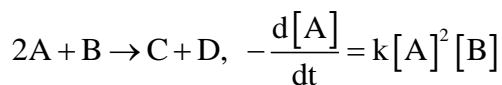


## Chemical Kinetics

## 1. Introduction, Rate of Reaction

- Q 1. Kinetics depends on
- (A) Intermediate steps through which reactions happen  
 (B) Initial & Final species of the reaction  
 (C) Stability of products  
 (D) Stability of reactant
- Q 2. In the reaction;  $A + 2B \rightarrow 3C + D$  which of the following expressions does not describe changes in the concentration of various species are a function of time. [CBSE PMT 2006]
- (A)  $\frac{d[C]}{dt} = \frac{-3d[A]}{dt}$  (B)  $\frac{3d[D]}{dt} = \frac{d[C]}{dt}$   
 (C)  $\frac{3d[B]}{dt} = \frac{-2d[C]}{dt}$  (D)  $\frac{2d[B]}{dt} = \frac{d[A]}{dt}$

- Q 3. For the reaction



The expression for  $-\frac{d[B]}{dt}$  will be

- (A)  $K[A]^2[B]$  (B)  $\frac{1}{2}K[A]^2[B]$   
 (C)  $K[A]^2[2B]$  (D)  $K[2A]^2[B]$
- Q 4. The rate of a reaction is expressed in different ways as follows

$$+\frac{1}{2} \frac{d[C]}{dt} = -\frac{1}{3} \frac{d[D]}{dt} = +\frac{1}{4} \frac{d[A]}{dt} = -\frac{d[B]}{dt}$$

The reaction is

- (A)  $4A + B \rightarrow 2C + 3D$   
 (B)  $B + 3D \rightarrow 4A + 2C$   
 (C)  $A + B \rightarrow C + D$   
 (D)  $B + D \rightarrow A + C$
- Q 5. Which of the following expressions is correct for the rate of reaction given below?

[NCERT EXAMPLAR]



(A)  $\frac{\Delta[Br^-]}{\Delta t} = 5 \frac{\Delta[H^+]}{\Delta t}$  (B)  $\frac{\Delta[Br^-]}{\Delta t} = \frac{6}{5} \frac{\Delta[H^+]}{\Delta t}$

(C)  $\frac{\Delta[Br^-]}{\Delta t} = \frac{5}{6} \frac{\Delta[H^+]}{\Delta t}$  (D)  $\frac{\Delta[Br^-]}{\Delta t} = 6 \frac{\Delta[H^+]}{\Delta t}$

- Q 6. Which is correct relation in between  $\frac{dC}{dt}$ ,  $\frac{dn}{dt}$

and  $\frac{P}{dt}$  where C, n, P, represents concentration, mole and pressure terms for gaseous phase reactant  $A(g) \rightarrow$  product

(A)  $-\frac{dC}{dt} = -\frac{1}{V} \frac{dn}{dt} = -\frac{1}{RT} \frac{dP}{dt}$

(B)  $\frac{dC}{dt} = \frac{dn}{dt} = -\frac{dP}{dt}$

(C)  $\frac{dC}{dt} = \frac{RT}{V} \frac{dn}{dt} = -\frac{dP}{dt}$

(D) All

- Q 7. For the reaction,  $N_2O_5 \rightarrow 2NO_2 + \frac{1}{2}O_2$

Given  $-\frac{d[N_2O_5]}{dt} = K_1[N_2O_5]$ ,

$\frac{d[NO_2]}{dt} = K_2[N_2O_5]$ ,  $\frac{d[O_2]}{dt} = K_3[N_2O_5]$

The relation between  $K_1, K_2$  and  $K_3$  is

(A)  $2K_1 = K_2 = 4K_3$

(B)  $K_1 = K_2 = K_3$

(C)  $2K_1 = 4K_2 = K_3$

(D) None

- Q 8. The instantaneous rate of disappearance of the  $MnO_4^-$  ion in the reaction is  $4.56 \times 10^{-3} Ms^{-1}$
- $$2MnO_4^- + 10I^- + 16H^+ \rightarrow 2Mn^{2+} + 5I_2 + 8H_2O$$
- The rate of appearance of  $I_2$  is

(A)  $1.14 \times 10^{-3} Ms^{-1}$  (B)  $5.7 \times 10^{-3} Ms^{-1}$

(C)  $4.56 \times 10^{-4} Ms^{-1}$  (D)  $1.14 \times 10^{-2} Ms^{-1}$

- Q 9. If Ammonia is treated with  $O_2$  at elevated temperatures, the rate of disappearance of ammonia is found to be  $3.5 \times 10^{-2} mol.L^{-1}.S^{-1}$

during a measured time interval. Calculate the rate of appearance of water for the reaction  $\text{NH}_3 + \text{O}_2 \rightarrow \text{H}_2\text{O} + \text{N}_2\text{O}$  in mol/lit.sec

- (A)  $13.5 \times 10^{-2}$  (B)  $5.25 \times 10^{-2}$   
 (C)  $1.7 \times 10^{-2}$  (D)  $1.1 \times 10^{-2}$

Q 10. Rate of formation of  $\text{SO}_3$  in the following reaction  $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$  is  $100 \text{ g min}^{-1}$ .

Hence rate of disappearance of  $\text{O}_2$  is

- (A) 50g/min (B) 40 g/min  
 (C) 200 g/min (D) 20 g/min

Q 11. For the reaction

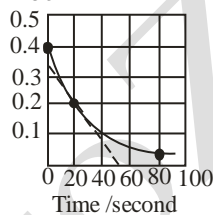
$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$  under certain conditions of temperature and partial pressure of the reactant the rate of formation of  $\text{NH}_3$  is  $0.001 \text{ kg h}^{-1}$ . Calculate the rate of conversion of  $\text{H}_2$  under the same conditions?

- (A) 0.00015 kg/hr (B) 0.001 kg/hr  
 (C) 0.00017 kg/hr (D) None of these

Q 12. Unit of rate is

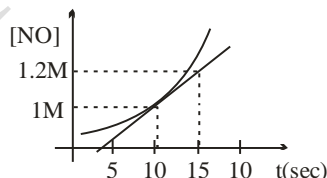
- (A)  $\text{mol lit}^{-1} \text{ sec}$  (B)  $\text{atm sec}^{-1}$   
 (C)  $\text{kg/sec}$  (D) All of these

Q 13. A reaction follows the given concentration (M)= time graph. The rate for this reaction at 20 seconds will be



- (A)  $4 \times 10^{-3} \text{ Ms}^{-1}$  (B)  $8 \times 10^{-2} \text{ Ms}^{-1}$   
 (C)  $2 \times 10^{-2} \text{ Ms}^{-1}$  (D)  $7 \times 10^{-3} \text{ Ms}^{-1}$

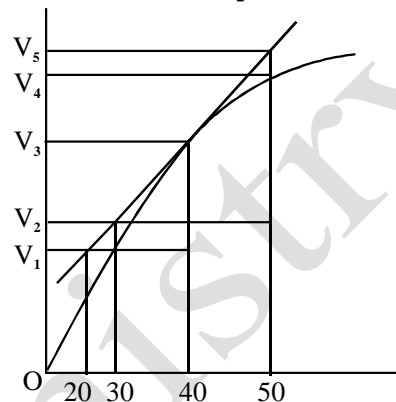
Q 14. For the reaction  $2\text{NO}_2 \rightarrow 2\text{NO} + \text{O}_2$ , the constant of 'NO' changes with time as follows. Find the rate of reaction at  $t = 10 \text{ sec}$



- (A)  $0.1 \text{ Msec}^{-1}$  (B)  $0.04 \text{ Msec}^{-1}$   
 (C)  $0.02 \text{ Msec}^{-1}$  (D)  $0.2 \text{ Msec}^{-1}$

Q 15. Consider the graph given in figure.

[NCERT EXAMPLAR]



Which of the following is correct option?

- (A) Avg. rate upto 40 sec is  $\frac{V_3 - V_2}{40}$   
 (B) Avg. rate upto 40 sec is  $\frac{V_3 - V_2}{40 - 30}$   
 (C) Avg. rate upto 40 sec is  $\frac{V_3}{40}$   
 (D) Avg. rate upto 40 sec is  $\frac{V_3 - V_1}{40 - 20}$

Q 16. Which of the following options does not show instantaneous rate of reaction at 40s?

- (A)  $\frac{V_5 - V_2}{50 - 30}$  (B)  $\frac{V_4 - V_2}{50 - 30}$   
 (C)  $\frac{V_3 - V_2}{40 - 30}$  (D)  $\frac{V_3 - V_1}{40 - 20}$

Q 17. The decomposition of  $\text{N}_2\text{O}_5$  in  $\text{CCl}_4$  at 318K has been studied by monitoring the concentration of  $\text{N}_2\text{O}_5$  in the solution. Initially the concentration of  $\text{N}_2\text{O}_5$  is  $2.33 \text{ mol.L}^{-1}$  and after 184 minutes, it is reduced to  $2.08 \text{ mol.L}^{-1}$ . The reaction takes place according to the equation;

$$2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$$

Calculate the average rate of this reaction in terms of hours, minutes and seconds. What is the rate of production of  $\text{NO}_2$  during this period? [NCERT Solved]

## 2. Differential Rate Law,

## Integrated rate laws for nth order Reaction

- Q 1. Order of a chemical reaction can have  
(A) -ve values (B) +ve values  
(C) Zero values (D) All of these
- Q 2. The value of Rate constant can be  
(A) -ve values (B) +ve values  
(C) Zero values (D) All of these
- Q 3. Calculate the overall order of a reaction which has the rate expression [NCERT Solved]  
(A)  $\text{Rate} = k[A]^{1/2}[B]^{3/2}$   
(B)  $\text{Rate} = k[A]^{3/2}[B]^{-1}$
- Q 4. Select the rate law that corresponds to the data shown for the following reaction  $A + B \rightarrow C$

Expt. No.	[A] <sub>0</sub>	[B] <sub>0</sub>	Initial rate
1	0.012	0.035	0.10
2	0.024	0.070	0.80
3	0.024	0.035	0.10
4	0.012	0.070	0.80

- (A)  $\text{rate} = k[B]^3$  (B)  $\text{rate} = k[B]^4$   
(C)  $\text{rate} = k[A][B]^3$  (D)  $\text{rate} = k[A]^2[B]^2$
- Q 5. For the reaction [NCERT EXAMPLAR]  
 $A(g) + 2B(g) \rightarrow 2C(g)$

Following data were obtained experimentally.

Exp.	[A] <sub>0</sub> Mol.L <sup>-1</sup>	[B] <sub>0</sub> Mol.L <sup>-1</sup>	d[C]/dt mol.L <sup>-1</sup> s <sup>-1</sup>
1.	0.30	0.30	0.10
2.	0.30	0.60	0.40
3.	0.60	0.30	0.20

Choose the correct option for the rate equations for this reaction

- (A)  $\text{Rate} = k[K]^2[B]$  (B)  $\text{Rate} = k[A][B]^2$   
(C)  $\text{Rate} = k[A][B]$  (D)  $\text{Rate} = k[A]^2[B]^0$
- Q 6. For the given reaction,  $A + B \rightarrow \text{Products}$

Following data were given [IIT-JEE 2004]

Initial conc. (m/L)	Initial conc. (m/L)	Initial rate [ml <sup>-1</sup> s <sup>-1</sup> ]
[A]	[B]	
0.1	0.1	0.05
0.2	0.1	0.1
0.1	0.2	0.05

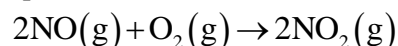
- (A)  $K[A][B]$  (B)  $K[A]$   
(C)  $K[A]^2$  (D)  $K[B]$

- Q 7. For the given reaction,  $A + B \rightarrow \text{Products}$   
The order is 1 w.r.t each of A and B. Value of X and Y in the given data is.

Initial conc. (m/L)	Initial conc. (m/L)	Initial rate [mol <sup>-1</sup> s <sup>-1</sup> ]
[A]	[B]	
0.20	0.05	0.10
x	0.05	0.40
0.40	Y	0.80

- (A) 0.20, 0.80 (B) 0.80, 0.40  
(C) 0.80, 0.20 (D) 0.40, 0.20
- Q 8. The rate of a reaction  $A + 2B \rightarrow 3C$ , get increased by 72 times when [A] was tripled & that of B is doubled. The order of the reaction with respect to A & B are respectively  
(A) 1,2 (B) 2,3  
(C) 3,2 (D) 2,2

- Q 9. For a simple reaction



If volume of vessel is suddenly halved then

- (A) Rate of reaction will decrease to 1/4th of its initial value  
(B) Rate of reaction will decrease to 1/8th of its initial value  
(C) Rate of reaction will increase four times to its initial value  
(D) Rate of reaction will increase 8 times to its initial value
- Q 10. For the reaction  $A + B \rightarrow \text{Products}$

Initial conc. (m/L)	Initial conc. (m/L)	Initial rate [mol <sup>-1</sup> s <sup>-1</sup> ]
[A]	[B]	
0.10	0.10	$5 \times 10^{-2}$
0.20	0.01	$7 \times 10^{-2}$
0.10	0.02	$8.67 \times 10^{-2}$

The rate expression is

- (A)  $K[A]^2[B]^1$  (B)  $K[A]^{1/2}[B]^{3/2}$   
(C)  $K[A]^{1/2}[B]^{1/2}$  (D) None of these

- Q 11. In a reaction  $A + B \rightarrow$  products, rate is doubled when concentration of B is doubled and rate increases by a factor of 8 when concentration of both the reactant A & B are doubled. Rate law for the reaction can be written as

[CBSE PMT 2012/JEE Main 2019]

The rate expression is

- (A) Rate =  $K[A]^1[B]^2$  (B) Rate =  $K[A]^2[B]^2$   
 (C) Rate =  $K[A][B]$  (D) Rate =  $K[A]^2[B]$

- Q 12. When the mechanism of reaction is not known, one often attempts to fit the data with an  $n^{\text{th}}$  order rate equation of the form

$$-r_A = -\frac{dC_A}{dt} = kC_A^n$$

For  $n \neq 1$ , the integration of this equation yields

- (A)  $C_A^{1+n} - C_{A_0}^{1+n} = (1+n)kt$   
 (B)  $C_A^{1-n} - C_{A_0}^{1-n} = (1-n)kt$   
 (C)  $C_A^{1-n} - C_{A_0}^{1-n} = (n-1)kt$   
 (D)  $C_A^{1-n} - C_{A_0}^{1-n} = kt/(n-1)$

- Q 13. Given that for a reaction of order n the integrated form of the rate equation is

$$k = \frac{1}{t(n-1)} \left[ \frac{1}{C^{n-1}} - \frac{1}{C_0^{n-1}} \right] \text{ where } C_0 \text{ and } C$$

are the values of the reactant concentration at the start and after time t. What is the relationship between  $t_{3/4}$  and  $t_{1/2}$  where  $t_{3/4}$

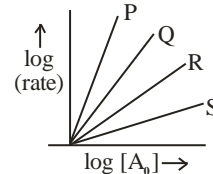
is the time required for C to become  $\frac{1}{4}C_0$

- (A)  $t_{3/4} = t_{1/2} [2^{n-1} + 1]$   
 (B)  $t_{3/4} = t_{1/2} [2^{n-1} - 1]$   
 (C)  $t_{3/4} = t_{1/2} [2^{n+1} - 1]$   
 (D)  $t_{3/4} = t_{1/2} [2^{n+1} + 1]$

- Q 14. For nth order reaction. [AIIMS 2016]

$$\left( \frac{dx}{dt} \right) = \text{Rate} = k[A]^n$$

Graph between  $\log(\text{rate})$  against  $\log[A_0]$  is of the type



Lines P,Q,R,S are for the order

- |     | P | Q | R | S |
|-----|---|---|---|---|
| (A) | 0 | 1 | 2 | 3 |
| (B) | 3 | 2 | 1 | 0 |
| (C) | 1 | 2 | 3 | 0 |
| (D) | 0 | 3 | 2 | 1 |

- Q 15. Time required to decompose half of the substance for nth order reaction is inversely proportional to

- (A)  $a^{n+1}$  (B)  $a^{n-1}$  (C)  $a^{n-2}$  (D)  $a^n$

- Q 16. The pressure of  $\text{NH}_3$  vs half life of its decomposition reactions are given

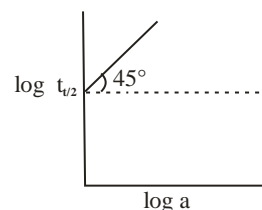
P (mm)	50	100	200
$t_{1/2}$ (min)	3.64	1.82	0.91

The order w.r.t.  $\text{NH}_3$  is

- (A) 0 (B) 1 (C) 2 (D) 3

- Q 17. What will be the order of reaction for a chemical change having  $\log t_{1/2}$  vs  $\log a$  ?

(Where  $a$  = initial concentration of reactant;  $t_{1/2}$  = half - life)



- (A) Zero order (B) First order  
 (C) Second order (D) None of these

- Q 18. For the reaction:  $2A + B_2 + C \rightarrow A_2B + BC$ , the rate law expression has been determined experimentally to be  $R = k[A]^2[C]$  with,  $k = 3.0 \times 10^{-4} \text{ M}^{-2} \text{ min}^{-1}$ . Determine the initial rate ( $\text{Mmin}^{-1}$ ) of the reaction, started with

concentration  $[A] = 0.1 \text{ M}$ ,

$[B_2] = 0.35 \text{ M}$  &  $[C] = 0.25 \text{ M}$

(A)  $7.5 \times 10^{-7}$  (B)  $3 \times 10^{-4}$

(C)  $2.5 \times 10^{-3}$  (D)  $6 \times 10^{-7}$

Q 19. The rate expression for the reaction  $A(g) + B(g) \rightarrow C(g)$  is  $\text{rate} = kC_A^2 C_B^{1/2}$ .

What changes in the initial concentration of A and B will cause the rate of reaction increase by a factor of eight

(A)  $C_A \times 2; C_B \times 2$  (B)  $C_A \times 2; C_B \times 4$

(C)  $C_A \times 1; C_B \times 4$  (D)  $C_A \times 4; C_B \times 1$

Q 20. For the irreversible process,  $A + B \rightarrow$  products, the rate is first order with respect to A and second order with respect to B. If 1.0 mol each of A and B introduced into a 1.0 L vessel, and the initial rate was  $1.0 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1}$ , rate when half reactants have been turned into products is

(A)  $1.25 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$

(B)  $1.0 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1}$

(C)  $2.50 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$

(D)  $2.0 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1}$

Q 21. For the reaction:  $2A + B \rightarrow A_2B$  [NCERT]

The rate =  $k[A][B]^2$ ;  $k = 2.0 \times 10^{-6} \text{ M}^{-2} \text{ s}^{-1}$ .

Calculate the initial rate of the reaction when  $[A] = 0.1 \text{ M}$  &  $[B] = 0.2 \text{ M}$ . Also Calculate the rate after  $[A]$  is reduced to 0.06 M.

### 3. Zeroth & First Order Reaction

Q 1. Identify the reaction order from each of the following rate constants [NCERT Solved]

(i)  $k = 2.3 \times 10^{-5} \text{ L mol}^{-1} \text{ s}^{-1}$

(ii)  $k = 3 \times 10^{-4} \text{ s}^{-1}$

Q 2. If for any reaction, the rate constant is equal to the rate of the reaction at all concentration. The order is

(A) 0 (B) 2 (C) 1 (D) 3

Q 3. If 'a' is the initial concentration of a substance which reacts according to zero order kinetics and K is rate constant, the time for the reaction to go to completion is

(A)  $\frac{a}{K}$  (B)  $\frac{2}{Ka}$  (C)  $\frac{K}{a}$  (D)  $\frac{2K}{a}$

Q 4. The decomposition of  $\text{NH}_3$  on platinum surface is zero order reaction. What are the rates of production of  $\text{N}_2$  and  $\text{H}_2$  if  $k = 2.5 \times 10^{-4} \text{ mol}^{-1} \text{ L s}^{-1}$ ? [NCERT]

Q 5. The rate constant of a zero order reaction is  $0.2 \text{ mol dm}^{-3} \text{ h}^{-1}$ . If the concentration of the reactant after 30 minutes is  $0.05 \text{ mol dm}^{-3}$ . Then its initial concentration would be

(A) 6.05 mol/lit (B) 0.15 mol/lit

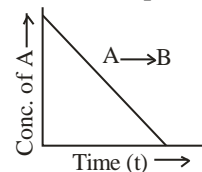
(C) 0.25 mol/lit (D) 4.00 mol/lit

Q 6. For the zero order reaction  $A \rightarrow B + C$ ; concentration of A is 0.1 M. If  $A = 0.08 \text{ M}$  after 10 minutes, then its half-life and completion time (in minute) are respectively

(A) 10, 20 (B)  $2 \times 10^{-3}$ , 500

(C) 25, 50 (D) 250, 500

Q 7. For a general reaction  $A \rightarrow B$ , plot of concentration of A vs time is given in figure. Answer the following questions on the basis of this graph. [NCERT EXAMPLAR]



(i) What is the order of the reaction ?

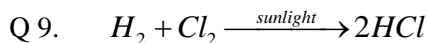
(ii) What is the slope of the curve ?

(iii) What are the units of rate constant ?

Q 8. For the reaction  $\frac{5}{2} A \rightarrow$  product, given that the rate law is  $\text{rate} = k[A]^0$ , find  $t_{1/2}$  of the reaction.

(A)  $\frac{[A]_2}{2k}$  (B)  $\frac{[A]_0}{5/2} k$

(C)  $\frac{[A]_0}{5k}$  (D) None of these



In the above reaction, the order of reaction is

(A) 3 (B) 2 (C) 0 (D) 1

Q 10. The concentration of R in the reaction  $R \rightarrow P$  was measured as a function of time and the following data is obtained. [JEE Adv. 2010]

[R]	1.0	0.75	0.40	0.10
T(min.)	0.0	0.05	0.12	0.18

(A) 0 (B) 1 (C) 2 (D) 3

Q 11. Let decomposition of  $Cl_2O_7(g)$  into  $ClO_2(g)$  &  $O_2(g)$  be a zero order reaction. If

at a particular time  $\frac{-d[Cl_2O_7]}{dt} = 50 \text{ mm of Hg/sec.}$

for the decomposition reaction having initial pressure of  $Cl_2O_7 = 600 \text{ mm of Hg.}$

(A) Calculate rate of production of  $O_2$  at  $t = 2 \text{ sec}$

(B) Calculate  $t_{1/2}$  for reaction of  $Cl_2O_7$

(C) Calculate rate of reaction  $2Cl_2O_7 \rightarrow 4ClO_2 + 3O_2$  at this time

(D) What is the total pressure after 10 sec initially  $ClO_2$  and  $O_2$  were absent ?

Q 12. The rate constant for a first order reaction is  $60 \text{ S}^{-1}$ . How much time will it take to reduce the initial concentration of the reactant to its  $1/16^{\text{th}}$  value ? [NCERT]

Q 13. Thermal decomposition of a compound is of first order. If 50% sample of the compound is decomposed in 120 minute, how long will it take for 90% of the compound to decompose?

(A) 6.6 hours (B) 200 min  
(C) 540 min (D) 6 hours

Q 14. A first order reaction is 50% completed in  $1.26 \times 10^{14} \text{ s}$ . How much time would it take for 100% completion? [NCERT EXAMPLAR]

(A)  $1.26 \times 10^{15} \text{ s}$  (B)  $2.52 \times 10^{14} \text{ s}$   
(C)  $2.52 \times 10^{28} \text{ s}$  (D) Infinite

Q 15. 99% of a first order reaction was completed in 32 minutes when 99.9% of the reaction will complete

(A) 50 min (B) 46 min  
(C) 48 min (D) 49 min

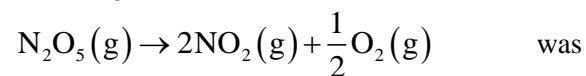
Q 16. The reaction  $A \rightarrow B$  follows first order kinetics. The time taken for 0.8 mole of A to produce 0.6 mole of B is 1 hr. what is the time taken for conversion of 0.9 mole of A to 0.675 mole of B? [CBSE PMT 2003]

(A) 0.25 hr (B) 2 hr  
(C) 1 hr (D) 0.5 hr

Q 17. For a given reaction of first order, it takes 20 minutes for the concentration to drop from 1.0 M to 0.6 M. The time required for the concentration to drop from 0.6 M to 0.36 M will be

(A) more than 20 minutes  
(B) less than 20 minutes  
(C) equal to 20 minutes  
(D) infinity

Q 18. The initial concentration of  $N_2O_5$  in the following first order reaction



$1.24 \times 10^{-2} \text{ mol L}^{-1}$  at 318 K. The concentration of  $N_2O_5$  after 60 minutes was  $0.20 \times 10^{-2} \text{ mol L}^{-1}$ . Calculate the rate constant of the reaction at 318 K. [NCERT Solved]

Q 19. Rate constant of a reaction is  $0.0693 \text{ min}^{-1}$ . Starting with 10 mol, rate of the reaction after 10 min is:

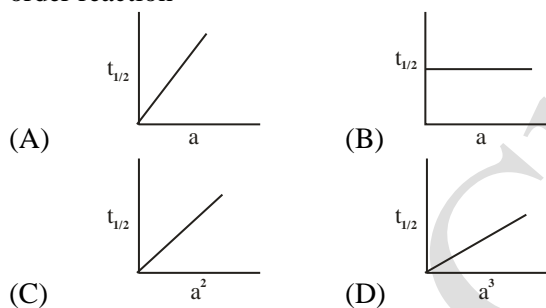
(A)  $0.693 \text{ M min}^{-1}$   
(B)  $0.0693 \times 2 \text{ M min}^{-1}$   
(C)  $0.0693 \times 5 \text{ M min}^{-1}$   
(D)  $0.0693 \times 25 \text{ M min}^{-1}$

Q 20. Rate constant  $k = 2.303 \text{ min}^{-1}$  for a particular reaction. The initial concentration of the reaction is 1 mol/litre then, rate of reaction after 1 minute is

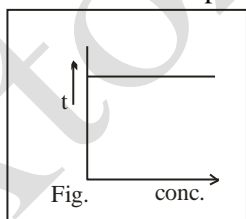
(A)  $2.303 \text{ M min}^{-1}$  (B)  $0.2303 \text{ M min}^{-1}$

- (C)  $0.1 \text{ M min}^{-1}$  (D) None of these
- Q 21. Two first order reaction have half – lives in the ratio 8:1. Calculate the ratio of the intervals  $t_1:t_2$ . The  $t_1$  and  $t_2$  are the time period for  $\left(\frac{1}{4}\right)^{\text{th}}$  completion of 1<sup>st</sup> reaction and  $\left(\frac{3}{4}\right)^{\text{th}}$  2<sup>nd</sup> reaction completion respectively
- (A) 1: 0.301 (B) 0.125: 0.602  
(C) 1 : 0.602 (D) None of these
- Q 22.  $t_{1/4}$  can be taken as the time taken for the conc. of a reactant to drop to  $\frac{3}{4}$  of its initial value. If rate constant for a 1st order reaction is K, then  $t_{1/4}$  is written as [JEE Main 2005/AIIMS 2011]
- (A)  $0.75/K$  (B)  $0.69/K$   
(C)  $0.29/K$  (D)  $0.10/K$

- Q 23. Which of the following curves represents a 1<sup>st</sup> order reaction

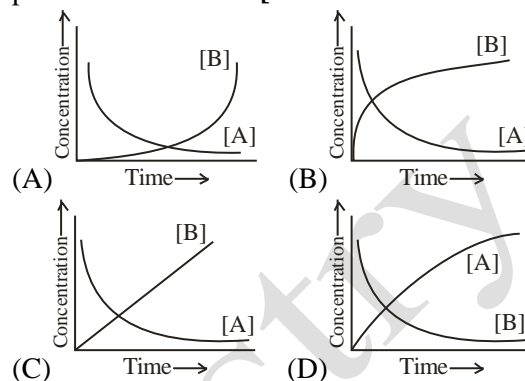


- Q 24. A graph between  $t_{1/2}$  and conc. For n<sup>th</sup> order reaction is a straight line. Reaction of this nature is completed 50% in 10 minutes when conc. is  $2 \text{ mol L}^{-1}$ . This is decomposed 50% in t minutes at  $4 \text{ mol L}^{-1}$  and t are respectively



- (A) 0, 20 min (B) 1, 10 min  
(C) 1, 20 min (D) 0, 5 min
- Q 25. Consider the reaction.  $A \rightarrow B$ . The concentration of both the reactants and the products varies exponentially with time. Which of the following figures correctly describes the

change in concentration of reactants and products with time? [NCERT EXAMPLAR]



#### 4. First Order & Second Order Reaction

- Q 1. In first order reaction,  $\log K$  vs  $t$  is a straight line with slope .....

- (A)  $-K$  (B)  $\frac{-K}{2.303}$   
(C)  $-\frac{K}{R}$  (D)  $\frac{-K}{2.303R}$

- Q 2. In the 1<sup>st</sup> order reaction

$$\text{Rate} = K_1 P_A \quad \& \quad \text{Rate} = K_2 \cdot C_A$$

- (A)  $K_1 > K_2$  (B)  $K_1 < K_2$   
(C)  $K_1 = K_2$  (D) None of these

- Q 3. In the 2<sup>nd</sup> order reaction

$$\text{Rate} = K_1 P_A^2, \quad \text{Rate} = K_2 C_A^2$$

- (A)  $K_p = K_2 RT$  (B)  $K_1 = K_2 (RT)^2$   
(C)  $K_2 = K_1 \cdot RT$  (D)  $K_2 = K_1 (RT)^2$

- Q 4. Find the time duration in which concentration of a substance producing by first order kinetics increases to 10 times of its value, if rate constant is  $2.303 \text{ min}^{-1}$

- (A) 1 min (B) 10 min  
(C) 2.303 min (D) 0.693 min

- Q 5. Double life of first order production is

- (A)  $(0.693)K$  (B)  $0.693/K$   
(C)  $2.303/K$  (D)  $2.303 \cdot K$

- Q 6. Avg life of a first order reaction is

- (A)  $\frac{1}{K}$  (B)  $\frac{1}{t_{1/2}}$   
 (C)  $(0.693) \cdot t_{1/2}$  (D)  $(0.693) \cdot k$

Q 7. In the reaction,  $A \rightarrow \text{Products}$ ,  $-\frac{dA}{dt} = K_1 A$

If we start with 10 M of A, then after one natural life time, concentration of A is

decreased to **[AIIMS 2016]**

- (A) 5 M (B) 2.5 M

- (C)  $\frac{10}{e} M$  (D)  $\frac{10}{e^2} M$

Q 8. For the 2<sup>nd</sup> order reaction

$$Kt = \frac{1}{[A]} - \frac{1}{[A]_0}$$

The ratio of  $t_{3/4}$  &  $t_{1/2}$  is equal to

- (A) 0.2 (B) 2

- (C) 3 (D) 5

Q 9. For the decomposition of NOCl(g)



$K = 0.81 \text{M}^{-1} \text{S}^{-1}$  If  $[\text{NOCl}]_0 = 4 \times 10^{-3} \text{M}$  then

time required for  $[\text{NOCl}]$  to be....

$1.50 \times 10^{-3} \text{M}$

- (A) 185.2 sec (B) 92.6 sec

- (C) 46.3 sec (D) None of these

Q 10. For the reaction  $2\text{NO}_2 \rightarrow \text{N}_2\text{O}_4$

$$\frac{-d[\text{NO}_2]}{dt} = (8 \times 10^{-4}) [\text{NO}]^2$$

If initial concentration of NO is 0.15M then half life of the reaction is

- (A)  $8.34 \times 10^3 \text{sec}$  (B)  $1.67 \times 10^4 \text{sec}$

- (C)  $8.34 \times 10^4 \text{sec}$  (D)  $1.67 \times 10^3 \text{sec}$

Q 11. For the reaction  $2A \rightarrow \text{products}$  :

$$K = 2 \times 10^{-1} \text{M}^{-1} \text{min}^{-1}$$

The time duration in which [A] decreases from 5.0 M to 0.5 M

- (A) 9 min (B) 4.5 min

- (C) 5 min (D) 18 min

Q 12. If production of 'B' follows 2<sup>nd</sup> order kinetics w.r.t B with rate constant of production of B is

$5 \times 10^{-2} \text{M}^{-1} \text{hr}^{-1}$  then the time duration in which [B] increases from 1.0 M to 5.0 M is

- (A) 16 min (B) 8 min

- (C) 32 min (D) None of these

Q 13. For the reaction  $A \rightarrow \text{products}$

time 0 5sec 10sec 12sec

[A] 1.0 0.6M 0.2M 0.04

The order of reaction is

- (A) 0 (B) 1

- (C) 2 (D) None of these

Q 14. For the reaction  $A \rightarrow \text{Products}$

t(min.)	0	10	20	40
[A]	0.020	0.0176	0.0156	0.0122

The order of reaction is

- (A) 0 (B) 1

- (C) 2 (D) None of these

Q 15. For the reaction  $A \rightarrow \text{Products}$

t(min.)	0	10	20	40
[A]	0.20	0.15	0.12	0.0866

The order of reaction is

- (A) 0 (B) 1

- (C) 2 (D) None of these

### 5. Pseudo Order Reaction, Pressure Change Method, Volume Change Method

Q 1. The rate law of the reaction  $A + 2B \rightarrow \text{product}$  is given by  $\frac{d[P]}{dt} = K[A]^2[B]$ . If A is taken in

large excess, the order of the reaction will be

- (A) Zero (B) 1 (C) 2 (D) 3

Q 2. The value of rate constant of a pseudo first order reaction **[NCERT EXAMPLAR]**

(A) depends on the concentration of reactants present in small amount

(B) depends on the concentration of reactants present in excess

(C) is independent of the conc. of reactants

(D) depends only on temperature

Q 3. For the reaction  $A + B \rightarrow \text{Products}$

$$\text{Rate} = K[A]^1[B]^1$$



If  $[A]_0 = 0.5M$  &  $[B]_0 = 0.0001M$  then new rate constant of the pseudo order reaction is

- (A)  $10^{-4}K$  (B)  $0.5K$   
(C)  $5K$  (D)  $10^4.K$

Q 4. In above reaction, time required for  $[B] = 10^{-5}M$  is

- (A)  $\frac{2.303}{K}$  (B)  $\frac{23.03}{K}$   
(C)  $\frac{4.606}{K}$  (D) None of these

Q 5. For the reaction  $2C + D \rightarrow \text{Products}$

Rate =  $K[C]^2[D]^1$  where  $K = 0.5M^{-2}min^{-1}$

If  $[C]_0 = 0.01M$  &  $[D] = 5.0M$  then find the time duration in which  $[C] = 0.001M$

- (A) 180 min (B) 360 min  
(C) 900 min (D) 1800 min

Q 6. In above questions if

$[C] = 2.0M$  &  $[D] = 0.05M$  then the time duration in which  $[D] = 0.02M$  is

- (A) 1.8424 min (B) 0.9212 min  
(C) 3.6848 min (D) None of these

Q 7. Example of pseudo 1<sup>st</sup> order reaction is

- (A) Basic hydrolysis of ester  
(B) Basic hydrolysis of ester  
(C) In version of cane sugar  
(D) Decomposition of  $H_2O_2$

Q 8. Hydrolysis of methyl acetate in aqueous solution has been studied by titrating the liberated acetic acid against sodium hydroxide. The concentration of the ester at different times is given below.

t/min	0	30	60	90
[C]	0.8500	0.8004	0.7538	0.7096

Show that it follows a pseudo first order reaction, as the concentration of water remains nearly constant (55.55M), during the course of the reaction. What is the value of  $k'$  in this equation? [NCERT Solved]

Rate =  $k'[\text{CH}_3\text{COOCH}_3][\text{H}_2\text{O}]$

Q 9. In a pseudo first order hydrolysis of ester in water, the following results were obtained:

t/s	0	30	60	90
[Ester]	0.55	0.31	0.17	0.085

- (i) Calculate the average rate of reaction between the time interval 30 to 60 seconds  
(ii) Calculate the pseudo first order rate constant for hydrolysis of ester. [NCERT]

Q 10. The decomposition of azo methane, at certain temperature according to the equation  $(\text{CH}_3)_2\text{N}_2 \rightarrow \text{C}_2\text{H}_6\text{N}_2$  is a first order reaction. After 40 minutes from the start, the total pressure developed is found to be 350 mm Hg in place of initial pressure 200 mm Hg of azo methane. The value of rate constant  $k$  is  
(A)  $2.88 \times 10^{-4} s^{-1}$  (B)  $1.25 \times 10^{-4} s^{-1}$   
(C)  $5.77 \times 10^{-4} s^{-1}$  (D) None of these

Q 11. The following data were obtained during the first order thermal decomposition of  $\text{N}_2\text{O}_5(g)$  at constant volume [NCERT Solved]  
 $2\text{N}_2\text{O}_5(g) \rightarrow 2\text{N}_2\text{O}_4(g) + \text{O}_2(g)$

S. NO.	Time/s	P <sub>Total</sub> (atm)
1.	0	0.5
2.	100	0.512

Calculate the rate constant

Q 12. The decomposition of a gaseous substance A to yield gaseous product,  $\text{A}(g) \rightarrow 2\text{B}(g) + \text{C}(g)$  follows first order kinetics. If the total pressure at the start of an experiment & 9 minutes after the start are 100 mm and 150 mm, what is the rate constant?  
(A)  $0.06804 \text{ min}^{-1}$  (B)  $0.032 \text{ min}^{-1}$   
(C)  $0.04536 \text{ min}^{-1}$  (D)  $0.3780 \text{ min}^{-1}$

Q 13. For a first order homogeneous gaseous reaction,  $\text{A} \rightarrow 2\text{B} + \text{C}$  then initial pressure was  $P$  while total pressure after time 't' was  $P_t$ . The write expression for the rate constant  $k$  in terms of  $P_t, P_i$  and t is

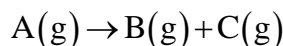
(A)  $k = \frac{2.303}{t} \log \left( \frac{2P_t}{3P_t - P_i} \right)$

$$(B) \quad k = \frac{2.303}{t} \log \left( \frac{2P_i}{3P_t - P_i} \right)$$

$$(C) \quad k = \frac{2.303}{t} \log \left( \frac{P_i}{P_i - P_t} \right)$$

(D) None of these

Q 14. Consider a first order gas phase decomposition reaction given below [NCERT EXAMPLAR]



The initial pressure of the system before decomposition of A was  $p_i$ . After lapse of time 't' total pressure of the system increased by x units and became ' $p_t$ '. The rate constant k for the reaction is given as

$$(A) \quad k = \frac{2.303}{t} \log \frac{p_i}{p_i - x}$$

$$(B) \quad k = \frac{2.303}{t} \log \frac{p_i}{2p_i - p_t}$$

$$(C) \quad k = \frac{2.303}{t} \log \frac{p_i}{2p_i + p_t}$$

$$(D) \quad k = \frac{2.303}{t} \log \frac{p_i}{p_i + x}$$

Q 15. The following data represent for the decomposition of  $NH_4NO_2$  in aqueous solution

T(min.)	10	15	20	25	$\infty$
$V_{N_2}$ (ml)	6.25	9.0	11.40	13.65	33.05

Calculate velocity constant

$$(A) \quad 2 \times 10^{-2} \text{ min}^{-1} \quad (B) \quad 3 \times 10^{-2} \text{ min}^{-1}$$

$$(C) \quad 4 \times 10^{-3} \text{ min}^{-1} \quad (D) \quad 2 \times 10^{-3} \text{ min}^{-1}$$

Q 16. The decomposition of  $N_2O_5$  in chloroform was followed by measuring the volume of  $O_2$  gas evolved  $2N_2O_5 \rightarrow 2N_2O_4 + O_2(g)$ . The maximum volume of  $O_2$  gas obtained was  $100\text{cm}^3$ . In 500 minutes,  $90\text{cm}^3$  of  $O_2$  were

evolved. The first order rate constant (in  $\text{min}^{-1}$ ) for the disappearance of  $N_2O_5$  is

$$(A) \quad \frac{2.303}{500} \quad (B) \quad \frac{2.303}{500} \log \frac{100}{90}$$

$$(C) \quad \frac{2.303}{500} \log \frac{90}{100} \quad (D) \quad \frac{100}{10 \times 500}$$

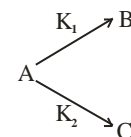
Q 17. The half - life of first order decomposition of  $NH_4NO_2$  is 2.10 hr at 288 K temperature  $NH_4NO_2(aq) \rightarrow N_2(g) + 2H_2O(l)$ , if 6.4g of  $NH_4NO_2$  is allowed to decompose, The time required for  $NH_4NO_2$  to decompose 90% and the volume of dry  $N_2$  produced at this point measured at NTP are respectively

$$(A) \quad 6.978 \text{ hr}, 2.016 \text{ L} \quad (B) \quad 0.319 \text{ hr}, 2.12 \text{ L}$$

$$(C) \quad 0.319 \text{ hr}, 2.016 \text{ L} \quad (D) \quad \text{None of these}$$

### 6. Parallel 1<sup>st</sup> order Reaction

Q 1. A substance undergoes first order decomposition. The decomposition follows two



parallel first order reaction as

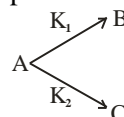
$$k_1 = 1.26 \times 10^{-4} \text{ sec}^{-1} \text{ and } k_2 = 3.6 \times 10^{-5} \text{ sec}^{-1}$$

. Calculate the % distribution of B & C.

$$(A) \quad 23.2, 76.8 \quad (B) \quad 77.7, 22.3$$

$$(C) \quad 66.5, 33.5 \quad (D) \quad 80.20$$

Q 2. A substance undergoes first order decomposition. The decomposition follows two parallel first order reactions as

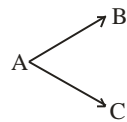


The percentage distributions of B and C are 76.83% B and 23.17% C If  $k_1 = 1.26 \times 10^{-4} \text{ s}^{-1}$  then find the value of  $k_2$

The percentage distributions of B and C are

- (A)  $3.8 \times 10^{-6} \text{ s}^{-1}$  (B)  $3.9 \times 10^{-5} \text{ s}^{-1}$   
 (C)  $3.8 \times 10^{-3} \text{ s}^{-1}$  (D)  $3.8 \times 10^{-4} \text{ s}^{-1}$

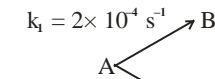
Q 3. For the following parallel chain reaction



the overall half life of A is 12 hrs of rate of formation of C is 60% of a rate of decomposition of A than what will be half life of A while it is converting into B

- (A) 40 hours (B) 60 hours  
 (C) 50 hours (D) 30 hours

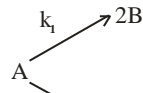
Q 4. For the following parallel chain reaction



if the sum of the concentration of B and C at any time is 2M then, what will be  $[B]_t$  and  $[C]_t$  respectively ?

- (A)  $\frac{11}{12} \text{ M}$  &  $\frac{13}{12} \text{ M}$  (B)  $\frac{3}{4} \text{ M}$  &  $\frac{5}{4} \text{ M}$   
 (C)  $\frac{4}{5} \text{ M}$  &  $\frac{6}{5} \text{ M}$  (D)  $\frac{8}{13} \text{ M}$  &  $\frac{18}{13} \text{ M}$

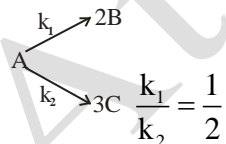
Q 5. For a hypothetical elementary reaction



where  $\frac{k_1}{k_2} = \frac{1}{2}$  Initially only 2 moles of A are present. The total number of moles of A, B & C at the end of 50% reaction are

- (A) 2 (B) 3  
 (C) 5 (D) None

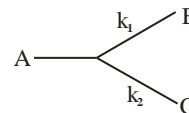
Q 6. For the reaction



The total no. of moles of A, B & C at the end of 50% reaction when started with 10 mole of A is

- (A) 30 mole (B)  $\frac{55}{3}$  mole  
 (C) 20mole (D) None of these

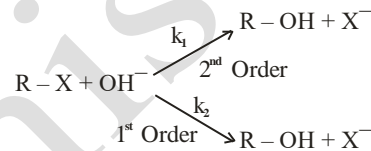
Q 7. A certain organic compound A decompose by two parallel first order mechanisms



If  $k_1 : k_2 = 1 : 9$  and  $k_1 = 1.3 \times 10^{-5} \text{ s}^{-1}$ . Calculate the concentration ratio of C to A if an experiment is started with only A and allowed to run for one hour

- (A) 0.537 (B) 0.355  
 (C) 0.0525 (D) 1.52

Q 8. For the reaction



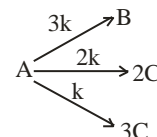
The rate is given by

$$\text{Rate} = k_1 [\text{RX}] [\text{OH}^-] + k_2 [\text{RX}]$$

Calculate % of RX which reacts by 2<sup>nd</sup> order mechanism, when  $[\text{OH}^-]$  is 0.1 M

- (A)  $\frac{k_1 \times 100}{k_1 + k_2}$  (B)  $\frac{k_2 \times 100}{k_1 + k_2}$   
 (C)  $\frac{10k_1}{k_1 + k_2}$  (D)  $\frac{100k_1}{k_1 + 10k_2}$

Q 9. For the first order parallel reaction of A starting with 1 M initial concentration of A



Which of the following is/are true

- (A)  $[B]_t : [C]_t : [D]_t$  is independent of time  
 (B)  $[C]_t > [B]_t = [D]_t$   
 (C)  $[C]_\infty = 0.67 \text{ M}$   
 (D) If  $k = 0.5 \text{ min}^{-1}$  then  $[B] = 1 \text{ M}$  after 1.386 min

Q 10. For the consecutive unimolecular type first order reaction,  $A \xrightarrow{k_1} R \xrightarrow{k_2} S$ , the concentration of component A, CA at any time is given by

- (A)  $C_A = C_{A_0} e^{(k_1+k_2)t}$  (B)  $C_A = C_{A_0} e^{-(k_1+k_2)t}$   
 (C)  $C_A = C_{A_0} e^{-k_1t}$  (D)  $C_A = C_{A_0} e^{k_1t}$
- Q 11. For the reaction  $A \rightarrow B \rightarrow C$ ,  $t_{1/2}$  for A and B are 4 & 2 minutes respectively. How much time would be required for B to reach maximum concentration.  
 (A) 2 min (B) 4 min  
 (C) 6 min (D) 8 min
- Q 12. In above question,  $\frac{[B]}{[A]}$  at any time 't' ( $t \neq 0$ ) is equal to  
 (A) 1 (B) 1:2  
 (C) 2:1 (D) None of these

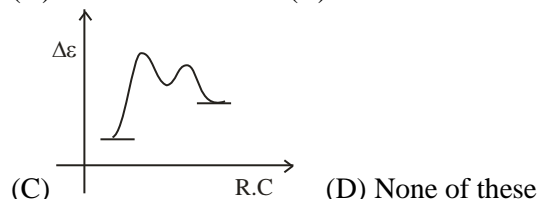
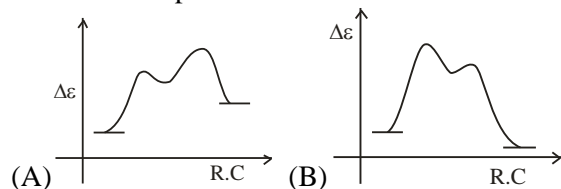
### 7. Reaction Mechanism

- Q 1. The rate law for the single -step reaction,  $2A + B \rightarrow 2C$ , is given by  
 (A) Rate =  $K[A] \cdot [B]$   
 (B) Rate =  $K[A]^2 \cdot [B]$   
 (C) Rate =  $K[2A] \cdot [B]$   
 (D) Rate =  $K[A]^2 \cdot [B]^0$
- Q 2. For the elementary step,  
 $(CH_3)_3.CBr(aq) \rightarrow (CH_3)_3.C^+(aq) + Br^-$   
 the molecularity is  
 (A) Zero (B) 1  
 (C) 2 (D) Can't determine
- Q 3. The following two step mechanism has been proposed for the gas - phase decomposition of nitrous oxide ( $N_2O$ )  
 Step I:  $N_2O(g) \rightarrow N_2(g) + O(g)$   
 Step II:  $N_2O(g) + O(g) \rightarrow N_2(g) + O_2(g)$   
 What is the molecularity of each of the elementary reactions and over all molecularity ?  
 (A) 1,2,3 (B) 1,2,2
- (C) 1,2,0 (D) 1,2, not defined
- Q 4. For the reaction  $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$  the experiment data suggested that  
 $r = k[H_2][Br_2]^{1/2}$  the molecularity and order of the reaction are respectively  
 (A) 2, 3/2 (B) 3/2, 3/2  
 (C) Not defined, 3/2 (D) 1, 1/2
- Q 5. For a reaction  $A + B \rightarrow$  Products, the rate law is  $-\text{Rate} = k[A][B]^{3/2}$ . Can the reaction be an elementary reaction ? Explain.  
**[NCERT EXAMPLAR]**
- Q 6. **Assertion (A):** Order and molecularity are same  
**[NCERT EXAMPLAR]**  
**Reason (R):** Order is determined experimentally & molecularity is the sum of the stoichiometric coefficient of rate determining elementary step  
 (A) Both assertion & reason are correct & the reason is correct explanation of assertion  
 (B) Both assertion and reason are correct, but reason does not explain assertion  
 (C) Assertion is correct, but reason is incorrect  
 (D) Both assertion and reason are incorrect  
 (E) Assertion is incorrect, but reason is correct
- Q 7. In the reversible reaction  $2NO_2 \xrightleftharpoons[K_2]{K_1} N_2O_4$ , the rate of disappearance of  $NO_2$  is equal to  
 (A)  $\frac{2K_1}{K_2}[NO_2]^2$   
 (B)  $2K_1[NO_2]^2 - 2K_2[N_2O_4]$   
 (C)  $2K_1[NO_2]^2 - K_2[N_2O_4]$   
 (D)  $(2K_1 - K_2)[NO_2]$
- Q 8. For  $2A \xrightleftharpoons[k_{-1}]{k_1} B + 3C, 2C \xrightarrow{k_2} 3D$ , assuming all reactions to be single step (Elementary) reactions. Find the expression for  $\frac{d[C]}{dt}$

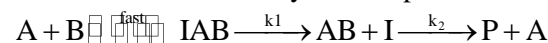
- Q 9. For the reaction sequence  
 $A + B \xrightleftharpoons{K_1} C + G$   
 $C + D \xrightarrow{K_2} E$ ;  $E + F \xrightarrow{K_3} 2C$   
 The term  $\frac{d[C]}{dt}$  is expressed as  
 (A)  $K_1[A][B] - K_{-1}[C][G] - K_2[C][D] + 2K_3[E][F]$   
 (B)  $K_1[A][B] - K_{-1}[C][G] - K_2[C][D] - K_3[E][F]$   
 (C)  $-K_2[C][D] + K_3[E][F][G] - K_2[C][D] + K_3[E][F]$   
 (D) None of these
- Q 10. For the reaction  $2NO_2 + F_2 \rightarrow 2NO_2F$ , following mechanism has been provided:  
 $NO_2 + F_2 \xrightarrow{\text{Slow}} NO_2F + F$   
 $NO_2 + F \xrightarrow{\text{fast}} NO_2F$   
 Thus rate expression of the above reaction can be written as  
 (A)  $r = k[NO_2]^2[F_2]$  (B)  $r = k[NO_2][F_2]$   
 (C)  $r = k[NO_2]$  (D)  $r = k[F_2]$
- Q 11. Following mechanism has been proposed for a reaction.  
 $2A + B \rightarrow D + E$   
 $A + B \rightarrow C + D \dots\dots$  (slow)  
 $A + C \rightarrow E \dots\dots$  (fast)  
 The rate law expression for the reaction is  
 (A)  $r = K[A]^2[B]$  (B)  $r = K[A][B]$   
 (C)  $r = K[A]^2$  (D)  $r = K[A][C]$
- Q 12. Mechanism of a hypothetical reaction  
 $X_2 + Y_2 \rightarrow 2XY$  is given below [NEET 2017]  
 $X_2 \rightleftharpoons X + X$  (fast)  
 $X + Y_2 \rightarrow XY + Y$  (slow)  
 $X + Y \rightarrow XY$  (fast)  
 The overall order of reaction will be  
 (A) 1 (B) 2 (C) 0 (D) 1.5
- Q 13. The chemical reaction,  $2O_3 \rightarrow 3O_2$  proceeds as follows  
 $O_3 \rightleftharpoons O_2 + O \dots\dots$  (fast)  
 $O + O_3 \rightarrow 2O_2 \dots$  (slow)  
 The rate law expression should be  
 (A)  $r = K[O_3]^2$  (B)  $r = K[O_3]^2[O_2]^{-1}$   
 (C)  $r = K[O_3][O_2]$  (D) Unpredictable
- Q 14. The mechanism of the reaction,  
 $2H_2 + 2NO \rightarrow N_2 + 2H_2O$   
 Follows the steps  
 $2NO \rightleftharpoons N_2O_2$   
 $N_2O_2 + H_2 \rightarrow N_2O + H_2O$  (slow)  
 $N_2O + H_2 \rightarrow N_2 + H_2O$  (fast)  
 The overall order of the reaction is  
 (A) 2 (B) 3 (C) 4 (D) 1
- Q 15. For a two step reaction  
 $A \rightleftharpoons R \xrightarrow{K_2} B$ ;  $R + C \xrightarrow{K_3} \text{Products}$   
 (where, R is a reactive intermediate, whose concentration is maintained at some low steady state throughout the reaction). Find the rate law expression.
- Q 16. For the reaction  
 $H^+ + HNO_2 + C_6H_5NH_2 \xrightarrow{Br^-} C_6H_5N_2^+ + 2H_2O$   
 The mechanism is given as  
 $H^+ + HNO_2 \rightleftharpoons H_2NO_2^+$  (fast eq.)  
 Intermediate  
 $H_2NO_2^+ + Br^- \xrightarrow{K_3} NOBr + H_2O$  (slow)  
 $NOBr + C_6H_5NH_2 \rightarrow C_6H_5N_2^+ + H_2O + Br^-$  fast  
 Find the rate law of the overall reaction.
- Q 17. The steady-state concentration of the activated molecule  $[A^*]$  in the following sequence of steps  
 $A + A \xrightarrow{K_1} A + A^*$   
 $A^* + A \xrightarrow{K_2} 2A$   
 is given by  
 (A)  $k_2[A] / k_1$  (B)  $k_1[A] / k_2$

(C)  $k_1 k_2 [A]$  (D)  $k_1 k_2 / [A]$

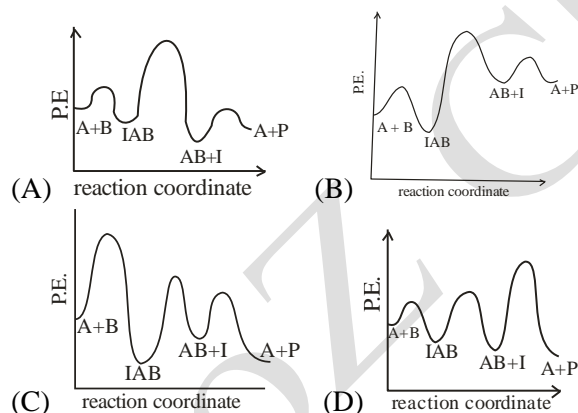
Q 18. A two step endothermic reaction with 1<sup>st</sup> step as Rds can be represented as



Q 19. The following mechanism has been proposed for the exothermic catalyzed complex reaction



If  $k_1$  is much smaller than  $k_2$ . The most suitable qualitative plot of potential energy (P.E.) versus reaction coordinate for the above reaction



## 8. Collision Model For Chemical Kinetics

Q 1. The rate of reaction becomes 2 times for every 10°C rise in temperature. How the rate of reaction will increase when temperature is increased from 30°C to 80°C [JEE Main 2011]

(A) 16 times (B) 32 times  
(C) 64 times (D) 128 times

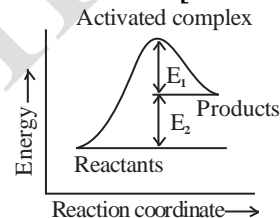
Q 2. For a certain reaction the variation of the rate constant with temperature is given by the equation in ( $t \geq 0^\circ\text{C}$ )

The value of the temperature coefficient of the reaction rate is, therefore

(A) 0.1 (B) 1.0  
(C) 10 (D) 2

Q 3. Consider figure and mark the correct option

[NCERT EXAMPLAR]



(A) Activation energy of forward reaction is  $E_1 + E_2$  and product is less stable than reactant

(B) Activation energy of forward reaction is  $E_1 + E_2$  and product is more stable than reactant

(C) Activation energy of both forward and backward reaction is  $E_1 + E_2$  and reactant is more stable than product

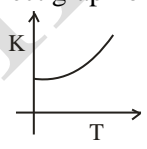
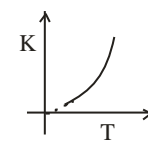
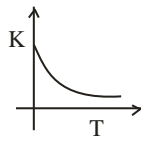
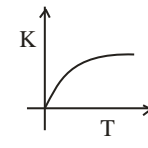
(D) Activation energy of backward reaction is  $E_1$  and product is more stable than reactant

Q 4. What percentage fraction of the molecule will cross over the energy barrier at 1000 K temperature for 18.424 KJ/mol activation energy ( $R = 8\text{J mol}^{-1}\text{K}^{-1}$ )

(A) 10 % (B) 20%  
(C) 90% (D) 80 %

Q 5. In a chemical reaction  $1/4^{\text{th}}$  of the molecules are in activated state at  $T = 127^\circ\text{C}$ . The activation energy of the reaction is (in  $2 = 0.7$ )

(A) 280 R (B) 560 R  
(C) 56 R (D) 28 R

- Q 6. The activation energy for the reaction  $2\text{HI}(\text{g}) \rightarrow \text{H}_2 + \text{I}_2(\text{g})$  is  $209.5 \text{ kJ mol}^{-1}$  at 581K. Calculate the fraction of molecules of reactants having energy equal to or greater than activation energy? [NCERT]
- Q 7. Rate of reaction increases by lower factor than increment in effective collision due to  
 (A) activation energy  
 (B) orientation factor  
 (C) Arrhenius Constant  
 (D) None of these
- Q 8. **Assertion (A):** All collision of reactant molecules lead to product formation  
**Reason (R):** Only those collisions in which molecules have correct orientation and sufficient kinetic energy lead to compound formation. [NCERT EXAMPLAR]  
 (A) Both assertion and reason are correct and the reason is correct explanation of assertion  
 (B) Both assertion and reason are correct, but reason does not explain assertion  
 (C) Assertion is correct, but reason is incorrect  
 (D) Both assertion and reason are incorrect  
 (E) Assertion is incorrect, but reason is correct
- Q 9. **Assertion (A):** Rate constant determined from Arrhenius equation are fairly accurate for simple as well as complex molecules  
**Reason (R):** Reactant molecules undergo chemical change irrespective of their orientation during collision. [NCERT EXAMPLAR]  
 (A) Both assertion and reason are correct and the reason is correct explanation of assertion  
 (B) Both assertion and reason are correct, but reason does not explain assertion  
 (C) Assertion is correct, but reason is incorrect  
 (D) Both assertion and reason are incorrect  
 (E) Assertion is incorrect, but reason is correct
- Q 10. Which of the following statements is incorrect about the collision theory of chemical reaction? [NCERT EXAMPLAR]  
 (A) It considers reacting molecules or atoms to be hard spheres and ignores their structural features  
 (B) Number of effective collisions determines the rate of reaction  
 (C) Collision of atoms or molecules possessing sufficient threshold energy results into the product formation  
 (D) Molecules should collide with sufficient threshold energy and proper orientation for the collision to be effective
- Q 11. Arrhenius constant is  
 (A) independent of temperature  
 (B) dependent on temperature  
 (C) Independent of orientation factor  
 (D) Independent of collision frequency
- Q 12. The correct graph of K vs T is  
 (A)  (B)   
 (C)  (D) 
- Q 13. What is the slope of the straight line for the graph drawn between  $\ln k$  and  $1/T$ , where  $k$  is the rate constant of a reacting at temperature  $T$ ?  
 (A)  $\frac{-E_a}{2.303R}$  (B)  $\frac{-E_a}{R}$   
 (C)  $\frac{E_a}{R}$  (D)  $\frac{R}{E_a}$
- Q 14. First order rate constant  $k$  is related to temp. as  $\log k = 15.0 - (10^6/T)$  which of the following pair of value is correct?  
 (A)  $A = 10^{15}$  and  $E = 1.9 \times 10^4 \text{ KJ}$   
 (B)  $A = 10^{-15}$  and  $E = 40 \text{ KJ}$   
 (C)  $A = 10^{15}$  and  $E = 40 \text{ KJ}$   
 (D)  $A = 10^{-15}$  and  $E = 1.9 \times 10^4 \text{ KJ}$
- Q 15. For a first order rate constant  $k$  is related to temp. as  $\log k = 6.0 - (2000/T)$ . Which of the following values are correct? [IIT-JEE 2009]  
 (A)  $A = 10^6$  and  $E_a = 9.2 \text{ KJ}$

- (B)  $A = 6$  and  $E_a = 16.6\text{KJ}$   
 (C)  $A = 10^6$  and  $E_a = 16.6\text{KJ}$   
 (D)  $A = 10^6$  and  $E_a = 38.3\text{KJ}$
- Q 16. Activation energy of a chemical reaction can be Determined by [NCERT E./CBSE PMT 1998]  
 (A) evaluating rate constant at standard temperature  
 (B) evaluating velocities of reaction at two different temperature  
 (C) evaluating rate constant at two different temperature  
 (D) changing concentration of reactants
- Q 17. How much faster would a reaction proceed at  $25^\circ\text{C}$  that at  $0^\circ\text{C}$  if the activation energy is  $65\text{ kJ}$ ?  
 (A) 2 times (B) 5 times  
 (C) 11 times (D) 16 times
- Q 18. A first order reaction is 50% completed in 20 minutes at  $27^\circ\text{C}$  if  $3.8 \times 10^{-16}\%$  of the reactant molecules exists in the activated state, the  $E_a$  (activation energy) of the reaction is  
 (A) 12 kJ/mole (B) 831.4 kJ/mole  
 (C) 100 kJ/mole (D) 88.57 kJ/mole
- Q 19. The activation energy of certain reaction is  $87\text{ KJ mol}^{-1}$ . What is the ratio of the rate constants for this reaction when the temperature is decreased from  $37^\circ\text{C}$  to  $15^\circ\text{C}$ ?  
 (A) 5/1 (B) 8.3/1  
 (C) 13/1 (D) 24/1
- Q 20. From the following data; the activation energy for the reaction (cal/mol)  $\text{H}_2 + \text{I}_2 \rightarrow 2\text{HI}$
- | T, (in, K) | 1/T, (in, $\text{K}^{-1}$ ) | $\log_{10} K$ |
|------------|-----------------------------|---------------|
| 769        | $1.3 \times 10^{-3}$        | 2.9           |
| 667        | $1.5 \times 10^{-3}$        | 1.1           |
- (A)  $4 \times 10^4$  (B)  $2 \times 10^4$   
 (C)  $8 \times 10^4$  (D)  $3 \times 10^4$
- Q 21. A reactant (A) forms two products  
 $\text{A} \xrightarrow{k_1} \text{B}$ , Activation energy  $E_{a_1}$   
 $\text{A} \xrightarrow{k_2} \text{C}$ , Activation energy  $E_{a_2}$   
 If  $E_{a_2} = 2E_{a_1}$ , then  $k_1$  and  $k_2$  are related as
- (A)  $k_1 = 2k_2 e^{E_{a_2}/RT}$  (B)  $k_1 = k_2 e^{E_{a_1}/RT}$   
 (C)  $k_2 = k_1 e^{E_{a_2}/RT}$  (D)  $k_1 = Ak_2 e^{E_{a_1}/RT}$
- Q 22. The rate constant  $K_1$  &  $K_2$  for two different reactions are  $10^{16} \cdot e^{-2000/T}$  &  $10^{15} \cdot e^{-1000/T}$  respectively. The temperature at which  $K_1 = K_2$  is [CBSE AIPMT 2008]  
 (A) 1000 K (B)  $\frac{2000}{2.303}$  K  
 (C) 2000 K (D)  $\frac{1000}{2.303}$  K
- Q 23. The rate constants of a reaction at  $500\text{ K}$  and  $700\text{ K}$  are  $0.02\text{s}^{-1}$  and  $0.07\text{s}^{-1}$  respectively. Calculate the values of  $E_a$  and  $A$ . [NCERT Solved]
- Q 24. The first order rate constant for the decomposition of ethyl iodide by the reaction  $\text{C}_2\text{H}_5\text{I}(\text{g}) \rightarrow \text{C}_2\text{H}_4(\text{g}) + \text{HI}(\text{g})$  at  $600\text{ K}$  is  $1.60 \times 10^{-5}\text{s}^{-1}$ . Its energy of activation is  $209\text{ kJ/mol}$ . Calculate the rate constant of the reaction at  $700\text{K}$ . [NCERT Solved]
- Q 25. The rate constant for the decomposition of hydrocarbons in  $2.418 \times 10^{-5}\text{s}^{-1}$  at  $546\text{ K}$ . If the energy of activation is  $179.9\text{ kJ/mol}$ . What will be the value of pre-exponential factor. [NCERT]
- Q 26. The decomposition of hydrocarbon follows the equation  $k = (4.5 \times 10^{11}\text{s}^{-1}) e^{-28000\text{K}/T}$   
 Calculate  $E_a$ . [NCERT]
- Q 27. The decomposition of A into product has value of  $k$  as  $4.5 \times 10^3\text{s}^{-1}$  at  $10^\circ\text{C}$  and energy of activation  $60\text{ kJ mol}^{-1}$ . At what temperature would  $k$  be  $1.5 \times 10^4\text{s}^{-1}$ ? [NCERT]
- Q 28. The time required for 10% completion of a first order reaction at  $298\text{K}$  is equal to that required for its 25% completion at  $308\text{ K}$ . If the value of  $A$  is  $4 \times 10^{10}\text{s}^{-1}$ . Find  $K$  at  $318\text{K}$  &  $E_a$  [NCERT]



### 9. Arrhenius Equation, Catalyst effect

- Q 1. A reaction takes place in various steps. The rate constant for first, second, third and fifth step are  $k_1, k_2, k_3$  and  $k_5$  respectively. The overall rate constant is given by

$$K = \frac{K_2}{K_3} \left( \frac{K_1}{K_5} \right)^{1/2}$$

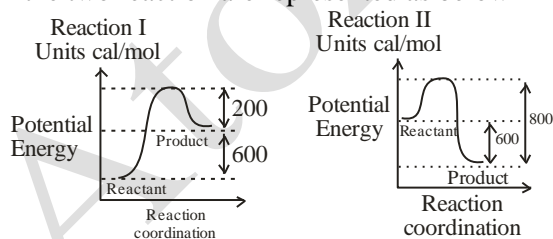
If activation energy are 40,60,50 and 10 KJ/mol respectively, the overall energy of activation (KJ/mol)

- (A) 10 (B) 20  
(C) 25 (D) None of these
- Q 2. The rate constant, the activation energy, and the Arrhenius parameter of a reaction at 25°C are  $3.0 \times 10^{-4} \text{ s}^{-1}$ ,  $104.4 \text{ KJ mol}^{-1}$ , and  $6.0 \times 10^{14} \text{ s}^{-1}$  respectively. The value of rate constant as  $T \rightarrow \infty$  is [IIT-JEE 1996S]
- (A)  $2.0 \times 10^{18} \text{ s}^{-1}$  (B)  $6.0 \times 10^{14} \text{ s}^{-1}$   
(C) Infinity (D)  $3.6 \times 10^{30} \text{ s}^{-1}$

- Q 3. The term  $\frac{1}{K} \frac{dK}{dT}$  is equal to

(A)  $\frac{\epsilon_a}{RT}$  (B)  $\frac{-\epsilon_a}{RT}$   
(C)  $\frac{\epsilon_a}{RT^2}$  (D)  $\frac{-\epsilon_a}{RT^2}$

- Q 4. For the two reactions I & II [ $A_i$  &  $E_a$  are constant]  $A_i = 2A_{ii}$  & the energy diagram of the two reaction are represented as below



Given:  $\Delta G^0 = \Delta H^0 - \Delta S^0 = 0 \ln K_{eq}$

- (i) The ratio of rate constant of forward reaction for both reaction is independent of temperature  
(ii) 1st reaction is endothermic & 2nd is exothermic.

- (iii) At 300K, value of equilibrium constant of reaction I = e  
(iv) At 300 K, value of equilibrium constant of reaction II = e  
(A) ii & iii are true  
(B) I & iv are true  
(C) only ii is true  
(D) None of these

- Q 5. For the reaction  $A + B \rightarrow C + D$ ;  $\Delta H = +20 \text{ kJ/mole}$ , the activation energy of the forward reaction is 85 kJ/mole. Calculate the activation energy of the reverse reaction  
(A) 105 kJ/mol (B) 85 kJ/mol  
(C) 65 kJ/mol (D) 45 kJ/mol
- Q 6. Water and oxygen atoms react in upper atmospheric level bimolecularly to form two OH radicals having heat of reaction 72 kJ at 400 K and energy of activation being 77 kJ. Calculate the  $E_{af}$  (kJ) for bimolecular combination of two OH radicals to form  $\text{H}_2\text{O}$  and O-atom.  
(A) 10 (B) 72  
(C) 77 (D) 5

- Q 7. In presence of catalyst, [NCERT EXAMPLAR]  
(A) Activation energy decreases  
(B) Enthalpy change decreases  
(C) Equation constant decreases  
(D) More amount of product is formed from a given amount of reactant
- Q 8. Which of the following statement is not correct for the catalyst? [NCERT EXAMPLAR]  
(A) It catalyses the forward and backward reactions to the same extent  
(B) It alters  $\Delta G$  of the reaction  
(C) It is a substance that does not change the equilibrium constant of a reaction  
(D) It provides an alternate mechanism by reducing activation energy between reactions and products

- Q 9. **Assertion (A):** The enthalpy of reaction remains constant in the presence of a catalyst  
**Reason (R):** A catalyst participating in the reaction forms different activated complex and lowers down the activation energy but the

difference in energy of reactant and product remains the same. [NCERT EXAMPLAR]

- (A) Both assertion and reason are correct and the reason is correct explanation of assertion  
 (B) Both assertion and reason are correct, but reason does not explain assertion  
 (C) Assertion is correct, but reason is incorrect  
 (D) Both assertion and reason are incorrect  
 (E) Assertion is incorrect, but reason is correct
- Q 10. on adding a catalyst at 300 K, the activation energy increases by 5.75 KJ/mol. The ratio of rate constant ( $\frac{K_1}{K_2}$ ) will be [AIIMS 2018]  
 (A) 20 times (B) 10 times  
 (C) 1000 times (D) 100 times
- Q 11. A hydrogenation reaction is carried out at 500 K. If the same reaction is carried out in presence of a catalyst at the same rate, the temperature required is 400 K. Calculate Activation energy of the reaction if catalyst decreases activation energy by 20 kJ mol<sup>-1</sup> [IIT-JEE 2003]  
 (A) 80 KJ (B) 100 KJ  
 (C) 120 KJ (D) None of these
- Q 12. Rate constant becomes 2 times if catalyst is add to a reaction at 400 K. The activation energy of the reaction in absence of catalyst, if in presence of catalyst activation energy is 20 kcal  
 (A) 580 kcal (B) 20.56 k cal
- (C) 540 k cal (D) None of these
- Q 13. At 380 °C, the half life period for the first order decomposition of H<sub>2</sub>O<sub>2</sub> is 360 min. The energy of activation of the reaction is 200 kJ K = 9.13 × 10<sup>-4</sup> sec<sup>-1</sup>, E<sub>a</sub> = 76.65kJ . Calculate the time required for 75% decomposition at 450 °C.
- Q 14. The time required for 10% completion of a first order reaction at 298 K is equal to that required for its 25 % completion at 308 K. If the pre – exponential factor for the reaction is 3.56 × 10<sup>9</sup> s<sup>-1</sup>, calculate its rate constant at 318 K and also the energy of activation
- Q 15. In the Arrhenius equation for a certain reaction, the values of A and E<sub>a</sub> (energy of activation) are 4 × 10<sup>13</sup> sec<sup>-1</sup> and 98.6kJ mol<sup>-1</sup> respectively. If the reaction is of first order, at what temperature will its half life period be 10 minute ?
- Q 16. A first order reaction A → B requires activation energy of 70 kJ. When a 20% solution of A was kept at 25 °C for 20 minutes, 50% decomposition took place. What will be the percent decomposition in the same time in a 30% solution maintained at 40°C ? Assume that activation energy remains constant in this range of temperature ? Given  $e^{\frac{745}{900}} \times \ln 2 = 1.6 = \ln 5$

## Answer Key

(13). A (14). B (15). C

## 1. Introduction, Rate of Reaction

- (1). A (2). D (3). B  
 (4). B (5). C (6). A  
 (7). A (8). D (9). B  
 (10). D (11). C (12). B  
 (13). D (14). C (15). C  
 (16). B (17).  $4.07 \times 10^{-2} \text{ mol.l}^{-1} \text{ h}^{-1}$ ,  
 $6.79 \times 10^{-4} \text{ mol.l}^{-1} \text{ min}^{-1}$ ,  
 $1.13 \times 10^{-5} \text{ mol.l}^{-1} \text{ s}^{-1}$

Rate of production of  $\text{NO}_2 = 2.72 \times 10^{-3} \text{ mol.l}^{-1} \text{ min}^{-1}$ 

## 2. Differential Rate Law,

## Integrated rate laws for nth order Reaction

- (1). D (2). B (3). A: 2, B: 1/2  
 (4). A (5). B (6). B  
 (7). C (8). B (9). D  
 (10). C (11). D (12). C  
 (13). A (14). B (15). B  
 (16). C (17). A (18). A  
 (19). B (20). A  
 (21).  $8 \times 10^{-9} \text{ MS}^{-1}$ ;  $3.89 \times 10^{-9} \text{ MS}^{-1}$

## 3. Zeroth &amp; First Order Reaction

- (1). 2, 1 (2). A (3). A  
 (4).  $1.25 \times 10^{-4}$ ,  $3.75 \times 10^{-4}$  (5). B  
 (6). C (7). 0, -K,  $\text{mol.l}^{-1} \text{ s}^{-1}$   
 (8). C (9). C (10). A  
 (11). A). 75 mm of Hg B). 6 sec  
 C). 25 mm of Hg D). 1850 mm of Hg  
 (12).  $\frac{0.693}{15} \text{ sec}$  (13). A (14). D  
 (15). C (16). C (17). C  
 (18).  $1.733 \times 10^{-4} \text{ M min}^{-1}$  (19). C  
 (20). B (21). C (22). C  
 (23). B (24). B (25). B

## 4. First Order &amp; Second Order Reaction

- (1). B (2). C (3). C  
 (4). A (5). B (6). A  
 (7). C (8). C (9). C  
 (10). A (11). B (12). A

## 5. Pseudo Order Reaction, Pressure Change

## Method, Volume Change Method

- (1). B (2). B (3). B  
 (4). A (5). A (6). D  
 (7). B (8).  $3.64 \times 10^{-5} \text{ M}^{-1} \text{ min}^{-1}$   
 (9).  $4.67 \times 10^{-5} \text{ MS}^{-1}$ ,  $1.98 \times 10^{-2} \text{ S}^{-1}$   
 (10). C (11). B (12). B  
 (13). A (14).  $4.98 \times 10^{-4} \text{ S}^{-1}$   
 (15). A (16). A (17). A

6. Parallel 1<sup>st</sup> order Reaction

- (1). B (2). B (3). D  
 (4). D (5). B (6). C  
 (7). A (8). D (9). D  
 (10). B (11). B (12). A

## 7. Reaction Mechanism

- (1). B (2). B (3). D  
 (4). C (5). No (6). D  
 (7). B  
 (8).  $3K_1[A]^2 - 3K_{-1}[B][C]^3 - 2K_2[C]^2$   
 (9). A (10). B (11). B  
 (12). D (13). B (14). B  
 (15).  $\text{Rate} = \frac{K_1[A]}{1 + \frac{K_2[B]}{K_3[C]}}$   
 (16).  $\text{Rate} = \frac{k_1 k_2}{k_3} [\text{H}^+][\text{HNO}_2][\text{Br}^-]$   
 (17). B (18). C (19). A

## 8. Collision Model For Chemical Kinetics,

## Arrhenius Equation

- (1). B (2). D (3). A  
 (4). A (5). B (6).  $1.47 \times 10^{-19}$   
 (7). B (8). E (9). C  
 (10). C (11). B (12). B  
 (13). B (14). A (15). D  
 (16). C (17). C (18). B  
 (19). C (20). A (21). B

- (22). D (23).  $E_a = 18230.8 \text{ J}$ ,  $A = 1.61$   
(24).  $K_2 = 6.36 \times 10^{-3} \text{ S}^{-1}$   
(25).  $A = 3.912 \times 10^{12} \text{ S}^{-1}$   
(26).  $232.79 \text{ KJ/mol}$  (27).  $24^\circ\text{C}$   
(28).  $K = 9.93 \times 10^{-3}$ ,  $E_a = 76.75 \text{ KJ/mol}$

**9. Arrhenius Equation, Catalyst effect**

- (1). C (2). B (3). C  
(4). C (5). C (6). D  
(7). A (8). B (9). A  
(10). B (11). B (12). B  
(13). 20.4 min  
(14).  $K = 9.13 \times 10^{-4} \text{ sec}^{-1}$ ,  $E_a = 76.65 \text{ kJ}$   
(15).  $T = 311.4 \text{ K}$   
(16). % decomposition = 80 %