CBSE Class 12 physics
Important Questions
Chapter 4
Chemical Kinetics

2 Marks Questions

1. Define the terms – i) Order of a reaction

ii) Molecularity of a reaction.

Ans. i) Order of a reaction.

The sum of powers of the concentration of the reactants in the rate law expression is called order of that reaction.

ii) Molecularity of a reaction.

The number of reacting species which must collide simultaneously in order to bring about a chemical reaction is called molecularity of a reaction.

2. What are elementary and complex reactions?

Ans. The reactions taking place in one step are called elementary reactions whereas when a sequence of elementary reactions, called mechanism , gives us the product , it is called complex reaction.

3. Differentiate between order and molecularity of a reaction?

Ans.

Order	Molecularity
i) It can be predicted from equation and cannot be predicted theoretically. ii) It cannot be zero.	i) it is an experimental parameter theoretically ii) It can be zero.

iii) It cannot be a fraction. It can only be fraction. A whole number.	iii) It can be a whole number as well as

4. Determine the overall order of a reaction which has the rate law $R = K[A]^{5/2}[B]^{3/2}$

Ans. $Rate = k[A]^x[B]^y$

Order = x +y

50 order = $\frac{5}{2} + \frac{3}{2} = 4$.

i.e; reaction is fourth order reaction.

5. What are the units of a rate constant of a

a) First order reaction

b) nth order reaction.

Ans. i) First order reaction –

Units of rate constant, $k = sec^{-1}$

ii) For nth order reaction

the units of rate constant, $k = mol^{(1-n)\ (n-1)} Ls^{-1}$

6. What is instantaneous rate of a reaction? How is it determined?

Ans. The rate of a reaction at a particular moment of time is called instantaneous rate of a reaction. For a reaction A $\rightarrow$ B R inst = $\frac{d[A]}{dt} = \frac{d[B]}{dt}$. Where dt = the smallest possible time interval $(\Delta t \rightarrow 0)$

7. For the chemical decomposition of SO_2Cl_2 **, its initial concentration is 0.8420 mol/L**

and final concentration is $0.215\ mol^{L-1}$ in 2 hours. What is the average rate of this reaction?

Ans. Rate of reaction = $\dfrac{\text{change in concentration}}{\text{time interval}}$

$= \dfrac{(0.8420 - 0.2105)\ \text{mol/L}}{2hr} = \dfrac{0.6315}{2} = 0.3158\ \text{mol /L/hr}$.

8. In the expression of rate of reaction in terms of reactants, what is the significance of negative sign?

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

9. For the reaction $2O_3(g) \rightleftharpoons 3O_2(g)$, $-\dfrac{\Delta[O_3]}{\Delta t}$ was found to be $5.0\times10^{-4} atm/s$. Determine the value of $\dfrac{\Delta[O_2]}{\Delta t}$ in atm /s during this period of time?

Ans. From the equation $2O_3(g) \rightleftharpoons 3O_2(g)$, $-\dfrac{1}{2}\dfrac{\Delta[O_3]}{\Delta t} = \dfrac{1}{3}\dfrac{\Delta[O_2]}{\Delta t}$

$$\frac{\Delta[O_2]}{\Delta t} = \frac{-3}{2}\frac{\Delta[O_3]}{\Delta t} = \frac{-3}{2} \times (-5.0\times10^{-4}\ \text{atms}^{-1}) = 7.5\times10^{-4}\ \text{atm s}^{-1}$$

10. The rate Law for the reaction A+B $\rightarrow$ C is rate $= K[A]^2[B]$. What would the reaction rate be when concentration of both A and B are doubled?

Ans. $R_1 = K[A]^2[B]$------------------1)

$R_2 = K[2A]^2[2B]$------------------2)

Dividing 2) by 1)

$$\frac{R_2}{R_1}=\frac{[2A]^2\ [2B]}{[A]^2\ [B]} = \frac{8\ [A]^2\ [B]}{[A]^2\ [B]} = \frac{R_2}{R_1} = 8:1 \text{ or } R_2 = 8R_1$$

The rate of reaction increases eight times.

11. Write the integrated rate equation for –

i) zero order reaction.

ii) first order reaction.

Ans. i) Zero order reaction - $K = \frac{[R_0]\ -[R]}{t}$

ii) First order reaction K = $\frac{2.303}{t} \log \frac{[R_0]}{[R]}$

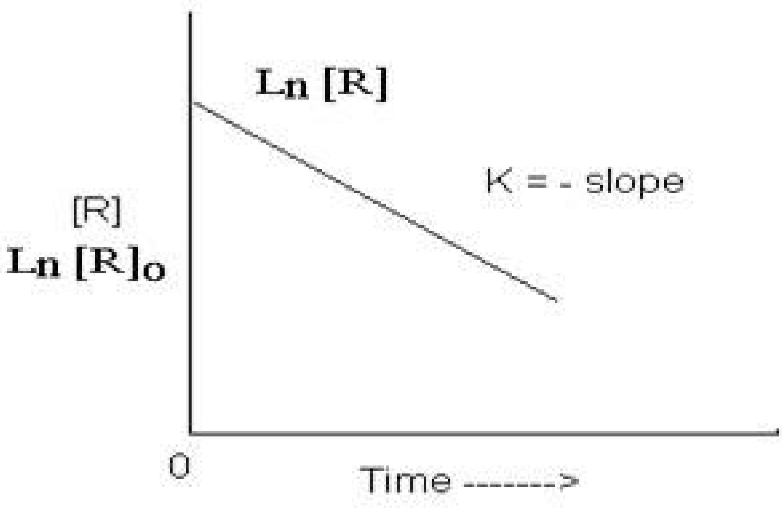
Where R_0 is the initial concentration

R is concentration at time t.

12. From the graph below

i) Identify the order of reaction.

ii) What will be the unit of rate constant?



Ans. From the graph

i) Reaction is first order reaction

ii) The unit of rate constant will be sec^{-1}.

13. What is the use of integrated rate equation?

Ans. Use of integrated rate equation -

1. The value of rate constant can be known when concentration of reactant at different times are known-

2. Order of a reaction can be determined by the knowledge of reaction concentration at different times.

14. For first order reaction - A $\rightarrow$ B Write

(1) Differential rate law.

(2) Integrated rate law.

Ans. For the reaction A $\rightarrow$ B, if the order =1

(i) Differential rate law is $\frac{-d[A]}{dt} = K[A]$

(ii) Integrated rate law is $t = \frac{2.303}{K} \log \frac{[R]_o}{[R]}$

15. The rate constant for the first order decomposition of N_2O_5 at 25^0C is $3\times10^{-2}\,min^{-1}$. It the initial concentration of N_2O_5 is $2\times10^{-3}\,mol/L$, How long will it take to drop the concentration to $5\times10^{-4}\,mol/L$?

Ans. t = $\frac{2.303}{k} \log \frac{[R]_o}{[R]}$

$$= \frac{2.303}{3\times10^{-2}\ \text{min}^{-1}} \log \frac{2\times10^{-3}}{5\times10^{-4}}$$

= $\frac{2.303}{3\times10^{-2}}$ log 4 (log 4 = 0.6021)

= 46.22 min.

16. Write Arrhenius equation.

Ans. Arrhenius equation

$K = A\ e^{-Ea/RT}$

Where K = rate constant , T = absolute temperature

E_a = Activation energy, R = gas constant.

17. If the activation energy of a reaction is zero, will the rate of reaction still depend on temperature?

Ans. $K = A\ e^{-Ea/RT}$

When Ea = 0

$K = A\ e^{-0/RT}$

$= A.\ e^0$

K = A

$\therefore$ Rate of reaction will not depend upon the temperature if activation energy is zero.

18. How does collision theory explain formation of products in a chemical reaction?

Ans. According to collision theory, the reactant molecules are assumed to be hard spheres and reaction occurs when these molecules collide with each other. The collisions in which molecules collide with sufficient kinetic energy (called threshold energy) and proper orientation, lead to formation of product. Here activation energy and proper orientation of the molecules determine the criteria for effective collision & hence the rate of a reaction.

19. From the fig. (1)

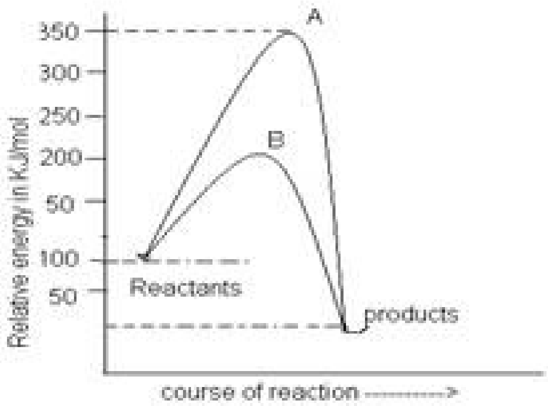
(a) Calculate ΔE for the reaction, activation

energy for forward reaction.

(b) Identify the curve for catalysed reaction.

(c) what is the energy of activation in the

presence of catalyst?



Ans. (a) From the figure-

Energy of reactions $E_r = 150 KJ / Mol$

Energy of products, $E_p = 50 Kj / Mol$

Change in energy, $\Delta E = E_P - E_R$

= 50-150 = 100KJ/Mol

Threshold energy, $E_r = 350 \ KJ / Mol$

Activation energy, $E_a = E_t - E_r$

= 350-150

= 200 KJ/Mol.

(b) The curve B is for catalysed reaction.

(C) In the presence of catalysts ,

Threshold energy $E_T = 250 KJ/Mol$

Activation energy, $E_a = 250 - 150$

= 100 KJ/Mol.

20. The activation energy of reaction is 75.2 KJ/mol in the absence of a catalyst and 50.14 KJ/Mol in the presence of a catalyst. How many times will the reaction grow in the presence of a catalyst, if the reaction proceeds at $25^0 C$?

Ans. Let the rate constant in the absence of catalyst be K_1, Let the rate constant in the presence of catalyst be K_2 Activation energy in the absence of catalyst, $E_1 = 75.2\ KJ/Mol$ Activation energy in the presence of catalyst, $E_2 = 50.14\ KJ/Mol$.

$$\log \frac{K_2}{K_1} = \frac{E_1 - E_2}{2.303RT}$$

$$= \frac{(75.2 - 50.14)\times 10^3 J/Mol}{2.303 \times 8.314 J/K/mol \times 298K}$$

= 4.391.

$$\frac{K_2}{K_1} = \text{Antilog } 4.391$$

$$\frac{K_2}{K_1} = 24604$$

Or $K_2 = 24604\ K_1$

21. In a reaction, $2A \rightarrow$ Products, the concentration of A decreases from 0.5mol L^{-1} to 0.4mol L^{-1} in 10 minutes. Calculate the rate during this interval?

Ans. Average rate $= -\frac{1}{2}\frac{\Delta[A]}{\Delta t}$

$$= -\frac{1}{2}\frac{[A]_2 - [A]_1}{t_2 - t_1}$$

$$= -\frac{1}{2}\frac{0.4 - 0.5}{10}$$

$$= -\frac{1}{2}\frac{-0.1}{10}$$

= 0.005 mol L - 1 min - 1

= 5 ×10 - 3M min - 1

22. For a reaction, $A + B \rightarrow$ **'Product; the rate law is given by,** $r = K[A]^{1/2}[B]^2$ **. What is the order of the reaction?**

Ans. The order of the reaction $= \frac{1}{2} + 2$

$$2\frac{1}{2}$$

= 2.5

23. Time required to decompose SO_2Cl_2 **to half of its initial amount is 60 minutes. If the decomposition is a first order reaction, calculate the rate constant of the reaction.**

Ans. We know that for a 1st order reaction,

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

It is given that $t_{1/2} = 60 \text{ min}$

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

$= \frac{0.693}{60}$

0.01155 min^{-1}

$= 1.155 \text{ min}^{-1}$

24. What will be the effect of temperature on rate constant?

Ans. The rate constant of a reaction is nearly doubled with a 10° rise in temperature. However, the exact dependence of the rate of a chemical reaction on temperature is given by Arrhenius equation,

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

Where,

A is the Arrhenius factor or the frequency factor

T is the temperature

R is the gas constant

E_a is the activation energy

25. Mention the factors that affect the rate of a chemical reaction.

Ans. The factors that affect the rate of a reaction areas follows.

(i) Concentration of reactants (pressure in case of gases)

(ii) Temperature

(iii) Presence of a catalyst