CBSE 2015

1. For the hydrolysis of methyl acetate in aqueous solution, the following results were obtained:

t/s	0	10	20
$[CH_3COOCH_3]$/mol L^{-1}	0.10	0.05	0.025

(*a*) Show that it follows pseudo first order reaction, as the concentration of water remains constant.

(*b*) Calculate the average rate of reaction between the time interval 10 to 20 seconds.

(Given: log 2 = 0.3010, log 4 = 0.6021) 5

Or

1 (*a*) For a reaction A + B → P, the rate is given by

Rate = k [A] $[B]^2$

(*i*) How is the rate of reaction affected if the concentration of B is doubled?

(*ii*) What is the overall order of reaction if A is present in large excess?

(*b*) A first order reaction takes 30 minutes for 50% completion. Calculate the time required for 90% completion of this reaction.

CBSE 2016

2. **For the first order thermal decomposition reaction, the following data were obtained:**

$$C_2H_5Cl(g) \longrightarrow C_2H_4(g) + HCl(g)$$

Time/sec	Total pressure/atm
0	0.30
300	0.50

Calculate the rate constant

(Given: log 2 = 0.301, log 3 = 0.4771, log 4 = 0.6021) **[3]**

$$C_2H_5Cl(g) \longrightarrow C_2H_4(g) + HCl(g)$$

p_i 0 0

$p_i - x$ x x

$p_T = p_i - x + x + x$ where p_T is total pressure after time 't', p is initial pressure and '$p_i - x$' is final pressure after time 't'.

$\Rightarrow x = p_T - p_i = 0.50 - 0.30 = 0.20$

$$k = \frac{2.303}{t}\log\frac{p_i}{p_i - x}$$

$$\Rightarrow k = \frac{2.303}{300}\log\frac{0.30}{0.10} \quad [p_i - x = 0.30 - 0.20 = 0.10]$$

$$\Rightarrow k = \frac{2.303}{300}(\log 3)$$

$$\Rightarrow k = \frac{2.303}{300}(0.4771)$$

$$\Rightarrow k = \frac{2.303 \times 0.4771}{300} = \frac{1.0987}{300} = 3.66 \times 10^{-3}\ atm^{-1}$$

3. **Show that in a first order reaction, time required for completion of 99.9% is 10 times that of half-life ($t_{1/2}$) of the reaction.** [2]

Or

3. **Derive integrated rate equation for rate constant for a first order reaction.**

CBSE 2017

4. **What is the effect of adding a catalyst on**

(a) Activation energy (E_a), and

(b) Gibbs energy (ΔG) of a reaction?

(a) E_a decreases, when catalyst is added

(b) ΔG remains same, when catalyst is added.

5. **A first order reaction taken 20 minutes for 25% decomposition. Calculate the time when 75% of the reaction will be completed.** [3]

(Given: log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021)

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

CBSE 2018

6. **For the reaction $2N_2O_5(g) \longrightarrow 4NO_2(g) + O_2(g)$,**

the rate of formation of $NO_2(g)$ is 2.8×10^{-3} $M s^{-1}$. Calculate the rate of disappearance of $N_2O_5(g)$. 2

Ans.

$$\text{Rate of reaction} = -\frac{d[N_2O_5]}{2dt} = +\frac{1}{4}\frac{d[NO_2]}{dt} = \frac{\Delta O_2}{\Delta t}$$

$$\text{Rate of disappearance of } N_2O_5 = -\frac{d[N_2O_5]}{2dt} = \frac{2}{4} \times 2.8 \times 10^{-3}\ Ms^{-1}$$

$$\text{Rate of disappearance of } N_2O_5 = 1.4 \times 10^{-3}\ Ms^{-1}$$

7. **A first order reaction is 50% completed in 40 minutes at 300 K and in 20 minutes at 320 K. Calculate the activation energy of the reaction. (Given: log 2 = 0.3010, log 4 = 0.6021, $R = 8.314\ JK^{-1}\ mol^{-1}$)** 3

CBSE 2019

8. **For a reaction**

$$2H_2O_2 \xrightarrow[\text{alkaline medium}]{I^-} 2H_2O + O_2$$

the proposed mechanism is as given below:

1. $H_2O_2 + I^- \longrightarrow H_2O + IO^-$ (slow) 2. $H_2O_2 + IO^- \longrightarrow H_2O + I^- + O_2$ (fast)

(i) Write rate law for the reaction.

(ii) Write the overall order of reaction.

(iii) Out of steps (1) and (2), which one is rate determining step?

9. **The decomposition of NH_3 on platinum surface is zero order reaction. If rate constant (k) is 4×10^{-3} Ms^{-1}, how long will it take to reduce the initial concentration of NH_3 from 0.1 M to 0.064 M.**

$k = 4 \times 10^{-3}$ Ms^{-1} $t = ?$ $[R]_0 = 0.1$ M $[R] = 0.064$ M

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

$$\Rightarrow \quad 4 \times 10^{-3}\ Ms^{-1} = \frac{0.1 - 0.064}{t} \quad \Rightarrow \quad t = \frac{0.1 - 0.064}{4 \times 10^{-3}} = \frac{0.036}{0.004} = 9 \text{ seconds.}$$

CBSE 2020

16. **Write the slope value obtained in the plot of log $[R_0]$ / [R] Vs time for a first order reaction.**

$$\text{Slope} = \frac{k}{2.303}$$

(*a*) **A first order reaction is 25% complete in 40 minutes. Calculate the value of rate constant. In what time will the reaction be 80% completed?** **3+2=5**

(*b*) **Define order of reaction. Write the condition under which a bimolecular reaction follows first order kinetics.**

Or

10. (*a*) **A first order reaction is 50% complete in 30 minutes at 300 K and in 10 minutes at 320 K. Calculate activation energy (E_a) for the reaction. (R = 8.314J K^{-1} mol^{-1})**

(*b*) **Write the two conditions for collisions to be effective collisions.**

(*c*) **How order of reaction and molecularity differ towards a complex reaction?**

[Given: log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021, log 5 = 0.6991] **3+1+1=5**

11. **In a chemical reaction X $\longrightarrow$ Y, it is found that the rate of reaction doubles when the concentration of X is increased four times. The order of the reaction with respect to X is**

(*a*) **1** (*b*) **0** (*c*) **2** (*d*) **1/2**

12. **The unit of rate constant depends upon the**

(*a*) **molecularity of the reaction.** (*b*) **activation energy of the reaction.**

(*c*) **order of the reaction.** (*d*) **temperature of the reaction.**

CBSE 2021

13. Define rate of reaction. Write two factors that affect the rate of reaction. **2**

14. A first order reaction is 50% complete in 40 minutes. Calculate the time required for the completion of 90% of reaction.

[Given : log 2 = 0.3010, log 10 = 1] **3**

15. The following reaction was carried out in water.

$$BrO_3^- + 2I^- \longrightarrow 2Br^- + I_2$$ CBSE-2021

The initial concentration of I^- was 0.30 M and conc. after 10 Minutes reduced to 0.28 M. Calculate rate of disappearance of I^- and production of I_2.

16. following data were obtained for the given reaction:

$$X + Y \longrightarrow \text{Product}$$

Exp.	[X]	[Y]	Initial Rate [M min^{-1}]
1	0.1	0.2	0.005 0.05
2	0.2	0.2	0.10
3	0.1	0.1	0.05
4	0.3		

(i) find order of reaction with respect to X and Y
(ii) Write rate law expression
(iii) find the rate constant
CBSE 2021

CBSE 2022

17. Define rate of reaction. Write two factors that affect rate of reaction. CBSE 2022

18. A first order reaction is 50% Complete in 40 min. Calculate the time required for the Completion of 90% reaction [Given $\log 2 = 0.3010$, $\log 10 = 1$]. 2022

19. In the given reaction

$$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$$ CBSE-2022

the rate of formation of NH_3 is 3.6×10^{-4} mol L^{-1} S^{-1}.
Calculate (i) Rate of reaction, and
(ii) Rate of disappearance of $H_2(g)$.

. ΔG and E°_{cell} for a spontaneous reaction will be : (From Electrochemistry)

(a) positive, negative (b) negative, negative

(c) negative, positive (d) positive, positive

20 The order of the reaction

$$H_2(g) + Cl_2(g) \xrightarrow{h\nu} 2HCl(g) \text{ is :}$$

(a) 2 (b) 1

(c) 0 (d) 3

21. (i) What is average rate of reaction ? *1*

(ii) Write two factors that affect the rate of reaction. *1*

(iii) (1) What happens to rate of reaction for zero order reaction ?

(2) What is the unit of k for zero order reaction ? *2×1=2*

OR

21. (iii) (1) For a reaction $P + 2Q \longrightarrow$ Products

Rate = $k[P]^{1/2}[Q]^1$. What is the order of the reaction ?

(2) Define pseudo first order reaction with an example. *2×1=2*

CBSE 2023

29. The following experimental rate were obtained for a reaction carried out at 25°C. CBSE-2023

$$A_{(g)} + B_{(g)} \longrightarrow C_{(g)} + D_{(g)}$$

Initial [A] (mol dm^{-3})	Initial [B] (mol dm^{-3})	Initial rate (mol L^{-1} s^{-1})
3×10^{-2}	2×10^{-2}	1.89×10^{-4}
3×10^{-2}	4×10^{-2}	1.89×10^{-4}
6×10^{-2}	4×10^{-2}	7.56×10^{-4}

What are the order of reaction w.r.t [A] and [B]

23. Assertion (A):- The half life of a reaction is the time in which the concentration of reactant is reduced to one half of its initial concentration

Reason (R):- In the first order kinetics when conc. is doubled, its half half life is doubled.

CBSE-2023

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24. What happens to the rate constant K and activation energy Ea as the temperature of a chemical reaction is increased? Justify.

25. (a) for the reaction

$$2\,N_2O_{5(g)} \longrightarrow 4NO_{2(g)} + O_{2(g)} \quad \text{at } 318K$$

Calculate the rate of reaction if rate of disappearance of $N_2O_{5(g)}$ is $1.4 \times 10^{-3}\ M\,s^{-1}$

(b) for the first order derive the relationship

$$t_{99.9\%} = 2 \times t_{90\%}$$

CBSE-2023

26. The slope in the plot of [R] vs. time for a zero order reaction is

(a) $\frac{+k}{2.303}$ (b) $-k$ (c) $\frac{-k}{2.303}$ (d) $+k$

27. For a reaction 2A → 3B, rate of reaction $-\frac{d[A]}{dt}$ is equal to

(a) $\frac{+3}{2}\frac{d[B]}{dt}$ (b) $\frac{+2}{3}\frac{d[B]}{dt}$ (c) $\frac{+1}{3}\frac{d[B]}{dt}$ (d) $+\frac{2d[B]}{dt}$

28. A first order reaction is 50% complete in 30 minutes at 300 K and in 10 minutes at 320 K. Calculate activation energy (E_a) for the reaction. [R = 8.314 J K^{-1} mol^{-1}] 3

[Given: log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021]

CBSE 2024

29. *Assertion (A) :* Order of reaction and molecularity are always same for complex reactions.

Reason (R) : Order is determined experimentally and molecularity is applicable only for elementary reactions.

30. A first-order reaction is 25% complete in 40 minutes. Calculate the value of rate constant. In what time will the reaction be 80% complete ?

[Given : log 2 = 0·30, log 3 = 0·48, log 4 = 0·60, log 5 = 0·69]

31. The rate of a reaction increases sixteen times when the concentration of the reactant increases four times. The order of the reaction is

(*a*) 2.5 (*b*) 2.0

(*c*) 1.5 (*d*) 0.5

32. Show that in case of a first order reaction, the time taken for completion of 99% reaction is twice the time required for 90% completion of the reaction. (log 10 = 1) 2

CBSE 2025

33. **A certain reaction is 50 complete in 20 minutes at 300 K and the same reaction is 50 complete in 5 minutes at 350 K. Calculate the activation energy if it is a first order reaction.**

34. **(i)** What is a rate determining step?

(a) (ii) Define complex reaction.

Solution: A complex reaction involves more than one elementary reaction step. These reactions occur through a sequence of individual reactions, each involving the collision and interaction of reactants. A complex reaction can have multiple intermediates and may involve different molecular species at various stages.

35. (A) The rate constant for a zero order reaction A → P is 0.0030 mol $L^{-1}s^{-1}$. How long will it take for the initial concentration of A to fall from 0.10 M to 0.075 M ? 2

OR

35. (B) The decomposition of NH_3 on platinum surface is zero order reaction. What are the rates of production of N_2 and H_2 if $k = 2.5 \times 10^{-4}$ mol L^{-1} s^{-1} ? 2

34. **(b) What is the effect of temperature on the rate constant of a reaction?**

Solution: The rate constant of a reaction generally increases with temperature. This is explained by the Arrhenius equation, which shows that the rate constant k increases exponentially with an increase in temperature. As the temperature rises, the number of molecules having sufficient energy to overcome the activation energy barrier increases, leading to an increase in the rate constant.

$$k = A \cdot e^{-\frac{E_a}{RT}}$$

OR

34 **(b) Why is molecularity applicable only for elementary reactions whereas order is applicable for elementary as well as complex reactions?**

Solution: Molecularity refers to the number of reacting species involved in an elementary reaction and is a property of that specific step. It applies only to elementary reactions because these reactions occur in a single step and involve a fixed number of reacting molecules. On the other hand, the order of a reaction is determined experimentally and refers to the relationship between the concentration of reactants and the rate of the overall reaction, which can apply to both elementary and complex reactions.

(c) The conversion of molecule X to Y follows second-order kinetics. If the concentration of X is increased 3 times, how will it affect the rate of formation of Y?

Assertion (A) : In a first order reaction, if the concentration of the reactant is doubled, its half-life is also doubled.

Reason (R) : The half-life of a reaction does not depend upon the initial concentration of the reactant in a first order reaction.

36. Which among the following is a false statement ?

(A) Rate of zero order reaction is independent of initial concentration of reactant.

(B) Half-life of a zero order reaction is inversely proportional to the rate constant.

(C) Molecularity of a reaction may be zero.

(D) For a first order reaction, $t_{1/2} = 0.693/k$.

37. A reaction is of second order with respect to a reactant. How is the rate of reaction affected if the concentration of the reactant is (i) doubled (ii) reduced to half ?