{Rate} = K[R]$$

Where, K = Rate constant

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

$$-\frac{d[R]}{[R]} = Kdt$$

$$\frac{d[R]}{[R]} = -Kdt$$

On integration

$$\int \frac{d[R]}{[R]} = -\int k\,dt$$

$$\log_e[R] = -Kt + I \longrightarrow (1) \qquad \text{I= integration constant}$$

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

$$(1) \Rightarrow \log_e[R]_0 = -K(0) + I$$

$$\Rightarrow \log_e[R]_0 = I \longrightarrow (2)$$

Substitute (2) in (1)

$$(1) \Rightarrow \log_e[R] = -Kt + \log_e[R]_0$$

$$Kt = \log_e[R]_0 - \log_e[R]$$

$$Kt = \log_e \frac{[R]_0}{[R]}$$

$$K = \frac{1}{t}\log_e \frac{[R]_0}{[R]}$$

$$K = \frac{2.303}{t}\log_{10} \frac{[R]_0}{[R]}$$

Where t = time interval

$[R]_0$ = Initial concentration

[R] = Equilibrium concentration

24. Derive an expression for the half life period of a first order reaction (or) show that half life period of a first order reaction is independent of initial concentration of the reactant.

Ans : we know that $K = \frac{2.303}{t} \log_{10} \frac{[R]_0}{[R]} \longrightarrow (1)$

Where K = rate constant, t=time

$[R]_0$ = Initial concentration

[R] = equilibrium concentration

When t = $t_{½}$ $R = \frac{[R]_0}{2}$

$$(1) \Rightarrow K = \frac{2.303}{t_{1/2}} \log_{10}2$$

$$K = \frac{2.303 \times 0.3010}{t_{1/2}} = \frac{0.693}{t_{1/2}}$$

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

25. Derive an integrated rate equation for a zero order reaction

$$R \longrightarrow P$$

$$\text{Rate} \propto [R]^0$$

$$\text{Rate} = K.[R]^0 \Rightarrow \text{Rate} = K$$

Where , K = Rate constant

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

$$-d[R] = Kdt$$

$d[R] = -Kdt$

On integration

$\int d[R] = - \int Kdt$

$[R] = -Kt + I \rightarrow (1)$

Where, I = Integration constant

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

$(1) \Rightarrow [R]_0 = -K(0) + I \quad \Rightarrow [R]_0 = I \rightarrow (2)$

Substitute (2) in (1) $\quad (1) \Rightarrow [R] = -Kt + [R]_0$

$Kt = [R]_0 - [R]$

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

T = Time interval $\quad [R]_0$ = Initial concentration

$[R]$ = Equilibrium concentration

26. Derive an expression for the half life period of a zero order reaction (or) show that half life period of zero order reaction is directly proportional to initial concentration of the reactant.

Ans : W.K.T $\quad K = \frac{[R]_0 - [R]}{t} \rightarrow (1)$

K = rate constant $\quad$ t=time

$[R]_0$ =initial concentration

$[R]$ = equilibrium concentration

When $t = t_{1/2} \quad [R] = \frac{[R]_0}{2}$

$[R]_0 - [R] = [R]_0 - \frac{[R]_0}{2} = \frac{[R]_0}{2} \rightarrow (2)$

Substitute (2) in (1)

$(1) \Rightarrow K = \frac{[R]_0}{2t\ 1/2} \quad \therefore \boxed{t_{1/2} = \frac{[R]_0}{2}}$

27. The rate constant of a first order reaction is $3.6 \times 10^{-3} S^{-1}$.Calculate the half life Period.

Ans : $\quad t_{1/2} = \frac{0.693}{K} \quad = \frac{0.693}{3.6 \times 10^{-3} S^{-1}} \quad = 0.1925 \times 10^3$ S

28. The half life period of a first order reaction is 60 minutes. Calculate the rate constant of the reaction.

Ans: $K = \frac{0.693}{t\frac{1}{2}} \quad = \frac{0.693}{60min} \quad \Rightarrow K = 0.01155\ min^{-1}$

29. A certain first order reaction is 75% completed in 30 minutes .Calculate the rate constant.

Ans: t = 30 min $\quad [R]_0 = 100 \quad [R]=100-75=25$

$K = \frac{2.303}{t} \log_{10} \frac{[R]_0}{[R]}$

$K = \frac{2.303}{30min} \log_{10} \left(\frac{100}{25}\right)$

$= \frac{2.303}{30min} \log_{10} \left(\frac{100}{25}\right) \quad = \frac{2.303}{30min} \times 0.6021 \quad K = 0.043221 min^{-1}$

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