Exercise-1

✍ Marked Questions may have for Revision Questions.

ONLY ONE OPTION CORRECT TYPE

Section (A) : Rate of reaction

1. xA + yB → zC. If $= -\frac{d[A]}{dt} = -\frac{d[B]}{dt}1.5 = \frac{d[C]}{dt}$ then x,y and z can be :

(1) 1,1,1 (2) 3,2,3 (3) 3,3,2 (4) 2,2,3

2.✍ The rate of a reaction is expressed in different ways as follows ;

+ 1/2(d[C]/dt) = – 1/3 (d[D]/dt) = + 1/4 (d[A]/dt) = – (d[B]/dt) The reaction can be :

(1) $4A + B \longrightarrow 2C + 3D$ (2) $B + 3D \longrightarrow 4A + 2C$

(3) $4A + 2B \longrightarrow 2C + 3D$ (4) $B + (1/2) D \longrightarrow 4A + 3C$

3. Consider the chemical reaction :

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

The rate of this reaction can be expressed ;in terms of time and of concentration of $N_2(g)$, $H_2(g)$ or $NH_3(g)$. Identify the correct relationship amongest the rate expressions.

(1) Rate $= -\frac{d[N_2]}{dt} = \frac{1}{3}\frac{d[H_2]}{dt} = \frac{1}{2}\frac{d[NH_3]}{dt}$ (2) Rate $= -\frac{d[N_2]}{dt} = -\frac{3d[H_2]}{dt} = \frac{2d[NH_3]}{dt}$

(3) Rate $= -\frac{d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = \frac{d[NH_3]}{dt}$ (4) Rate $= -\frac{d[N_2]}{dt} = \frac{d[H_2]}{dt} = \frac{d[NH_3]}{dt}$

4. In a reaction $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$ the rate of appearance of NH_3 is 2.5×10^{-4} mol L^{-1} sec^{-1}. The rate of reaction & rate of disappearance of H_2 will be (in mol L^{-1} sec^{-1})

(1) 3.75×10^{-4} , 1.25×10^{-4} (2) 1.25×10^{-4}, 2.5×10^{-4}

(3) 1.25×10^{-4}, 3.75×10^{-4} (4) 5.0×10^{-4}, 3.75×10^{-4}

5. $3A \rightarrow 2B$, rate of reaction $\frac{+d[B]}{dt}$ is equal to :

(1) $-\frac{3}{2}\frac{d[A]}{dt}$ (2) $-\frac{2}{3}\frac{d[A]}{dt}$ (3) $-\frac{1}{3}\frac{d[A]}{dt}$ (4) $+2\frac{d[A]}{dt}$

6. In the reaction; $A + 2B \longrightarrow 3C + D$, which of the following expression does not describe changes in the concentration of various species as a function of time :

(1) {d [C] / dt} = – {3d [A] / dt} (2) {3d [D] / dt} = {d [C] / dt}

(3) {3d [B] / dt} = – {2d [C] / dt} (4) {2d [B] / dt} = – {d [A] / dt}

7.✍ In the following reaction : $xA \longrightarrow yB$

$$\log\left[-\frac{d[A]}{dt}\right] = \log\left[\frac{d[B]}{dt}\right] + \log 2$$

where –ve sign indicates rate of disappearance of the reactant. Thus, x : y is :

(1) 1 : 2 (2) 2 : 1 (3) 3 : 1 (4) 3 : 10

8. Which of the following statements is correct?

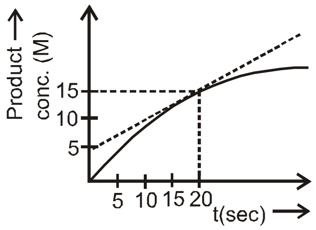
(1) The rate of a reaction decreases or remain constant with passage of time as the concentration of reactants dereases.
(2) The rate of a reaction is same at any time during the reaction.
(3) The rate of a reaction is independent of temperature change.
(4) The rate of a reaction decreases with increase in concentration of reactant(s).

9. Which of the following expressions is correct for the rate of reaction given below ?

$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \longrightarrow 3Br_2(aq) + 3H_2O(l)$

(1) $\frac{\Delta[Br^-]}{\Delta t} = 5\ \frac{\Delta[H^+]}{\Delta t}$ (2) $\frac{\Delta[Br^-]}{\Delta t} = \frac{6}{5}\frac{\Delta[H^+]}{\Delta t}$

(3) $\frac{\Delta[Br^-]}{\Delta t} = \frac{5}{6}\frac{\Delta[H^+]}{\Delta t}$ (4) $\frac{\Delta[Br^-]}{\Delta t} = 6\ \frac{\Delta[H^+]}{\Delta t}$

10. 

Rate of formation of product at t = 20 seconds is

(1) 0.5 MS^{-1} (2) 1 M S^{-1} (3) 1.5 M S^{-1} (4) 2MS^{-1}

11. Rate of formation of SO_3 in the following reaction $2SO_2 + O_2 \rightarrow 2SO_3$ is 100 g min^{-1}. Hence rate of disappearance of O_2 is :

(1) 50 g min^{-1} (2) 40 g min^{-1} (3) 200 g min^{-1} (4) 20 g min^{-1}

12. If rate constant is numerically the same for the three reactions of first, second and third order respectively. Assume all the reactions of the kind A → products. Which of the following is correct :

(1) if [A] = 1 then $r_1 = r_2 = r_3$ (2) if [A] < 1 then $r_1 > r_2 > r_3$
(3) if [A] > 1 then $r_3 > r_2 > r_1$ (4) All

Section (B) : Rate law

1. aA + bB ⟶ Product, $dx/dt = k\,[A]^a\,[B]^b$. If conc of A is doubled, rate is four times. If conc. of B is made four times, rate is doubled. What is relation between rate of disappearance of A and that of B ?

(1) {– d [A] / dt} = {– d [B] / dtK (2) – {d [A] / dt} = – 4 {d [B] / dt}
(3) – 4 {d [A] / dt) = {– d [B]/ dt} (4) None of these

2. For a reaction pA + qB → products, the rate law expression is $r = k[A]^1\,[B]^m$, then :

(1) (p+1) < (1+ m) (2) (p + q) > (1 + m)
(3) (p + q) may or may not be equal to (1+ m) (4) (p + q) = (1 + m)

3. For the reaction $H_2 + Br_2 \rightarrow 2\,HBr$ overall order is found to be 3/2. The rate of reaction can be expressed as:

(1) $[H_2][Br_2]^{1/2}$ (2) $[H_2]^{1/2}\,[Br_2]$ (3) $[H_2]^{3/2}\,[Br_2]^0$ (4) All of these

4.✍ The rate of certain hypothetical reaction A + B + C → products is given by $r = \frac{-d[A]}{dt} = K\,[A]^{1/2}[B]^{1/3}[C]^{1/4}$ The order of the reaction :

(1) 1 (2) $\frac{1}{2}$ (3) 2 (4) $\frac{13}{12}$

5. 2A → B + C it would be a zero order reaction when :

(1) The rate of reaction is proportional to square of conc. of A

(2) The rate of reaction remains same at any conc. of A
(3) The rate remains unchanged at any conc. of B and C
(4) The rate of reaction doubles if conc. of B is increased to double

6. The rate equation for the reaction 2A + B $\rightarrow$ C is found to be : rate k[A][B]. The correct statement in relation to this reaction is that the
(1) Rate of formation of C is twice the rate of disappearance of A.
(2) Half life is a constant
(3) Unit of k must be s^{-1}
(4) Value of k is independent of the initial concentration of A and B

7.✍ For the reaction, $2NO(g) + 2H_2(g) \longrightarrow N_2(g) + 2H_2O(g)$ the rate expression can be written in the following ways:
$\{dt\,[N_2] / dt\} = k_1\,[NO][H_2]$; $\{d[H_2O] / dt) = k[NO][H_2]$; $\{-\,d[NO] / dt\} = k'_1\,[NO]\,[H_2]$; $\{-d[H_2] / dt\} = k''_1\,[NO][H_2]$
The relationship between k, k_1 , k'_1 and k''_1. is :
(1) $k = k_1 = k'_1 = k''_1$ (2) $k = 2k_1 = k'_1 = k''_1$ (3) $k = 2k'_1 = k_1 = k''_1$ (4) $k = k_1 = k'_1 = 2\,k''_1$

8. If a reaction gets completed in finite time then its order can be :
(1) 3 (2) 2 (3) 1 (4) Zero

9. For the reaction A + B $\rightarrow$ Products, it is found that the order of A is 2 and of B is 3 in the rate expression. When concentration of both is doubled the rate will increase by a factor of :
(1) 10 (2) 6 (3) 32 (4) 16

10. For a reaction A + B $\rightarrow$ products, the rate of the reaction was doubled when the concentration of. A was doubled, the rate was again doubled when the conc. of A & B were doubled the order of the reaction with respect to A & B are :
(1) 1,1 (2) 2,0 (3) 1,0 (4) 0,1

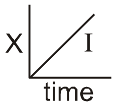
Section (C) : The integrated rate laws

1. The rate constant of reaction 2 A + B $\longrightarrow$ C is 2.57×10^{-5} lt mole^{-1} sec^{-1} after 10 sec. 2.65×10^{-5} lt. mole^{-1} sec^{-1} after 20 sec. and 2.55×10^{-5} lt. mole^{-1} sec^{-1} after 30 sec. The order of the reaction is:
(1) 0 (2) 1 (3) 2 (4) 3

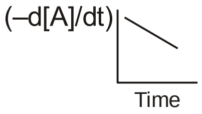
2. For a first order reaction, the plot of 't' against log C gives a straight line with slope equal to :
(1) (k / 2.303) (2) (– k / 2.303) (3) (ln k / 2.303) (4) – k.

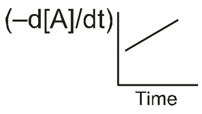
3. In a first order reaction the amount of reactant decayed in three half lives (let a be is initial amount) would be:
(1) 7a / 8 (2) a / 8 (3) a / 6 (4) 5a / 6

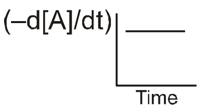
4.✍ Graph between concentration of the product and time of the reaction A $\rightarrow$ B is of the type

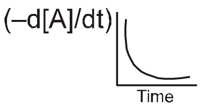


Hence graph between – d[A]/dt and time will be of the type :

(1)


(2)


(3)


(4)


5.✍ The reaction N_2O_5 (in CCl_4) $\rightarrow 2NO_2 + 1/2O_2(g)$ is first order in N_2O_5 with rate constant $6.2 \times 10^{-4}\ S^{-1}$. What is the value of rate of reaction when $[N_2O_5] = 1.25$ mole L^{-1}
(1) 7.75×10^{-4} mol $L^{-1}\ S^{-1}$ (2) 6.35×10^{-3} mol $L^{-1}\ S^{-1}$

(3) 5.15×10^{-5} mol L^{-1} S^{-1} (4) $3,85 \times 10^{-4}$ mol L^{-1} S^{-1}

6. K for a zero order reaction is 2×10^{-2} mol L^{-1} sec^{-1} . If the concentration of the reactant after 25 sec is 0.5 M, the initial concentration must have been.

(1) 0.5 M (2) 1.25 M (3) 12.5 M (4) 1.0 M

7. Plot of log(a–x) vs time t is straight line. This indicates that the reaction is of

(1) Second order (2) First order (3) Zero order (4) Third order

8. In a certain reaction, 10% of the reactant decomposes in one hour, 20 % in two hours, 30% in three hours and so on the dimensions of the rate constant is :

(1) $hour^{-1}$ (2) mole $litre^{-1}$ sec^{-1} (3) litre $mole^{-1}$ sec^{-1} (4) mole sec^{-1}

9. If a first order reaction is completed to the extent of 75% and 50% in time intervals, t_1 and t_2, what is the ratio, $t_1 : t_2$?

(1) ln 2 (2) $\frac{\ln(3/4)}{\ln 2}$ (3) 2 (4) 1/2

10. The rate constant for a reaction is $\frac{\ln 2}{10}$ min^{-1}. What will be the order of reaction and time taken to change concentration from 1 M to 0.25 M.

(1) one, 10 min (2) zero, 10 min (3) one, 20 min (4) two, 20 min

11. In the case of zero order reaction, the ratio of time required for 75% completion to 50% completion is :

(1) ln 2 (2) 2 (3) 1.5 (4) None

12.✍ For the irreversible process, A + B $\longrightarrow$ products, the rate is first–order w.r.t. A and second–order w.r.t. B. If 1.0 mol each of A and B introduced into a 1.0 L vessel, and the initial rate was 1.0×10^{-2} mol L^{-1} s^{-1} , rate when half reactants have been turned into products is :

(1) 1.25×10^{-3} mol L^{-1} s^{-1} (2) 1.0×10^{-2} mol L^{-1} s^{-1}

(3) 2.50×10^{-3} mol L^{-1} s^{-1} (4) 2.0×10^{-2} mol L^{-1} s^{-1}

13. The rate constant of the reaction $A \rightarrow 2B$ is 1.0×10^{-3} mol lit^{-1} min^{-1}, if the initial concentration of A is 1.0 mole lit^{-1} what would be the concentration of B after 100 minutes.

(1) 0.1 mol lit^{-1} (2) 0.2 mol lit^{-1} (3) 0.9 mol lit^{-1} (4) 1.8 mol lit^{-1}

14.✍ Two substances A ($t_{1/2}$ = 5 min) and B ($t_{1/2}$ = 15 min) are taken in such a way that initially [A] = 4[B]. The time after which both the concentration will be equal is : (Assume that reaction is first order)

(1) 5 min (2) 15 min

(3) 20 min (4) concentration can never be equal

15.✍ In a first order reaction the reacting substance has half-life period of ten minutes. What fraction of the substance will be left after an hour the reaction has occurred ? :

(1) 1/6 of initial concentration (2) 1/64 of initial concentration

(3) 1/12 of initial concentration (4) 1/32 of initial concentration

16. A reaction, which is second order, has a rate constant of 0.002 L mol^{-1} s^{-1}. If the initial conc. of the reactant is 0.2 M. how long will it take for the concentration to become 0.0400 M ?

(1) 1000 sec (2) 400 sec (3) 200 sec (4) 10, 000 sec

17.✍ Which is not true for a second order reaction ?

(1) It can have rate constant 1×10^{-2} L mol^{-1} s^{-1}

(2) Its half-life is inversely proportional to its initial concentration

(3) Time to complete 75% reaction is twice of half-life

(4) $T_{50} = \frac{1}{K \times \text{Initial conc.}}$

Section (D) : Methods to determine the rate law

1.✍ The data for the reaction $A + B \rightarrow C$ is

Exp.	$[A]_0$	$[B]_0$	initial rate
1	0.012	0.035	0.10
2	0.024	0.035	0.80
3	0.012	0.070	0.10
4	0.024	0.070	0.80

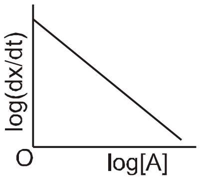
(1) $r = k\,[B]^3$ (2) $r = k\,[A]^3$ (3) $r = k\,[A]\,[B]^4$ (4) $r = k\,[A]^2\,[B]^2$.

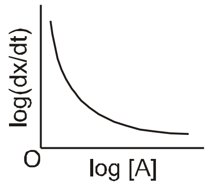
2. $A + B \longrightarrow$ Product, $\frac{dx}{dt} = k\,[A]^a\,[B]^b$

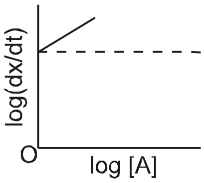
If $\left(\frac{dx}{dt}\right) = k$, then order is :

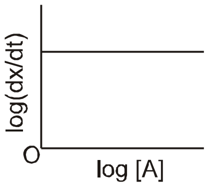
(1) 4 (2) 2 (3) 1 (4) 0

3. $A \rightarrow$ Product and $\left(\frac{dx}{dt}\right) = k[A]^2$. If log $\left(\frac{dx}{dt}\right)$ is plotted against log [A],then graph is of the type :

(1)


(2)


(3)


(4)


4. For the reaction A $\longrightarrow$ Products, $-\frac{d[A]}{dt} = k$ and at different time interval, [A] values are :

Time	0	5 min	10 min	15 min
[A]	20 mol	18 mol	16 mol	14 mol

At 20 minute, rate will be :

(1) 12 mol /min (2) 10 mol/min (3) 8 mol/min (4) 0.4 mol/min

5.✍ The rate law for a reaction $A + B \rightarrow$ product is rate $= K[A]^1[B]^2$. Then which one of the following statement is false :

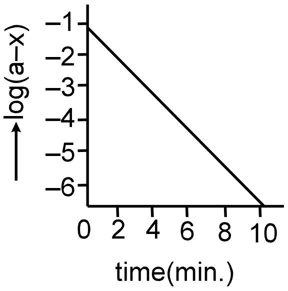
(1) If [B] is held constant while [A] is doubled, the reaction will proceed twice as fast

(2) If [A] is held constant while [B] is reduced to one quater, the rate will be halved

(3) If [A] and [B] are both doubled, the reaction will proceed 8 times as fast

(4) This is a third order reaction

6. The conversion of vinyl allyl ether to pent-4-enol follows a certain kinetics. The following plot is obtained for such a reaction. The order for the reaction is



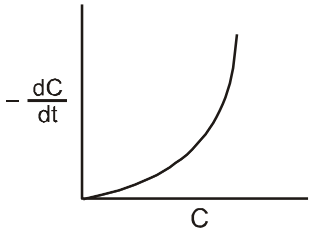
(1) zero (2) –1 (3) 1 (4) 2

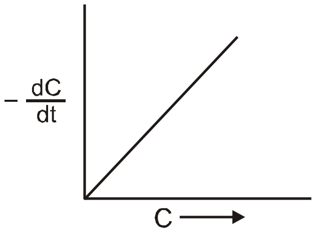
7. The reaction A(s) $\rightarrow$ 2 B(g) + C(g) is first order. The pressure after 20 min. and after very long time are 150 mm Hg and 225 mm Hg. The value of rate constant and pressure after 40 min. are :

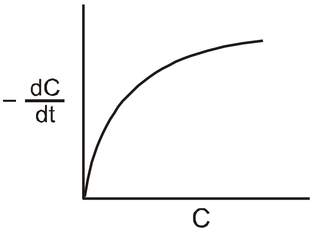
(1) 0.05 In 1.5 min^{-1}, 200 mm (2) 0.5 ln 2 min^{-1} ,300 mm

(3) 0.05 In 3 min^{-1}, 300 mm (4) 0.05 In 3 min^{-1}, 200 mm

8. In three different reactions, involving a single reactant in each case, a plot of rate of the reaction on the y–axis, versus concentration of the reactant on the x–axis, yields three different curves shown below.

(i)


(ii)


(iii)


What are the possible orders of the reactions (i), (ii), (iii).

(1) 1, 2, 3 (2) 2, 1, 1/2 (3) 0, 1, 2 (4) 0, 1, 1/2

Section (E) : Methods to monitor the progress of the reaction

1. Consider the reaction 2A(g) $\longrightarrow$ 3B(g) + C(g). Starting with pure A initially, the total pressure doubled in 3 hrs. The order of the reaction might possibly be

(1) zero (2) first

(3) second (4) unpredictable from this data

2. At 373 K, a gaseous reaction A $\rightarrow$ 2B + C is found to be of first order. Starting with pure A, the total pressure at the end of 10 min. was 176 mm and after a long time when A was completely dissociated, it was 270 mm. The pressure of A at the end of 10 minutes was :

(1) 94 mm (2) 47 mm (3) 43 mm (4) 90 mm

3. Let there be as first-order reaction of the type, A $\longrightarrow$ B + C. Let us assume that only A is geseous. We are required to calculate the value of rate constant based on the following data.

Time	0	T	∞
Partial pressure of A	P_0	P_t	–

Calculate the expression of rate constant.

(1) $k = \frac{1}{t}\ \ln\left(\frac{P_0}{P_t}\right)$ (2) $k = \frac{1}{t}\ \ln\left(\frac{P_t}{P_0}\right)$ (3) $k = \frac{1}{t}\ln\left(\frac{2P_0}{P_t}\right)$ (4) $k = \frac{1}{t}\ln\left(\frac{P_t}{2P_0}\right)$

4. The decompostion NH_3 gas on a heated tungsten surface gave the following results :

Initial pressure (mm)	65	105	y	185
Half-life (sec)	290	x	670	820

Calculate approximately the values of x
(1) x = 410 sec (2) x = 467 sec (3) x = 490 sec (4) x = 430 sec

5. In the reaction NH_4NO_2 (aq.) → N_2 (g) + 2 H_2O (*l*) the volume of N_2 after 20 min and after a long time is 40 ml and 70 ml respectively. The value of rate constant is :
(1) (1/20) In (7/4) min^{-1}
(2) (2.303 /1200) log (7/3) sec^{-1}
(3) (1/20) log (7/3) min^{-1}
(4) (2.303 / 20) log (11/7) min^{-1}

Section (F) : Effect of Temperature

1. Rate of which reactions increases with temperature :
(1) of any
(2) of exothermic reactions
(3) of endothermic
(4) of none.

2. For a zero order reaction. Which of the following statement is false :
(1) the rate is independent of the temperature of the reaction.
(2) the rate is independent of the concentration of the reactants.
(3) the half life depends as the concentration of the reactants.
(4) the rate constant has the unit mole lt^{-1} sec^{-1}.

3.✍ A large increase in the rate of a reaction for a rise in temperature is due to
(1) increase in the number of collisions
(2) the increase in the number of activated molecules
(3) The shortening of mean free path
(4) the lowering of activation energy

4. The rate constant, the activation energy and the frequency factor of a chemical reaction at 25°C are 3.0×10^{-4} s^{-1}, 104.4 KJ mol^{-1} and 6.0×10^{14} s^{-1} respectively. The value of the rate constant as $T \to \infty$ is :
(1) 2.0×10^{18} s^{-1} (2) 6.0×10^{14} s^{-1} (3) ∞ (4) 3.6×10^{30} s^{-1}

5. According to collision theory of reaction rates –
(1) Every collision between reactant leads to chemical reaction
(2) Rate of reaction is proportional to velocity of molecules
(3) All reactions which occur in gaseous phase are zero order reaction
(4) Rate of reaction is directly proportional to collision frequency.

6. The minimum energy for molecules to enter into chemical reaction is called.
(1) Kinetic energy (2) Potential energy (3) Threshold energy (4) Activation energy

7. The activation energy for the forward reaction $X \rightleftharpoons Y$ is 60 KJ mol^{-1} and ΔH is –20 KJ mol^{-1}. The activation energy for the backard reaction $Y \rightleftharpoons X$ is :
(1) 80 KJ mol^{-1} (2) 40 KJ mol^{-1} (3) 60 KJ mol^{-1} (4) 20 KJ mol^{-1}

8.✍ For producing the effective collisions, the colloiding molecules must posses :
(1) A certain minimum amount of energy
(2) Energy equal to or greater than threshold energy
(3) Proper orientation
(4) Threshold energy as well as proper orientation of collision.

9. For the first order reaction, $X_{(s)} \longrightarrow X_{(g)}$
the monitoring is done by observing the volume :

time	t	∞
volume	V_t	V_∞

The rate constant is given by :

(1) $\frac{1}{t}\ln\left(\frac{V_\infty}{V_t}\right)$ (2) $\frac{1}{t}\ln\left(\frac{V_\infty}{V_\infty - V_t}\right)$ (3) $\frac{1}{t}\ln\left(\frac{V_\infty + V_t}{V_\infty}\right)$ (4) $\frac{1}{t}\ln\left(\frac{V_\infty + V_t}{V_\infty - V_t}\right)$

10. The 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 ?

(1) A = 10^{15} and E = 1.9 × 10^4 KJ (2) A = 10^{-15} and E = 40 KJ

(3) A = 10^{15} and E = 40 KJ (4) A = 10^{-15} and E = 1.9 × 10^4 KJ.

11. For a given reaction, energy of activation for forward reaction (E_{af}) is 80kJ.mol^{-1}. $\Delta H = -40$kJ.mol^{-1} for the reaction. A catalyst lowers E_{af} to 20 kJ.mol^{-1}. The ratio of energy of activation for reverse reaction before and after addition of catalyst is :

(1) 1.0 (2) 0.5 (3) 1.2 (4) 2.0

12.✍ The E_a of a reaction in presence of a catalyst is 4.15 kJ mol^{-1} and in absence of a catalyst is 8.3 kJ mol^{-1}. What is slope of the plot of ln k vs $\frac{1}{T}$ in the absence of catalyst

(1) + 1 (2) –1 (3) + 1000 (4) –1000

Section (G) : Mechanism of reactions

1. 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 :

(1) 2, 3/ 2 (2) 3/2 , 3/2 (3) Not defined, 3/2 (4) 1,1/2

2.✍ The reaction of hydrogen, and iodine monochloride is represented by the equation :

$$H_2(g) + 2ICl(g) \longrightarrow 2HCl(g) + I_2(g)$$

This reaction is first–order in $H_2(g)$ and also first–order in ICl(g). Which of these proposed mechanism can be consistent with the given information about this reaction ?

Mechanism I : $H_2(g) + 2ICl(g) \longrightarrow 2HCl(g) + I_2(g)$

Mechanism II : $H_2(g) + ICl(g) \xrightarrow{\text{Slow}} HCl(g) + HI(g)$

$HI(g) + ICl(g) \xrightarrow{\text{fast}} HCl(g) + I_2(g)$

(1) I only (2) II only (3) both I and II (4) neither I nor II

3. Following mechanism has been proposed for a reaction.

$2A + B \rightarrow D + E$

Step -1 $A + B \rightarrow C + D$ (slow)

Step -2 $A + C \rightarrow E$ (fast)

The rate law expression for the reaction is :

(1) r = K[A]^2 [B] (2) r = K [A] [B] (3) r = K [A]^2 (4) r = K[A][C]

4. A following mechanism has been proposed for a reaction :

$2A + B \longrightarrow D + E$ K = 2 × 10^{-1} lt^2 mol^{-2} sec^{-1}

$A + B \longrightarrow C + D$ K = 1.5 × 10^{-6} lt/mol sec

$A + C \longrightarrow E$ K = 2 × 10^{-3} lt/mol sec

The rate law expression for the reaction is :

(1) r = k[A]^2 [B] (2) r = k[A][B] (3) r = k[A]^2 (4) r = k[A][C]

5.✍ A hypothetical reaction $A_2 + B_2 \rightarrow 2AB$ follows the mechanism as given below :

$A_2 \rightleftharpoons A + A$ fast

$A + B_2 \rightarrow AB + B$ slow

$A + B \rightarrow AB$ fast

The order of the overall reaction is :

(1) 2 (2) 1 (3) 1.5 (4) 0

6. For an elementary process $2X + Y \rightarrow Z + W$, the molecularity is :

(1) 2 (2) 1 (3) 3 (4) Unpredictable

7. The reaction of NO_2 (g) and O_3 (g) is first-order in NO_2 (g) and O_3 (g)

$$2\,NO_2\,(g) + O_3\,(g) \longrightarrow N_2O_5\,(g) + O_2\,(g)$$

The reaction can take place by mechanism :

I : $NO_2 + O_3 \xrightarrow{\text{slow}} NO_3 + O_2$

$NO_3 + NO_2 \xrightarrow{\text{fast}} N_2O_5$

II : $O_3 \underset{k_b}{\overset{k_a\ \text{fast}}{\rightleftharpoons}} O_2 + [O]$

$NO_2 + O \xrightarrow{\text{slow}} NO_3$

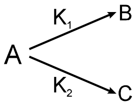
$NO_3 + NO_2 \xrightarrow{\text{fast}} N_2O_5$

Select correct mechanism.

(1) I only (2) II only (3) both I and II (4) None of I and II

Section (H) : Complications in first order reactions

1.✍ The substance undergoes first order decomposition. The decomposition follows two parallel first order reactions as :



$K_1 = 1.26 \times 10^{-4}\ sec^{-1}$ and $K_2 = 3.8 \times 10^{-5}\ sec^{-1}$

The percentage distribution of B and C

(1) 80% B and 20% C (2) 76.83% B and 23.17%C

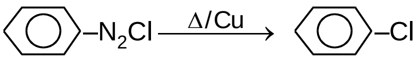
(3) 90% B and 10% C (4) 60% B and 40% C

Exercise-2

✍ **Marked Questions may have for Revision Questions.**

1.✍ A drop of solution (volume 0.05 mL) contains 3.0×10^{-6} moles of H^+. If the rate contant of disappearance of H^+ is 1.0×10^{7} mole litre^{-1} sec^{-1}. How long would it take for H^+ in drop to disappear :

(1) 6×10^{-8} sec (2) 6×10^{-7} sec (3) 6×10^{-9} sec (4) 6×10^{-10} sec

2. 

+ N_2 Half-life is independent of concentration of reactant. After 10 minutes volume of N_2 gas is 10 L and after complete reaction it is 50 L. Hence rate constant is:

(1) (2.303 /10) log 5 min^{-1} (2) (2.303 /10) log 1.25 min^{-1}

(3) (2.303 /10) log 2 min^{-1} (4) (2.303 /10) log 4 min^{-1}

3. If concentration of reactants is increased by a factor x then the rate constant k becomes :

(1) ln $\frac{k}{x}$ (2) $\frac{k}{x}$ (3) k + x (4) k

4. The rate constant for a reaction is 10.8×10^{-5} mol L^{-1} S^{-1} The reaction obeys :

(1) First order (2) Zero order (3) Second order (4) All are wrong

5. For the irreversible process, A + B $\longrightarrow$ products, the rate is first–order w.r.t. A and second–order w.r.t. B.If 1.0 mol each of A and B introduced into a 1.0 L vessel, and the initial rate was 1.0×10^{-2} mol L^{-1} s^{-1}, rate when half reactants have been turned into products is :

(1) 1.25×10^{-3} mol L^{-1} s^{-1} (2) 1.0×10^{-2} mol L^{-1} s^{-1}

(3) 2.50×10^{-3} mol L^{-1} s^{-1} (4) 2.0×10^{-2} mol L^{-1} s^{-1}

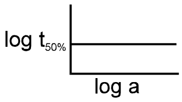
6. A certain zero order reaction has k = 0.025 M s^{-1} for the disappearance of A. What will be the concentration of A after 15 seconds if the initial concentration is 0.50 M ?

(1) 0.50 M (2) 0.375 M (3) 0.125 M (4) 0.060 M

7.✍ The rate law for the single step reaction 2A + B 2C, is given by

(1) Rate = K [A][B] (2) Rate = K $[A]^2[B]$ (3) Rate = K [2A][B] (4) Rate = K$[A]^2[B]^0$

8. A graph plotted between log $t_{50\%}$ vs. log concentration is a straight line. What conclusion can you draw from this graph.



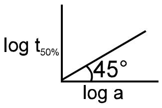
(1) n = 1 ; $t_{1/2} \propto a$ (2) n = 2, $t_{1/2} \propto 1/a$

(3) n = 1 ; $t_{1/2} = (0.693/k)$ (4) None of these

9. In a first order reaction the concentration of the reactant is decreased from 1.0 M to 0.25 M in 20 min. The rate constant of the reaction would be –

(1) 10 min^{-1} (2) 6.931 min^{-1} (3) 0.6931 min$^{-`1}$ (4) 0.06931 min^{-1}

10.✍ What will be the order of reaction and rate constant for a chemical change having log $t_{50\%}$ vs log concentration of (A) curves as :



(1) 0, 1/2 (2) 1, 1 (3) 2, 2 (4) 3, 1

11. In the first order reaction 75% of the reactant disappeared in 1.388 hrs. Calculate the rate constant of the reaction :

(1) 1 s^{-1} (2) 2.8×10^{-4} s^{-1} (3) 17.2×10^{-3} s^{-1} (4) 1.8×10^{-3} s^{-1}

12. Which integrated equation is correct for the following I^{st} order reaction started with only A(g) in a closed rigid vessel.

$$A(g) \longrightarrow B(g) + C(g) + D(g)$$

P_i = initial pressure ; P_t = total pressure at time t

(1) $K = \frac{2.303}{t}\log_{10}\left[\frac{P_i}{P_t}\right]$ (2) $K = \frac{2.303}{t}\log_{10}\left[\frac{P_t}{P_i}\right]$

(3) $K = \frac{2.303}{t}\log_{10}\left[\frac{2P_i}{3P_i - P_t}\right]$ (4) $K = \frac{2.303}{t}\log_{10}\left[\frac{3P_i}{2P_i - 3P_t}\right]$

13. Catalyst increases the rate of reaction because :

(1) it decreases ΔH (2) it increases ΔH

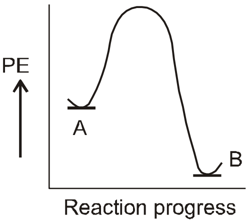
(3) it decreases activation energy (4) it increases activation energy

14. The rate constant K_1 of a reaction is found to be double that of rate constant K_2 of another reaction. The relationship between corresponding activation energies of the two reactions at same temperature (E_1 and E_2) can be represented as :

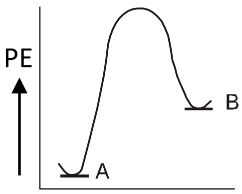
(1) $E_1 > E_2$ (2) $E_1 < E_2$ (3) $E_1 = E_2$ (4) None of these

15. For a reaction $A \rightarrow B$, $E_a = 10$ kJ mol^{-1} , $\Delta H = 5$ kJ mol^{-1} . Thus, potential energy profile for this reaction is :

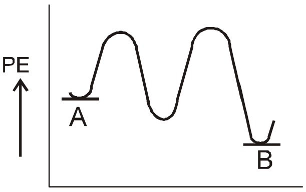
(1)



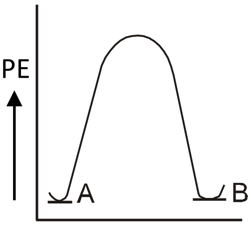
(2)



(3)



(4)



16. For a reaction following nth order kinetics, the half life ($t_{1/2}$) would depend upon the initial concentration (1) as:

(1) $t_{1/2} \propto a^{1-n}$ (2) $t_{1/2} \propto a^{n-1}$ (3) $t_{1/2} \propto a^{n}$ (4) $t_{1/2} \propto a^{-n}$

17. Trimolecular reactions are uncommon because

(1) the probability of three molecules colliding at an instant is very low.
(2) the probability of three molecules colliding at an instant is high.
(3) the probability of three molecules colliding at an instant is zero.
(4) the probability of many molecules colliding at an instant is high.

18.✍ A hypothetical reaction $X_2 + Y_2 \longrightarrow 2XY$ follows the mechanism given below.

$X_2 \rightleftharpoons X + X$ [Fast]

$X + Y_2 \longrightarrow XY + Y$ [Slow]

$X + Y \longrightarrow XY$ [Fast]

The order of overall reaction is

(1) 2 (2) 1 (3) 1.5 (4) Zero

19. The reaction of hydrogen, and iodine monochloride is represented by the equation :

$$H_2(g) + 2ICl(g) \longrightarrow 2HCl(g) + I_2(g)$$

This reaction is first–order in $H_2(g)$ and also first–order in ICl(g). Which of these proposed mechanism can be consistent with the given information about this reaction ?

Mechanism I : $H_2(g) + 2ICl(g) \longrightarrow 2HCl(g) + I_2(g)$

Mechanism II : $H_2(g) + ICl(g) \xrightarrow{\text{Slow}} HCl(g) + HI(g)$

$HI(g) + ICl(g) \xrightarrow{\text{fast}} HCl(g) + I_2(g)$

(1) I only (2) II only (3) both I and II (4) neither I nor II

20. Radioactivity is affected by :
(1) temperature (2) Pressure
(3) electric and magnetic field (4) none of these

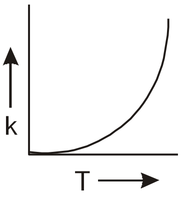
21. Half life period of 10 gm radioactive element is 20 days. Then half life period of 100 gm of this element is :
(1) 20 days (2) 200 days (3) 100 days (4) 10 days

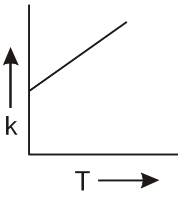
22. A radioactive element has a half life of one day. After three days the amount of the element left will be :
(1) 1/2 of the original amount (2) 1/4 of the original amount
(3) 1/8 of the original amount (4) 1/16 of the original amount

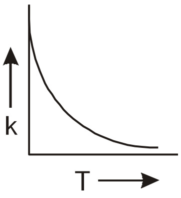
23. Given X $\longrightarrow$ product (Taking 1st order reaction)
conc (mol/lit) 0.01 0.0025
time (min) 0 40
Initial rate of reaction is in mol /ℓ/min.
(1) 3.43×10^{-4} (2) 1.73×10^{-4} (3) 3.43×10^{-5} (4) 1.73×10^{-5}

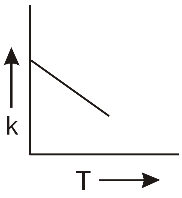
24. For a first order reaction A $\rightarrow$ P, the temperature (T) dependent rate constant (k) was found to follow the equation $\log k = -(2000)\frac{1}{T} + 6.0$. The pre-exponential factor A and the activation energy E_a, respectively, are :
(1) 1.0×10^6 s^{-1} and 9.2 kJ mol^{-1} (2) 6.0 s^{-1} and 16.6 kJ mol^{-1}
(3) 1.0×10^6 s^{-1} and 16.6 kJ mol^{-1} (4) 1.0×10^6 s^{-1} and 38.3 kJ mol^{-1}

25. Plots showing the variation of the rate constant (k) with temperature (T) are given below. The plot that follows Arrhenius equation is :

(1)


(2)


(3)


(4)


26. For the reaction **M** $\rightarrow$ **N**, the rate of disappearance of **M** increases by a factor of 8 upon doubling the concentration of **M**. The order of the reaction with respect to **M** is :
(1) 4 (2) 3 (3) 2 (4) 1

Exercise-3

PART - I : NEET / AIPMT QUESTION (PREVIOUS YEARS)

1. In the following reaction, how is the rate of appearance of the underlined product related to the rate of disappearance of the underlined reactant ? **[AIPMT 2000]**
BrO_3^- (aq) + $5Br^-$(aq) + $6H^+$ (aq) $3Br_2(l) + 3H_2O(l)$

(1) $\frac{d[Br_2]}{dt} = \frac{5}{3} - \frac{d[Br^-]}{dt}$ (2) $\frac{d[Br_2]}{dt} = -\frac{d[Br^-]}{dt}$

(3) $\frac{d[Br_2]}{dt} = \frac{3}{5} + \frac{d[Br^-]}{dt}$ (4) $\frac{d[Br_2]}{dt} = \frac{3}{5} - \frac{d[Br^-]}{dt}$

2. For the reaction $2N_2O_5 \longrightarrow 4NO_2 + O_2$, rate and rate constant are 1.02×10^{-4} and 3.4×10^{-5} s^{-1} respectively, then conc. of N_2O_5 at that time will be **[AIPMT 2001]**

(1) 1.732 (2) 3 (3) 1.02×10^{-4} (4) 3.4×10^{-5}

3. $3A \longrightarrow 2B$, rate of reaction $+\frac{d[B]}{dt}$ is equal to **[AIPMT 2002]**

(1) $-\frac{3}{2}\frac{d[A]}{dt}$ (2) $-\frac{2}{3}\frac{d[A]}{dt}$ (3) $-\frac{1}{3}\frac{d[A]}{dt}$ (4) $+2\frac{d[A]}{dt}$

4. $3A \longrightarrow B + C$

It would be a zero order reaction, when **[AIPMT 2002]**

(1) the rate of reaction is proportional to square of concentration of A

(2) the rate of reaction remains same at any concentration of A

(3) the rate remains unchanged at any concentration of B and C

(4) the rate of reaction doubles if concentration of B is increased to double.

5. The reaction $A \longrightarrow B$ follows first order kinetics. The time taken for 0.8 mole of A to produce 0.6 mole of B is 1 h. What is the time taken for the conversion of 0.9 mole of A to 0.675 mole of B ? **[AIPMT 2003]**

(1) 0.25 h (2) 2 h (3) 1 h (4) 0.5 h

6. The temperature dependence of rate constant (k) of a chemical reaction is written in terms of arrhenius equation, $k = Ae^{-E^*/RT}$. Activation energy (E) of the reaction can be calculated by plotting. **[AIPMT 2003]**

(1) log k vs $\frac{1}{T}$ (2) log k vs $\frac{1}{\log T}$ (3) k vs T (4) k vs $\frac{1}{\log T}$

7. If the rate of a reaction is equal to the rate constant, the order of the reaction is **[AIPMT 2003]**

(1) 2 (2) 3 (3) 0 (4) 1

8. The rate of first order reaction is 1.5×10^{-2} mol L^{-1} min^{-1} at 0.5 M concentration of the reactant. The half life of the reaction is **[AIPMT 2004]**

(1) 0.383 min (2) 23.1 min (3) 8.73 min (4) 7.53 min

9. For a first order reaction $A \longrightarrow B$, the reaction rate at reactant concentration of 0.01 M is found to be 2.0×10^{-5} mol L^{-1} s^{-1}. The half life of the reaction is **[AIPMT 2005]**

(1) 300 s (2) 30 s (3) 220 s (4) 347 s

10. The rate of reaction between two reactants A and B decreases by a factor of 4, if the concentration of reactant B is doubled. The order of this reaction with respect to reactant B is **[AIPMT 2005]**

(1) – 1 (2) – 2 (3) 1 (4) 2

11. For the reaction **[AIPMT 2006]**

$2A + B \rightarrow 3C + D$

Which of the following does not express the reaction rate ?

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

12. Consider the reaction **[AIPMT 2006]**

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

The equality relationship between $\frac{d[NH_3]}{dt}$ and $-\frac{d[H_2]}{dt}$ is

(1) $\frac{d[NH_3]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt}$ (2) $+\frac{d[NH_3]}{dt} = -\frac{2}{3}\frac{d[H_2]}{dt}$

(3) $+\frac{d[NH_3]}{dt} = -\frac{3}{2}\frac{d[H_2]}{dt}$ (4) $\frac{d[NH_3]}{dt} = -\frac{d[H_2]}{dt}$

13. If 60% of a first order reaction was completed in 60 minutes, 50% of the same reaction would be completed in approximately : **[AIPMT 2007]**

(1) 40 minutes (2) 50 mintes (3) 45 minutes (4) 60 miniutes

14. In a first order reaction $A \rightarrow B$, if k is rate constant and initial concentration of the reactant A is 0.5 M then the half life is : **[AIPMT 2007]**

(1) $\frac{\ln 2}{k}$ (2) $\frac{0.693}{0.5k}$ (3) $\frac{\log 2}{k}$ (4) $\frac{\log 2}{k\sqrt{0.5}}$

15. The rate constant k_1 and k_2 for two different reactions are $10^{16} \times e^{-2000/T}$ and $10^{15} \times e^{-1000/T}$ respectively. The temperature at which $k_1 = k_2$ is **[AIPMT 2008]**

(1) 1000 K (2) $\frac{2000}{2.303}$ K (3) 2000 K (4) $\frac{1000}{2.303}$ K

16. Half-life period of a first order reaction is 1386 s. The specific rate constant of the reaction is **[AIPMT 2009]**

(1) $5.0 \times 10^{-3}\ s^{-1}$ (2) $0.5 \times 10^{-2}\ s^{-1}$ (3) $0.5 \times 10^{-3}\ s^{-1}$ (4) $5.0 \times 10^{-3}\ s^{-1}$

17. For the reaction $A + B \longrightarrow$ Products, it is observed that : **[AIPMT 2009]**

(1) On doubling the initial concentration of A only, the rate of reaction is also doubled and

(2) On doubling the initial concentration of both A and B, there is change by a factor of 8 in the rate of the reaction.

(1) rate = $k[A]^2[B]$ (2) rate = $k[A][B]^2$ (3) rate = $k[A]^2[B]^2$ (4) rate = $k[A][B]$

18. For the reaction, $N_2 + 3H_2 \longrightarrow 2NH_3$, if $\frac{d[NH_3]}{dt} = 2 \times 10^{-4}$ mol L^{-1} s^{-1}, the value of $\frac{-d[H_2]}{dt}$ would be **[AIPMT 2009]**

(1) 3×10^{-4} mol L^{-1} s^{-1} (2) 4×10^{-4} L^{-1} s^{-1} (3) 6×10^{-4} mol L^{-1} s^{-1} (4) 1×10^{-4} mol L^{-1} s^{-1}

19. Which one of the following statements for the order of a reaction is incorrect ? **[AIPMT 2011]**

(1) Order can be determined only experimentally.

(2) Order is not influenced by stoichiometric coefficient of the reactants.

(3) Order of reaction is sum of power to the concentration terms of reactants to express the rate of reaction.

(4) Order of reaction is always whole number.

20. Activation energy (E_a) and rate constants (k_1 and k_2) of a chemical reaction at two different temperatures (T_1 and T_2) are related by : **[AIPMT 2012]**

(1) $\ln\frac{K_2}{K_1} = -\frac{E_a}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$ (2) $\ln\frac{K_2}{K_1} = -\frac{E_a}{R}\left(\frac{1}{T_2}-\frac{1}{T_1}\right)$

(3) $\ln\frac{K_2}{K_1} = -\frac{E_a}{R}\left(\frac{1}{T_2}+\frac{1}{T_1}\right)$ (4) $\ln\frac{K_2}{K_1} = \frac{E_a}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$

21. In a reaction, A + B $\rightarrow$ Product, rate is doubled when the concentration of B is doubled, and rate increases by a factor of 8 when the concentrations of both the reactants (A and B) are doubled, rate law for the reaction can be written as : **[AIPMT 2012]**

(1) Rate = $k[A][B]^2$ (2) Rate = $k[A]^2[B]^2$ (3) Rate = $k[A][B]$ (4) Rate = $k[A]^2[B]$

22. In a zero- order reaction for every 10° rise of temperature, the rate is doubled. If the temperature is increased from 10°C to 100°C, the rate of the reaction will become : **[AIPMT 2012]**

(1) 256 times (2) 512 times (3) 64 times (4) 128 times

23. What is the activation energy for a reaction if its rate doubles when the temperature is raised from 20°C to 35°C ? (R = 8.314 J mol^{-1} K^{-1}) **[NEET 2013]**

(1) 269 kJ mol^{-1} (2) 34.7 kJ mol^{-1} (3) 15.1 kJ mol^{-1} (4) 342 kJ mol^{-1}

24. The activation energy of a reaction can be determined from the slope of which of the following graphs ? **[AIPMT 2015]**

(1) $\frac{\ln K}{T}$ vs. T (2) ln K vs. $\frac{1}{T}$ (3) $\frac{T}{\ln K}$ vs. $\frac{1}{T}$ (4) ln K vs. T

25. When initial concentration of a reactant is doubled in a reaction, its half-life period is not effected. The order of the reaction is : **[AIPMT 2015]**

(1) First (2) Second

(3) More than zero but less than first (4) Zero

26. The rate of a first-order reaction is 0.04 mol ℓ^{-1} s^{-1} at 10 seconds and 0.03 mol ℓ^{-1} s^{-1} at 20 seconds after initiation of the reaction. The half-life period of the reaction is : **[NEET-1-2016]**

(1) 54.1 s (2) 24.1 s (3) 34.1 s (4) 44.1 s

27. The decomposition of phosphine (PH_3) on tungsten at low pressure is a first-order reaction. It is because the **[NEET-2-2016]**

(1) Rate of decomposition is very slow
(2) Rate is proportional to the surface coverage
(3) Rate is inversely proportional to the surface coverage
(4) Rate is independent of the surface coverage

28. A first order reaction has a specific reaction rate of 10^{-2}. How much time will it take for 20 g of the reaction to reduce to 5 g ? **[NEET-2017]**

(1) 238.6 sec (2) 138.6 sec (3) 346.5 sec (4) 693.0 sec

29. The correct difference between first and second-order reactions is that **[NEET-2018]**

(1) The rate of a first-order reaction does not depend on reactant concentrations ; the rate of a second order reaction does depend on reactant concentrations
(2) The rate of a first-order reaction does depend on reactant concentrations ; the rate of a second-order reaction does not depend on reactant concentrations
(3) A first-order reaction can be catalyzed ; a second –order reaction cannot be catalyzed

(4) The half-life of a first-order reaction does not depend on $[A]_0$; the half-life of a second-order reaction does depend on $[A]_0$

30. When initial concentration of the reactant is doubled, the half-life period of a zero order reaction **[NEET-2018]**

(1) in halved (2) remains unchanged (3) is tripled (4) is doubled

31. If the rate constant for a first order reaction is k, the time (t) required for the completion of 99% of the reaction is given by : **[NEET-1-2019]**

(1) t = 2.303 /k (2) t = 0.693 / k (3) t = 6.909 /k (4) t = 4.606 / k

32. A first order reaction has a rate constant of $2.303 \times 10^{-3}\ s^{-1}$. The time required for 40 g of this reactant to reduce to 10 g will be – [Given that $\log_{10} 2 = 0.3010$] **[NEET-2-2019]**

(1) 230.3 s (2) 301 s (3) 2000 s (4) 602 s

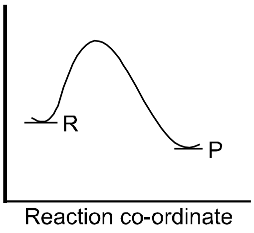
33. For a reaction, activation energy $E_a = 0$ and the rate constant at 200 K is $1.6 \times 10^6 s^{-1}$.The rate constant at 400 K will be –[Given that gas constant, $R = 8.314\ J\ K^{-1}\ mol^{-1}$] **[NEET-2-2019]**

(1) $3.2 \times 10^4\ s^{-1}$ (2) $1.6 \times 10^6\ s^{-1}$ (3) $1.6 \times 10^3\ s^{-1}$ (4) $3.2 \times 10^6\ s^{-1}$

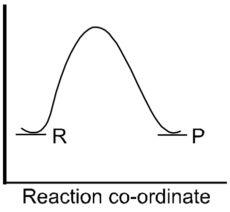
PART - II : AIIMS QUESTION (PREVIOUS YEARS)

1. An endothermic reaction with high activation energy for the forward reaction is given by the diagram : **[AIIMS 2005]**

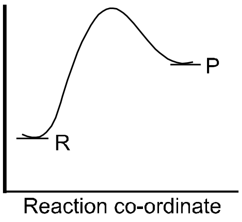
(1)



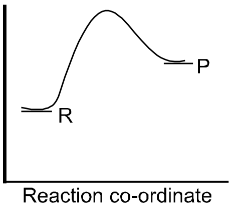
(2)



(3)



(4)

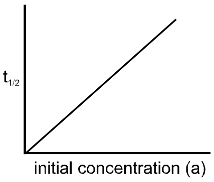


2. For reaction aA → xP, when [A] = 2.2 mM, the rate was found to be 2.4 mM s^{-1}. On reducing concentration of A to half, the rate changes to 0.6 mM s^{-1}. The order of reaction with respect to A is : **[AIIMS 2005]**

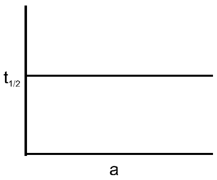
(1) 1.5 (2) 2.0 (3) 2.5 (4) 3.0

3. Which of the following graphs represent relation between initial concentration of reactants and half-life for third order reaction ? **[AIIMS 2005]**

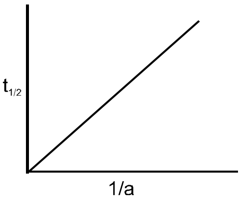
(1)



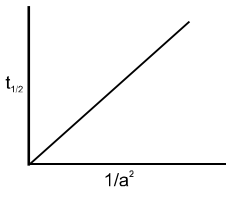
(2)



(3)



(4)



4. For the reaction $2N_2O_5 \longrightarrow 4NO_2 + O_2$ rate of reaction is : **[AIIMS 2006]**

(1) $\frac{1}{2}\frac{d}{dt}[N_2O_5]$ (2) $2\frac{d}{dt}[N_2O_5]$ (3) $\frac{1}{4}\frac{d}{dt}[NO_2]$ (4) $4\frac{d}{dt}[NO_2]$

5. The half-life for the reaction $N_2O_5 \longrightarrow 2NO_2 + \frac{1}{2}O_2$ is 2.4 h at STP. Starting with 10.8 g of N_2O_5 how much oxygen will be obtained after a period of 9.6 h ? **[AIIMS 2007]**

(1) 1.5 L (2) 3.36 L (3) 1.05 L (4) 0.07 L

6. The temperature dependence of rate constant (k) of a chemical reaction is written in terms of Arrhenius equation $k = Ae^{-E_a/RT}$. Activaiton energy (E_a) of the reaction can be calculated by ploting **[AIIMS 2007]**

(1) log k vs T (2) log k vs $\frac{1}{T}$ (3) k vs T (4) k vs $\frac{1}{\log T}$

7. **Statement-1 :** The order of a reaction can have fractional value. **[AIIMS 2008]**

Statement-2 : The order of a reaction cannot be written from balanced equation of a reaction.

(1) Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statement-1.
(2) Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of Statement-1
(3) Statement-1 is false, Statement-2 is true.
(4) Statement-1 is true, Statement-2 is false.

8. $3BrO^- \longrightarrow BrO_3^- + 2Br^-$

If $-\frac{d\ [BrO^-]}{dt} = k_1\ [BrO^-]^2$; $+\frac{d\ [BrO_3^-]}{dt} = k_2\ [BrO^-]^2$; $+\frac{d\ [Br^-]}{dt} = k_3\ [BrO^-]^2$ the correct relation between k_1, k_2 and k_3 is **[AIIMS 2009]**

(1) $3k_1 = k_2 = 2k_3$ (2) $k_1 = 3k_2 = 1.5\ k_3$ (3) $k_1 = k_2 = k_3$ (4) $2k_1 = 3k_2 = k_3$

9. The two-third life ($t_{2/3}$) of a first order reaction in which $k = 5.48 \times 10^{-14}\ sec^{-1}$ is **[AIIMS 2010]**

(1) $\frac{2.303}{5.48\times10^{-14}}\log 3$ (2) $\frac{2.303}{5.48\times10^{-14}}\log 2$ (3) $\frac{2.303}{5.48\times10^{-14}}\log\frac{1}{3}$ (4) $\frac{2.303}{5.48\times10^{-14}}\log\frac{2}{3}$

10. For a first-order reaction A → B the plot of log $\{[A]_t / 1\ M\}$ versus t is linear with a **[AIIMS 2010]**

(1) positive slope and zero intercept (2) positive slope and non zero intercept
(3) negative slope and zero intercept (4) negative slope and non zero intercept

11. At a certain temperature, the first order rate constant, k_1 is found to be smaller than the second order rate constant, k_2. If the energy of activation, E_1 of the first order reaction is greater than energy of activation, E_2 of the second order reaction then with increase in temperature **[AIIMS 2010]**

(1) k_1 will increase faster than k_2, but always will remain less than k_2
(2) k_2 will increase faster than k_1
(3) k_1 will increase faster than k_2 and becomes equal to k_2
(4) k_1 will increase faster than k_2 and becomes greater than k_2

12. For a first order gas phase reaction :

$$A_{(g)} \rightarrow 2B_{(g)} + C_{(g)}$$

P_0 be initial pressure of A and P_t the total pressure at time 't'. Integrated rate equation is : **[AIIMS 2011]**

(1) $\frac{2.303}{t}\log\left(\frac{P_0}{P_0 - P_t}\right)$ (2) $\frac{2.303}{t}\log\left(\frac{2P_0}{3P_0 - P_t}\right)$

(3) $\frac{2.303}{t}\log\left(\frac{P_0}{2P_0-P_t}\right)$ (4) $\frac{2.303}{t}\log\left(\frac{2P_0}{2P_0-P_t}\right)$

13. **Assertion :** Two different reactions can never have same rate of reaction.
Reason : Rate of reaction always depends only on frequency of collision and Arrhenius factor.
[AIIMS 2011]
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If both assertion and reason are false.

14. Select the rate law that corresponds to the data shown for the following reaction : **[AIIMS 2012]**

$$A + B \longrightarrow C$$

Expt. No.	(A)	(B)	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

(1) Rate = $k[B]^3$ (2) Rate = $k[B]^4$ (3) Rate = $k[A][B]^3$ (4) Rate = $4[A]^2[B]^2$

15. **Assertion :** If the activation energy of a reaction is zero, temperature will have no effect on the rate constant.
Reason : Lower the activation energy, faster is the reaction. **[AIIMS 2012]**
(1) If both Assertion and Reason are correct and Reasons is the correct explanation of Assertion.
(2) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(3) If Assertion is correct but Reason is incorrect.
(4) If Assertion is incorrect but Reason is correct.

16. A reaction which is of first order w.r.t. reactant A, has a rate constant 6 min^{-1} . If we start with [A] = 0.5 mol L^{-1}, when would [A] reach the value of 0.05 mol L^{-1} **[AIIMS 2013]**
(1) 0.384 min (2) 0.15 min (3) 3 min (4) 3.84 min

17. Half-lives of a first order and a zero order reaction are same. Then the ratio of the initial rates of first order reaction to that of the zero order reaction is **[AIIMS 2014]**
(1) $\frac{1}{0.693}$ (2) 2 × 0.693 (3) 0.693 (4) $\frac{2}{0.693}$

18. If the rate of decomposition of N_2O_5 during a certain time internal is 2.4×10^{-4} mol L^{-1} min^{-1}
$N_2O_5 \rightarrow 2\,NO_2 + \frac{1}{2}O_2$ **[AIIMS 2015]**
What is the rate of formation of NO_2 and O_2 mol L^{-1} min^{-1}
(1) 2.3×10^{-5} and 1.2×10^{-5} respectively (2) 3.8×10^{-5} and 0.6×10^{-4} respectively
(3) 2.4×10^{-4} and 1.5×10^{-4} respectively (4) 4.8×10^{-4} and 1.2×10^{-4} respectively

19. In the reaction, A → product, $\frac{-dA}{dt} = K_1 A$. If we start with 10 M of A, then after one natural life time, concentration of A decreased to **[AIIMS 2016]**
(1) 5 m (2) 2.5 m (3) $\frac{10m}{e}$ (4) $\frac{10m}{e^2}$

20. For the reaction
$2NO + Br_2 \rightarrow 2NOBr$, **[AIIMS 2016]**

the following mechanism has been given

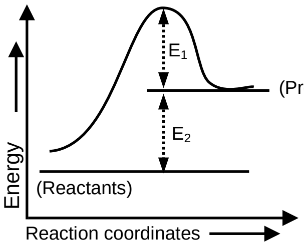
$NO + Br_2 \xrightarrow{Fast} NOBr_2$

$NOBr_2 + NO \xrightarrow{Slow} 2NOBr$

Hence, rate law is

(1) $k[NO]^2 [Br_2]$ (2) $k[NO] [Br_2]$ (3) $k[NOBr_2] [NO]$ (4) $k[NO] [Br_2]^2$

21. Consider the below given figure. **[AIIMS 2017]**



The correct option for the above presentation is

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

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

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

(4) Activation energy for the backward direction is E_1 and product is more stable than reactant.

22. Rate constant (K) varies with temperature as given by equation **[AIIMS 2017]**

$\log K \ (min^{-1}) = 5 - \frac{2000}{T}$

Consider the following about this equation

I. Pre exponential factor is 10^5.

II. Es is 9.212 kcal.

III. Variation of log K with $\frac{1}{T}$ is linear.

Select the correct statement.

(1) I, II and III (2) Both I and II (3) Both II and III (4) Both I and III

23. Which option is valid for zero order reaction. **[AIIMS 2018]**

(1) $t_{1/2} = \frac{3}{2} t_{1/4}$ (2) $t_{1/2} = \frac{4}{3} t_{1/4}$ (3) $t_{1/2} = 2t_{1/4}$ (4) $t_{1/4} = (t_{1/2})^2$

24. If reaction A and B are given with Same temperature and same concentration but rate of A is double than B. Pre exponential factor is same for both the reaction then difference in activation energy $E_A - E_B$ is ? **[AIIMS 2018]**

(1) $-RT \ \ell n2$ (2) $RT \ \ell n2$ (3) 2RT (4) $\frac{RT}{2}$

25. It first order reaction 80% reaction complete in 60 minute, What is $t_{\frac{1}{2}}$ of reaction **[AIIMS 2018]**

(1) 30 min (2) 42 min (3) 25.72 min (4) 14.28 min

26. Rate of two reaction whose rate constants are k_1 & k_2 are equal at 300 k such that : **[AIIMS 2018]**

So calculate $\ell n \frac{A_2}{A_1} = ?$ $Ea_2 - Ea_1 = 2RT$, **[AIIMS 2018]**

(1) $\ell n4$ (2) 2 (3) log 2 (4) $2\text{-}\ell n2$

27. For first order reaction as time duration goes from 10min to 30 min rate of reaction decreases from 0.4Ms^{-1} to 0.04 Ms^{-1} . What is the half life of the reaction ? **[AIIMS 2018]**

(1) 8 min (2) 4 min (3) 6 min (4) 2 min

28. At 300 K, activation energy of A is higher than B by 5.75 kJ/mol in presence of catalyst. Calculate $\frac{K_B}{K_A}$ **[AIIMS 2018]**

(1) 1 (2) 10 (3) 1000 (4) 100

29. Time taken for 12.8 g of a radioactive substance to decay to 0.4 g, is (half life is 138s) **[AIIMS 2018]**

(1) 720 s (2) 690 s (3) 345 s (4) 69 s

PART - III : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. A reaction involving two different reactants can never be : **[AIEEE- 2005]**

(1) unimolecular reaction (2) first order reaction
(3) second order reaction (4) bimolecular reaction

2. A reaction was found to be second order with respect to the concentration of carbon monoxide. If the concentration of carbon monoxide is doubled, with everything else kept the same, the rate of reaction will be **[AIEEE- 2006]**

(1) remain unchanged (2) tripled
(3) increased by a factor of 4 (4) doubled

3. The following mechanism has been proposed for the reaction of NO with Br_2 to form NOBr.

$NO(g) + Br_2(g) \rightleftharpoons NOBr_2(g)$; $NOBr_2(g) + NO(g) \longrightarrow 2NOBr(g)$ (slow step)

If the second step is the rate determining step, the order of the reaction with respect to NO(g) is **[AIEEE- 2007, 3/120]**

(1) 1 (2) 0 (3) 3 (4) 2

4. The energies of activation for forward and reverse reactions for $A_2 + B_2 \rightleftharpoons 2AB$ are 180 kJ mol^{-1} and 200 kJ mol^{-1} respectively. The presence of a catalyst lowers the activation energy of both (forward and reverse) reactions by 100 kJ mol^{-1}. The enthalpy change of the reaction ($A_2 + B_2 \rightarrow 2AB$) in the presence of catalyst will be (in kJ mol^{-1}). **[AIEEE- 2007, 3/120]**

(1) 280 (2) 20 (3) 300 (4) 120

5. A radioactive element gets spilled over the floor of a room. Its half-life period is 30days. If the initial activity is ten times the permissible value, after how many days will it be safe to enter the room : **[AIEEE- 2007, 3/120]**

(1) 10 days (2) 100 days (3) 1000 days (4) 300 days

6. For a reaction $\frac{1}{2}A \longrightarrow 2B$, rate of disappearance of 'A' related to the rate of appearance of 'B' by the expression. **[AIEEE- 2008, 3/105]**

(1) $-\frac{d[A]}{dt} = \frac{1}{4}\frac{d[B]}{dt}$ (2) $-\frac{d[A]}{dt} = \frac{d[B]}{dt}$ (3) $-\frac{d[A]}{dt} = 4\frac{d[B]}{dt}$ (4) $-\frac{d[A]}{dt} = \frac{1}{2}\frac{d[B]}{dt}$

7. The half life period of a first order chemical reaction is 6.93 minutes. Time required for the completion of 99% of the chemical reaction will be (log 2 = 0.301) : **[AIEEE - 2009, 8/144]**

(1) 23.03 minutes (2) 46.06 minutes (3) 460.6 minutes (4) 230.3 minutes

8. The time for half life period of a certain reaction $A \longrightarrow$ Products is 1 hour. When the initial concentration of the reactant 'A', is 2.0 mol L^{-1}, how much time does it take for its concentration to come from 0.50 to 0.25 mol L^{-1}. If it is a zero order reaction? **[AIEEE - 2010, 8/144]**

(1) 4 h (2) 0.5 h (3) 0.25 h (4) 1 h

9. Consider the reaction **[AIEEE - 2010, 4/144]**

$Cl_2\,(aq) + H_2S(aq) \longrightarrow S(s) + 2H^{+}\,(aq) + 2Cl^{-}\,(aq)$

The rate equation for this reaction is

rate = $k\,[Cl_2][H_2S]$

Which of these mechanisms is/are consistent with this rate equation?

A. $Cl_2 + H_2S \longrightarrow H^{+} + Cl^{-} + Cl^{+} + HS^{-}$ (slow)

$Cl^{+} + HS^{-} \longrightarrow H^{+} + Cl^{-} + S$ (fast)

B. $H_2S \Leftrightarrow H^{+} + HS^{-}$ (fast equilibrium)

$Cl_2 + HS^{-} \longrightarrow 2Cl^{-} + H^{+} + S$ (slow)

(1) B only (2) Both A and B (3) Neither A nor B (4) A only

10. The rate of a chemical reaction doubles for every 10ºC rise of temperature. If the temperature is raised by 50ºC, the rate of the reaction increases by about : **[AIEEE - 2011, 4/120]**

(1) 10 times (2) 24 times (3) 32 times (4) 64 times

11. A reactant (A) forms two products :

$A \xrightarrow{k_1} B$, Activation Energy Ea_1

$A \xrightarrow{k_2} C$, Activation Energy Ea_2

If $Ea_2 = 2\,Ea_1$, then k_1 and k_2 are related as : **[AIEEE - 2011, 4/120]**

(1) $k_2 = k_1 e^{Ea_1/RT}$ (2) $k_2 = k_1 e^{Ea_2/RT}$ (3) $k_1 = Ak_2 e^{Ea_1/RT}$ (4) $k_1 = 2k_2 e^{Ea_2/RT}$

12. For a first order reaction (A) → products the concentration of A changes from 0.1 M to 0.025 M in 40 minutes. The rate of reaction when the concentration of A is 0.01 M is : **[AIEEE - 2012, 4/120]**

(1) 1.73×10^{-5} M/min (2) 3.47×10^{-4} M/min (3) 3.47×10^{-5} M/min (4) 1.73×10^{-4} M/min

13. The rate of a reaction doubles when its temperature changes from 300 K to 310 K. Activation energy of such a reaction will be : (R = 8.314 $JK^{-1}\,mol^{-1}$ and log 2 = 0.301) **[JEE(Main) - 2013, 4/120]**

(1) 53.6 kJ mol^{-1} (2) 48.6 kJ mol^{-1} (3) 58.5 kJ mol^{-1} (4) 60.5 kJ mol^{-1}

14. For the non-stoichiometre reaction 2A + B → C + D, the following kinetic data were obtained in three separate experiments, all at 298 K.

Initial Concentraton (A)	Initial Concentraton (B)	Initial rate of formation of C ($mol\,L^{-}S^{-}$)
0.1 M	0.1 M	1.2×10^{-3}
0.1 M	0.2 M	1.2×10^{-3}
0.2 M	0.1 M	2.4×10^{-3}

The rate law for the formation of C is : **[JEE(Main) - 2014, 4/120]**

(1) $\frac{dc}{dt} = k[A]\,[B]$ (2) $\frac{dc}{dt} = k[A]^2[B]$ (3) $\frac{dc}{dt} = k[A]\,[B]^2$ (4) $\frac{dc}{dt} = k[A]$

15. Higher order (>3) reactions are rare due to : **[JEE(Main) - 2015, 4/120]**

(1) low probability of simultaneous collision of all the reacting species

(2) increase in entropy and activation energy as more molecules are involved

(3) shifting of equilibrium towards reactants due to elastic collisions

(4) loss of active species on collision

16. Decomposition of H_2O_2 follows a first order reaction. In fifty minutes the concentration of H_2O_2 decreases from 0.5 to 0.125 M in one such decomposition. When the concentration of H_2O_2 reaches 0.05 M, the rate of formation of O_2 will be : **[JEE(Main) - 2016, 4/120]**

(1) 6.93×10^{-4} mol min^{-1}
(2) 2.66 L min^{-1}at STP (STP)
(3) 1.34×10^{-2} mol min^{-1}
(4) 6.93×10^{-2} mol min^{-1}

17. Two reactions R_1 and R_2 have identical pre-exponential factors. Activation energy of R_1 exceeds that of R_2 by 10kJ mol^{-1}. If k_1 and k_2 are rate constants for reactions R_1 and R_2 respectively at 300 K, then $\ln(k_2/k_1)$ is equal to : (R = 8.314 J $mol^{-1} K^{-1}$) **[JEE(Main) - 2017, 4/120]**

(1) 12
(2) 6
(3) 4
(4) 8

18. At 518° C, the rate of decomposition of a sample of gaseous acetaldehyde, initially at a pressure of 363 Torr, was 1.00 Torr s^{-1} when 5% had reacted and 0.5 Torr s^{-1} when 33% had reacted. The order of the reaction is : **[JEE(Main) - 2018, 4/120]**

(1) 1
(2) 0
(3) 2
(4) 3

19. The following results were obtained during kinetic studies of the reaction ; **[JEE(Main) - 2019, 4/120]**
$2A + B \rightarrow$ Products

Experiment	[A] (in mol L^{-1})	[B] (in mol L^{-1})	Initial Rate of reaction (in mol L^{-1} min^{-1})
I	0.10	0.20	6.93×10^{-3}
II	0.10	0.25	6.93×10^{-3}
III	0.20	0.30	1.386×10^{-2}

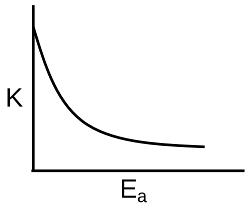
Time time (in minutes) required to consume half of A is :

(1) 1
(2) 5
(3) 10
(4) 100

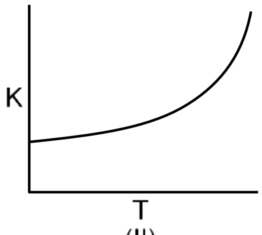
20. For the reaction, $2A + B \rightarrow$ products, when the concentration of A and B both were doubled, the rate of the reaction increased from 0.3 mol $L^{-1}s^{-1}$ to 2.4 mol $L^{-1}s^{-1}$. When the concentration of A alone is doubled, the rate increased from 0.3 mol $L^{-1}s^{-1}$ to 0.6 mol $L^{-1}s^{-1}$. **[JEE(Main) - 2019, 4/120]**
Which one of the following statements is correct?

(1) Order of the reaction with respect to B is 1
(2) Order of the reaction with respect to B is 2
(3) Total order of the reaction is 4
(4) Order of the reaction with respect to A is 2

21. Consider the given plots for a reaction obeying Arrhenius equation (0°C < T < 300°C) : (k and E_a are rate constant and activation energy, respectively) **[JEE(Main) - 2019, 4/120]**



(I)



(II)

Choose the correct option :

(1) I is right but II is wrong
(2) Both I and II are wrong
(3) I is wrong but II is right
(4) Both I and II are correct

22. For an elementary chemical reaction, **[JEE(Main) - 2019, 4/120]**

$A_2 \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} 2A$ the expression for $\frac{d[A]}{dt}$

(1) $2k_1[A_2]-k_{-1}[A]^2$ (2) $k_1[A_2]+k_{-1}[A]^2$ (3) $k_1[A_2]-k_{-1}[A]^2$ (4) $2k_1[A_2]-2k_{-1}[A]^2$

23. If a reaction follows the Arrhenius equation the plot lnk vs 1/(RT) gives straight line with a gradient (–y) unit . The energy required to activate the reactant is : **[JEE(Main) - 2019, 4/120]**

(1) –y unit (2) y unit (3) y/R unit (4) yR unit

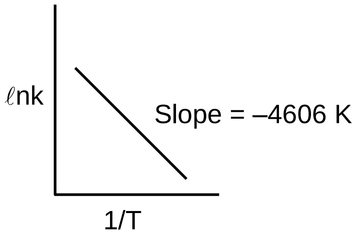
24. The reaction $2X \rightarrow B$ is a zeroth order reaction. If the intial concentration of X is 0.2 M, the half-life is 6 h. When the initial concentration of X is 0.5 M, the time required to reach its final concentration of 0.2 M will be : **[JEE(Main) - 2019, 4/120]**

(1) 18.0 h (2) 12.0 h (3) 7.2 h (4) 9.0 h

25. Decomposition of X exhibits a rate constant of 0.05 μg/year. How many years are required for the decomposition of 5 μg of X into 2.5 μg ? **[JEE(Main) - 2019, 4/120]**

(1) 40 (2) 25 (3) 20 (4) 50

26. For a reaction, consider the plot of ln k versus 1/T given in the figure. If the rate constant of this reaction at 400 K is 10^{-5} s^{-1}, then the rate constant at 500 K is: **[JEE(Main) - 2019, 4/120]**



(1) 10^{-4} s^{-1} (2) 4×10^{-4} s^{-1} (3) 2×10^{-4} s^{-1} (4) 10^{-6} s^{-1}

Answers

EXERCISE - 1

SECTION (A)

1.	(3)	**2.**	(2)	**3.**	(1)	**4.**	(3)	**5.**	(2)	**6.**	(4)	**7.**	(2)
8.	(1)	**9.**	(3)	**10.**	(1)	**11.**	(4)	**12.**	(4)				

SECTION (B)

1.	(2)	**2.**	(3)	**3.**	(4)	**4.**	(4)	**5.**	(2)	**6.**	(4)	**7.**	(2)
8.	(4)	**9.**	(3)	**10.**	(3)								

SECTION (C)

1.	(3)	**2.**	(2)	**3.**	(1)	**4.**	(3)	**5.**	(1)	**6.**	(4)	**7.**	(2)
8.	(2)	**9.**	(3)	**10.**	(3)	**11.**	(3)	**12.**	(1)	**13.**	(2)	**14.**	(2)
15.	(2)	**16.**	(4)	**17.**	(3)								

SECTION (D)

1.	(2)	**2.**	(4)	**3.**	(3)	**4.**	(4)	**5.**	(2)	**6.**	(3)	**7.**	(4)
8.	(2)												

SECTION (E)

1.	(1)	**2.**	(2)	**3.**	(1)	**4.**	(2)	**5.**	(2)

SECTION (F)

1.	(1)	**2.**	(1)	**3.**	(2)	**4.**	(2)	**5.**	(4)	**6.**	(3)	**7.**	(1)
8.	(4)	**9.**	(2)	**10.**	(1)	**11.**	(4)	**12.**	(4)				

SECTION (G)

1.	(3)	**2.**	(2)	**3.**	(2)	**4.**	(2)	**5.**	(3)	**6.**	(3)	**7.**	(3)

SECTION (H)

1.	(2)

EXERCISE - 2

1.	(3)	**2.**	(2)	**3.**	(4)	**4.**	(2)	**5.**	(1)	**6.**	(3)	**7.**	(2)
8.	(3)	**9.**	(4)	**10.**	(1)	**11.**	(2)	**12.**	(3)	**13.**	(3)	**14.**	(2)
15.	(2)	**16.**	(1)	**17.**	(1)	**18.**	(3)	**19.**	(2)	**20.**	(4)	**21.**	(1)
22.	(3)	**23.**	(1)	**24.**	(4)	**25.**	(1)	**26.**	(2)				

EXERCISE - 3

PART-I

1.	(4)	**2.**	(2)	**3.**	(2)	**4.**	(2)	**5.**	(3)	**6.**	(1)	**7.**	(3)
8.	(2)	**9.**	(4)	**10.**	(2)	**11.**	(1)	**12.**	(2)	**13.**	(3)	**14.**	(1)
15.	(4)	**16.**	(3)	**17.**	(2)	**18.**	(1)	**19.**	(4)	**20.**	(2,4)	**21.**	(4)
22.	(2)	**23.**	(2)	**24.**	(2)	**25.**	(1)	**26.**	(2)	**27.**	(4)	**28.**	(2)
29.	(4)	**30.**	(4)	**31.**	(4)	**32.**	(4)	**33.**	(2)				

PART-II

1.	(3)	**2.**	(2)	**3.**	(4)	**4.**	(3)	**5.**	(3)	**6.**	(2)	**7.**	(2)
8.	(2)	**9.**	(1)	**10.**	(4)	**11.**	(1)	**12.**	(2)	**13.**	(4)	**14.**	(1)
15.	(2)	**16.**	(1)	**17.**	(2)	**18.**	(1)	**19.**	(3)	**20.**	(1)	**21.**	(1)
22.	(1)	**23.**	(3)	**24.**	(1)	**25.**	(2)	**26.**	(2)	**27.**	(2)	**28.**	(2)
29.	(2)												

PART-III

1.	(1)	**2.**	(3)	**3.**	(4)	**4.**	(2)	**5.**	(2)	**6.**	(1)	**7.**	(2)
8.	(3)	**9.**	(4)	**10.**	(3)	**11.**	(3)	**12.**	(2)	**13.**	(1)	**14.**	(4)
15.	(1)	**16.**	(1)	**17.**	(3)	**18.**	(3)	**19.**	(3)	**20.**	(2)	**21.**	(4)
22.	(4)	**23.**	(2)	**24.**	(1)	**25.**	(4)	**26.**	(1)				