CBSE Test Paper-03

Class - 12 Chemistry (Chemical Kinetics)

1. For the first order reaction, half life is equal to
   a. $\frac{0.693}{K}$
   b. $\frac{2.303[R_o]}{K}$
   c. $\frac{[R_o]}{K}$
   d. $\frac{[R_o]}{2K}$
2. The ionic reactions are generally very fast because
   a. It does not involve bond breaking
   b. The number of collisions between ions are very large
   c. Reactions are highly exothermic
   d. The energy of interaction is between charged ion is greater than between neutral molecules
3. The rate of reaction can be measured as
   a. Rate of reaction can be measured in terms of Rate of disappearance of reactant or rate of appearance of product
   b. Rate of appearance of the product
   c. Rate of appearance of reactant
   d. Rate of disappearance of reactant
4. The rate is independent of the concentration of the reactants in
   a. Zero order
   b. Third order
   c. First order
   d. Second order
5. The half life periods of a reaction at initial concentration 0.1 mol/L and 0.5 mol/L are 200 s and 40 s respectively. The order of the reaction is
   a. 2
   b. $\frac{1}{2}$
   c. 0
   d. 1
6. What is average rate of a reaction? How is it determined?

7. Define - Rate of reaction and the factors affecting the rate of reaction.
8. The reaction $A + B \rightarrow C$ has zero order. What is the rate equation?
9. For the assumed reaction,
   $X_2 + 2Y_2 \rightarrow 2XY_2$
   Write the rate equation in terms of the rate of disappearance of Y_2.
10. Derive the general form of expression of the half life of first order reaction.
11. In the expression of rate of reaction in terms of reactants, what is the significance of negative sign?
12. Show that in case of first order reaction, the time required for 99.9% of the reaction to complete its 10 times that required for half of the reaction to take place.
    (Given: $log2 = 0.3010$)
13. The decomposition of dimethyl ether leads to the formation of CH_4, H_2 and CO and the reaction rate is given by Rate = $k[CH_3OCH_3]^{3/2}$. The rate of reaction is followed by increase in pressure in a closed vessel, so the rate can also be expressed in terms of the partial pressure of dimethyl ether, i.e.,$Rate = k(P_{CH_3OCH_3})^{3/2}$ If the pressure is measured in bar and time in minutes, then what are the units of rate and rate constants?
14. The following experimental data was collected for the reaction:
    $Cl_2\,(g) + 2NO\,(g) \rightarrow 2NOCl\,(g)$

Trial	[Cl_2] (mol/L)	[NO] (mol/L)	Initial Rate, (mol/L/s)
1	0.10	0.010	1.2×10^{-4}
2	0.10	0.030	10.8×10^{-4}
3	0.20	0.030	21.6×10^{-4}

    Construct the rate equation for the reaction.
15. The rate constant for the decomposition of hydrocarbons is $2.418 \times 10^{-5} s^{-1}$ at 546 K. If the energy of activation is 179.9 kJ/mol, what will be the value of pre-exponential factor.

Solutions

1. a. $\frac{0.693}{K}$

   Explanation: half life period means the time when concentration of reactant become half to original concentration of reactant.

   for first order reaction rate constant can be calculated as follows:

   $t=\frac{2.303}{k}\log\frac{[A_0]}{[A]}$

   for half life period, $t=t_{1/2}$, $[A]=\frac{[A_0]}{2}$

   on solving,

   $t_{1/2}=\frac{2.303}{k}\log\frac{[A_0]}{\frac{[A_0]}{2}}$

   $t_{1/2}=\frac{2.303}{k}\log 2=\frac{2.303\times 0.3010}{k}$

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

   where letters have their usual meanings.

2. a. It does not involve bond breaking

   Explanation: Ionic reactions does not involve bond breaking. energy is directly used in completing the reaction, therefore they are fast.

3. a. Rate of reaction can be measured in terms of Rate of disappearance of reactant or rate of appearance of product

   Explanation: rate of reaction = (+) rate of appearance of products = (-) rate of disappearance of reactants

4. a. Zero order

   Explanation: $-\frac{d[R]}{d[t]}=k[R]^{\circ}$

5. a. 2

   Explanation: As initial concentration is increased half life is decreasing so order of reaction is 2.

   for second order reaction, $rate\ \alpha\ \frac{1}{[R]}$

6. Average rate of a reaction is defined as the change in concentration of a reactant or a product per unit time. It can be determined by dividing the change in concentration

of reactant or product by the time interval.

For the reaction: $A \rightarrow B$

$R_{av} = \frac{-\Delta[A]}{\Delta t} = \frac{\Delta[B]}{\Delta t}$ where R_{av} is the average rate of reaction.

7. The reaction rate for a given chemical reaction is the measure of the change in concentration of the reactants or the change in concentration of the products per unit time. Chemical kinetics of a reaction depend on various factors such as reactant concentrations, temperature, physical states and surface areas of reactants, and also on solvent and catalyst properties if either are present.

8. The rate equation is $Rate = k[A]^0[B]^0$ or Rate = k.

9. Rate of reaction = $-\frac{1}{2}\left[\frac{dY_2}{dt}\right]$

10. For a first order chemical reaction

$k = \frac{2.303}{t}\log\frac{[R]_0}{[R]}$

$t = t_{1/2}, when\,[R] = \frac{[R]_0}{2}$

$k = \frac{2.303}{t_{1/2}}\log\left[\frac{[R]_0}{[R]} \times 2\right]$

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

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

$k = \frac{0.693}{t_{1/2}} \Rightarrow t_{1/2} = \frac{0.693}{k}$

Half life period ($t_{1/2}$)is independent of concentration.

11. While writing the expression for rate of a reaction is terms of reactants, the negative sign indicates a decrease in concentration of reactants with time.

12. For a first order reaction

$k = \frac{2.303}{t}\log\frac{[R]_0}{[R]}$

For 99.9% completion of reaction

$[R]_0$ = 100M, [R] = 100 - 99.9 = 0.1M

$\therefore\ t_{99.99\%} = \frac{2.303}{t}\log\left[\frac{100}{0.1}\right]$ ...(i)

Simiarly, $t_{1/2} = \frac{2.303}{k}\log\left[\frac{100}{50}\right]$ ...(ii)

Divide equation (i) by equation (ii)

$$\frac{t_{99.9}}{t_{1/2}} = \frac{\log[1000]}{\log[2]} = \frac{3.0}{0.3010} \approx 10$$

Hence $t_{99.9\%} = 10t_{1/2}$

13. If pressure is measured in bar and time in minutes, then

Unit of rate = $bar \min^{-1}$

$Rate = k(P_{CH_3OCH_3})^{3/2}$

$k = \frac{Rate}{\left(P_{CH_3OCH_3}\right)^{3/2}}$

Therefore, unit of rate constants$(k) = \frac{bar \min^{-1}}{bar^{3/2}}$

$= bar^{-1/2}\min^{-1}$

14. Let Rate = $k[Cl_2]^x[NO]^y$ where k=rate constant, x and y are orders of reaction w.r.t. X and Y respectively

When Rate = $1.2 \times 10^{-4} mol\ L^{-1}S^{-1}$

$[Cl_2]$ = 0.10 mol/L: [NO] = 0.010 mol/L

$1.2 \times 10^{-4} mol\ L^{-1}S^{-1}$=k[0.10 mol$L^{-1}$]x[0.010 mol $L^{-1}]^y$....(i)

When Rate = $10.8 \times 10^{-4} molL^{-1}s^{-1}$

$[Cl_2]$ = 0.10 mol L^{-1}; [NO] = 0.030 mol L^{-1}

$10.8 \times 10^{-4} = k[0.10molL^{-1}]^x[0.030molL^{-1}]^y$.......(ii)

Divide ii by i we get

$9=3^y$ so y=2

When Rate $= 21.6 \times 10^{-4} molL^{-1}S^{-1}$

$[Cl_2]$ = 0.20 mol L^{-1}; [NO] = 0.030 mol L-1

$21.6 \times 10^{-4} = k[0.20molL^{-1}][0.030molL^{-1}]^2$....(iii)

Divide iii by ii we get

$2=2^x$ so x=1

Put these values in i we get

$1.2\text{x}10^{-4}$ mol $L^{-1}s^{-1}$=k(0.01 mol/L)(0.01 mol/L)^2

$1.2\text{x}10^{-4}$ mol $L^{-1}s^{-1}$=k$(0.01)^3$ $(mol/L)^3$

k=$1.2\text{x}10^{-4}$ mol $L^{-1}s^{-1}/10^{-6}$ mol^3L^{-3}=120 $mol^{-2}L^2s^{-1}$

So the rate is given as

Rate=120x$[Cl_2][NO]^2$

15. $k = 2.418 \times 10^{-5} s^{-1}$

T= 546 K

$E_a = 179.9 kJmol^{-1} = 179.9 \times 10^3 \, J \, mol^{-1}$

According to the Arrhenius equation,

$k = Ae^{-E_a/RT}$

$\text{Ink} = \text{InA} - \frac{E_a}{RT}$

$\log k = \log \, A - \frac{E_a}{2.303 \, RT}$

$\log A = \log k + \frac{E_a}{2.303 \, RT}$

$= \log\left(2.418 \times 10^{-5} s^{-1}\right) + \frac{179.9 \times 10^3 J \, mol^{-1}}{2.303 \times 8.314 \, Jk^{-1} \, mol^{-1} \times 546K}$

= (0.3835 - 5) + 17.2082

= 12.5917

Therefore, A = antilog (12.5917)

=$3.9 \times 10^{12} s^{-1}$ (approximately)