

PLOT 5C, 2ND FLOOR, GANAPATI COMPLEX, SEC-13, OPP. JAIPURIA  
SCHOOL, VASUNDHARA, GHAZIABAD (U.P)  
CHEMICAL KINETICS -4

- For the reaction  $\text{Cl}_2(\text{g}) + 2\text{NO}(\text{g}) \rightarrow 2\text{NOCl}(\text{g})$  the rate law is expressed as  $\text{rate} = k[\text{Cl}_2][\text{NO}]^2$ . What is the overall order of this reaction?
- Express the rate of the following reaction in terms of disappearance of hydrogen in the reaction:  
 $3\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$ .
- For the reaction  $\text{A} \rightarrow \text{B}$ , the rate of reaction becomes twenty seven times when the concentration of A is increased three times. What is the order of the reaction?
- A reaction is 50% complete in 2 hours and 75% complete in 4 hours. What is the order of the reaction?
- The rate of reaction  $\text{X} \rightarrow \text{Y}$  becomes 8 times when the concentration of the reactant X is doubled. Write the law of the reaction.
- What is meant by elementary step in a reaction?
- Define activation energy of a reaction?
- Express the relation between the half-life period of a reactant and its initial concentration if the reaction involved is of second order.
- Express the relation between the half-life period of a reactant and its initial concentration for a reaction of  $n^{\text{th}}$  order.
- How does the value of the rate constant vary with reactant concentration?
- A substance with initial concentration 'a' follows zero order kinetics with the rate constant ' $k$ '  $\text{mol L}^{-1}\text{s}^{-1}$ . In how much time will the reaction go to completion?
- When is the rate of reaction equal to specific reaction rate?
- The reaction  $\text{A} + \text{B} \rightarrow \text{C}$  has zero order. What is the rate equation?
- In some cases, it is found that a large number of colliding molecules have energy more than threshold value, yet the reaction is slow. Why?
- Give an example of pseudo first order reaction.
- The rate law for the decomposition of  $\text{N}_2\text{O}_5$  is:  $\text{rate} = k[\text{N}_2\text{O}_5]$ . What is the significance of ' $k$ ' in this equation?
- The reaction of  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$ , is thermodynamically feasible. How is it that a mixture of hydrogen and oxygen kept at room temperature shows no tendency to form water?
- For the reaction  $3\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$ , how is the rate of reaction expressions  $-\frac{d(\text{H}_2)}{dt}$  and  $\frac{d(\text{NH}_3)}{dt}$  interrelated?
- Why is it that instantaneous rate of reaction does not change when a part of the reacting solution is taken out?
- For a reaction  $\text{A} + \text{H}_2\text{O} \rightarrow \text{B}$ .  
 $\text{rate} \propto [\text{A}]$   
What is its (i) molecularity (ii) order of reaction?
- The rate constant of a reaction is  $1.5 \times 10^7 \text{s}^{-1}$  at  $50^\circ\text{C}$  and  $4.5 \times 10^7 \text{s}^{-1}$  at  $100^\circ\text{C}$ . Calculate the value of activation energy,  $E_a$  for the reaction. [ $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$ ].
- What are photochemical reactions? Explain the mechanism of the photochemical reaction occurring between hydrogen and chlorine gas?
- What is known as 'activation energy'? How is the activation energy affected by
  - The use of a catalyst
  - A rise in temperature?
- The reaction  $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$  is a first order reaction with half-life  $3.15 \times 10^4 \text{s}$  at  $320^\circ\text{C}$ . What percentage of  $\text{SO}_2\text{Cl}_2$  would be decomposed on heating at  $320^\circ\text{C}$  for 90 minutes?

25. What will be the initial rate of reaction if its rate constant is  $10^{-3}\text{s}^{-1}$  and the concentration of the reactant is  $0.2\text{mol L}^{-1}$ ? What fraction of the reactant will be converted into the products in 200 seconds?
26. The rate constant for a first order reaction becomes six times when the temperature is raised from 350K to 400K. calculate the activation energy for the reaction. [ $R = 8.314\text{ JK}^{-1}\text{mol}^{-1}$ ].
27. Why is it that rate of most of the reactions increase, when the temperature is increased? In what unit is the rate of reaction expressed?
28. A first order reaction is 20% complete in 20 minutes. Calculate the time it will take the reaction to complete 80%.

29. a. Draw a schematic graph showing how the rate of reaction changes with change in concentration of reactant.

b. Rate of reaction is given by the equation :

$$\text{Rate} = k [\text{A}]^2[\text{B}]^1.$$

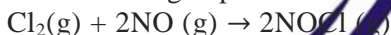
What are the units of rate and the rate constant for the reaction?

30. Rate constant  $k$  of a reaction varies with temperature according to the equation:

$\text{Log } k = \text{constant} - \frac{E_a}{2.303RT}$ , where  $E_a$  is the energy of activation for the reaction. When a graph is plotted for  $\text{log } k$  versus  $1/T$ , a straight line with a slope  $-6670\text{K}$  is obtained. Calculate energy of activation for this reaction. State the units, ( $R = 8.314\text{ JK}^{-1}\text{mol}^{-1}$ ).

31. State the role of activated complex in the reaction and state its relation with activation energy.

32. The following experimental data were collected for the reaction:



TRIAL	Initial conc. $[\text{Cl}_2]\text{mol L}^{-1}$	Initial conc. $[\text{NO}_2]\text{mol L}^{-1}$	Initial rate $\text{mol L}^{-1}\text{s}^{-1}$
1	0.010	0.010	$1.20 \times 10^{-4}$
2	0.010	0.030	$10.8 \times 10^{-4}$
3	0.020	0.030	$21.6 \times 10^{-4}$

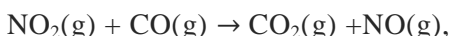
Construct the rate equation for the reaction.

33. What aspect of a reaction is influenced by presence of catalyst which increases the rate or possibility of the reaction?

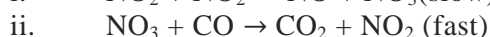
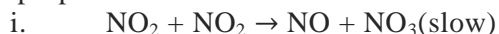
34. The rate of reaction  $2\text{NO} + \text{Cl}_2 \rightarrow 2\text{NOCl}$  is double when concentration of  $\text{Cl}_2$  is doubled and it becomes eight times when concentration of both  $\text{NO}$  and  $\text{Cl}_2$  are doubled. Deduce the order of this reaction.

35. For the decomposition of  $\text{N}_2\text{O}_5$  at 298 K, the rate law is  $\frac{d[\text{N}_2\text{O}_5]}{dt} = k[\text{N}_2\text{O}_5]$ . Starting with moles 2.5 moles of  $\text{N}_2\text{O}_5(\text{g})$  in a five litre container, how many moles per litre of  $\text{N}_2\text{O}_5$  would remain after 75 seconds if rate constant for the reaction is  $16.8 \times 10^{-3}\text{s}^{-1}$ ?

36. For the reaction at 500 K



The proposed mechanism is as follows:



What is the rate law for the reaction?

37. Nitric oxide reacts with  $\text{H}_2$  to give  $\text{N}_2$  and water  $2\text{NO} + 2\text{H}_2 \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$

The rate law for the above reaction is  $\frac{-d[\text{NO}]}{dt} = k[\text{NO}]^2[\text{H}_2]$ , explain the mechanism of the reaction.

38. The rate constant for the first order decomposition of  $\text{N}_2\text{O}_5$  at  $45^\circ\text{C}$  is  $3.00 \times 10^{-2}\text{min}^{-1}$ . If the initial concentration of  $\text{N}_2\text{O}_5$  is  $2.00 \times 10^{-2}\text{mol L}^{-1}$ . If the initial concentration of  $\text{N}_2\text{O}_5$  is  $2.00 \times 10^{-3}\text{mol L}^{-1}$ , how long will it take for the concentration to drop to  $5.00 \times 10^{-4}\text{mol L}^{-1}$ ?

39. The catalytic decomposition of  $\text{H}_2\text{O}_2$  was studied by titrating it at different intervals with  $\text{KMnO}_4$  solution. Calculate the rate constant from the following data assuming the reaction to be of first order.

t(seconds)	0	600	1200
$\text{KMnO}_4(\text{ml})$	22.8	13.8	8.2

40. The decomposition of phosphine

$4\text{PH}_3(\text{g}) \rightarrow \text{P}_4 + 6\text{H}_2\text{O}(\text{g})$  has rate law, rate =  $k[\text{PH}_3]$ . The rate constant is  $6.0 \times 10^{-4} \text{ s}^{-1}$  at 300 K and  $E_a$  is  $3.05 \times 10^5 \text{ Jmol}^{-1}$ . What is the value of rate constant at 310 K? [ $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$ ].

41. The rate constant for the reaction  $\text{CH}_3\text{I} + \text{C}_2\text{H}_5\text{ONa} \rightarrow \text{CH}_3\text{OC}_2\text{H}_5 + \text{NaI}$  at 273 K is  $5.60 \times 10^{-5}$  and at 300 K is  $100 \times 10^{-5} \text{ Lmol}^{-1}\text{s}^{-1}$  respectively. Calculate the value of activation energy of the reaction.
42. Calculate the activation energy of a reaction whose reaction rate at 310 K gets doubled for 10K rise in temperature.
43. The decomposition of  $\text{N}_2\text{O}_5$  in  $\text{CCl}_4$  solution follows the first order rate law. The concentrations of  $\text{N}_2\text{O}_5$  measured at different time intervals are given below:

Time in seconds (t)	0	80	160	410	600	1130	1740
$[\text{N}_2\text{O}_5] \text{ mol L}^{-1}$	5.5	5.0	4.8	4.0	3.4	2.4	1.6

Calculate its rate constant at  $t = 410\text{s}$  and  $t = 1130 \text{ s}$ . what do these results show?

44. For a reaction the energy of activation is zero. What is the value of rate constant at 300 K, if  $k = 1.6 \times 10^6 \text{ s}^{-1}$  at 280 K? [ $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$ ].
45. For a reaction:  $2\text{A} + \text{B} + \text{C} \rightarrow \text{A}_2 + \text{B} + \text{C}$ , the rate law has been determined to be: rate =  $k[\text{A}][\text{B}]^2$  if the value of  $k$  is  $2.0 \times 10^{-6} \text{ mol}^{-2}\text{L}^2\text{s}^{-1}$  for the reaction, determine the initial rate of the reaction with  $[\text{A}] = 0.2 \text{ molL}^{-1}$ ,  $[\text{B}] = 0.1 \text{ mol L}^{-1}$ ,  $[\text{C}] = 0.5 \text{ mol L}^{-1}$ .
46. What are pseudo unimolecular reactions? Give two examples.
47. Show graphically, how the rate of reaction depends on the concentration of reactant when there is only reactant and the reaction is of first order?
48. What is meant by relative rates of reaction? Write the relative rate expressions for the following chemical reactions:  
 $4\text{NH}_3(\text{g}) + 5\text{O}_2 \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$
49. The rate constant of a reaction is  $0.01439 \text{ min}^{-1}$  at  $25^\circ\text{C}$  and its activation energy is  $70,000 \text{ Jmol}^{-1}$ . What is value of rate constant at  $40^\circ\text{C}$ ? [ $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$ ].
50. The rate constant for a first order reaction is  $60\text{s}^{-1}$ . How much time will it take to reduce the concentration of the reactant to  $1/10^{\text{th}}$  of its initial value?
51. The rate of a particular reaction triples when temperature changes from  $50^\circ\text{C}$  to  $100^\circ\text{C}$ . Calculate the activation energy of the reaction. [ $\log 3 = 0.4771$ ;  $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$ ].
52. A first order reaction takes 69.3 minutes for 50% completion. Set up an equation determining the time needed for 80% completion of this reaction. (Calculation of result is not required).
53. The activation energy of a reaction is  $75.2 \text{ kJmol}^{-1}$  with a catalyst. How many times will the rate of reaction grow in the presence of the catalyst if the reaction proceeds at  $25^\circ\text{C}$ ? [ $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$ ].
54. During nuclear explosion, one of the products is  $^{90}\text{Sr}$  with half-life of 28.1 years. If  $1 \mu\text{g}$  of  $^{90}\text{Sr}$  was absorbed in the bones of a newly born baby instead of calcium, how much of it will remain after 10 years and 60 years if it is not lost metabolically?
55. The rate of a particular reaction doubles when temperature changes from  $27^\circ\text{C}$  to  $37^\circ\text{C}$ . Calculate the activation energy of such reaction.
56. A reaction is first order in A and second order in B.
- Write differential rate equation.
  - How is the rate affected if the concentration of B is tripled?
  - How is the rate affected when the concentrations of both A and B are doubled?
- What is the significance of rate constant in the rate expression?
57. In general it is observed that the rate of a chemical reaction doubles with every  $10^\circ$  rise in temperature. If this generalization holds for a reaction in the temperature range 295 K to 305 K, what would be the value of activation energy for this reaction?