Chemical Kinetics and Nuclear Chemistry

1. The half life period of a first order chemical reaction is 6.93 minutes. The time required for the completion of 99% of the chemical reaction will be (log 2 = 0.301) **[AIEEE-2009]**

   (1) 23.03 minutes (2) 46.06 minutes

   (3) 460.6 minutes (4) 230.3 minutes

2. Consider the reaction

   $Cl_2(aq) + H_2S(aq) \rightarrow S(s) + 2H^+(aq) + 2Cl^-(aq)$

   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. $Cl_2 + H_2S \rightarrow H^+ + Cl^- + Cl^+ + HS^-$ (slow)

   $Cl^+ + HS^- \rightarrow H^+ + Cl^- + S$ (fast)

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

   $Cl_2 + HS^- \rightarrow 2Cl^- + H^+ + S$ (slow)

   [AIEEE-2010]

   (1) A only (2) B only

   (3) Both (A) & (B) (4) Neither (A) nor (B)

3. The time for half life period of a certain reaction $A \longrightarrow$ Products is 1 h. 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]**

   (1) 1 h (2) 4 h

   (3) 0.5 h (4) 0.25 h

4. 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 $E_{a_2} = 2E_{a_1}$, then k_1 and k_2 are related as **[AIEEE-2011]**

   (1) $k_1 = Ak_2e^{E_{a_1}/RT}$ (2) $k_1 = 2k_2e^{E_{a_2}/RT}$

   (3) $k_2 = k_1e^{E_{a_1}/RT}$ (4) $k_2 = k_1e^{E_{a_2}/RT}$

5. For a first order reaction, (A) $\rightarrow$ 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 0.01M, is **[AIEEE-2012]**

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

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

6. The rate of a reaction doubles when its temperature changes from 300 K to 310 K. Activation energy of such a reaction will be **[JEE (Main)-2013]**

   (R = 8.314 JK^{-1} mol^{-1} and log2 = 0.301)

   (1) 53.6 kJ mol^{-1} (2) 48.6 kJ mol^{-1}

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

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

Initial Concentration (A)	Initial Concentration (B)	Initial rate of formation of C (mol $L^{-1}s^{-1}$)
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]**

   (1) $\frac{dC}{dt} = k[A][B]$ (2) $\frac{dC}{dt} = k[A]^2[B]$

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

8. Higher order (>3) reactions are rare due to **[JEE (Main)-2015]**

   (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

9. Decomposition of H_2O_2 follows a first order reaction. In fifty minutes, the concentration of H_2O_2 decreases from 0.5 to 0.25 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]**

(1) 6.93×10^{-4} mol min^{-1}

(2) 2.66 L min^{-1} at STP

(3) 1.34×10^{-2} mol min^{-1}

(4) 6.93×10^{-2} mol min^{-1}

10. Two reactions R_1 and R_2 have identical pre-exponential factors. Activation energy of R_1 exceeds that of R_2 by 10 kJ 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 $mole^{-1}$ K^{-1}) **[JEE (Main)-2017]**

(1) 6 (2) 4

(3) 8 (4) 12

11. 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]**

(1) 2 (2) 3

(3) 1 (4) 0

12. The following results were obtained during kinetic studies of the reaction ; 2 A + B → 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}

The time (in minutes) required to consume half of A is **[JEE (Main)-2019]**

(1) 100 (2) 1

(3) 5 (4) 10

13. For the reaction, 2A + B → 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 $L^{-1}s^{-1}$. Which one of the following statements is correct? **[JEE (Main)-2019]**

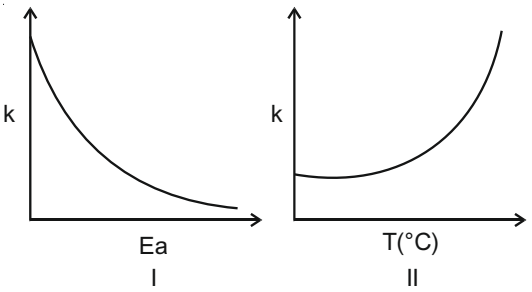
(1) Order of the reaction with respect to A is 2

(2) Order of the reaction with respect to B is 1

(3) Order of the reaction with respect to B is 2

(4) Total order of the reaction is 4

14. 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)



Choose the correct option: **[JEE (Main)-2019]**

(1) I is wrong but II is right

(2) Both I and II are correct

(3) Both I and II are wrong

(4) I is right but II is wrong

15. Which of the following is not an example of heterogeneous catalytic reaction? **[JEE (Main)-2019]**

(1) Combustion of coal

(2) Ostwald's process

(3) Hydrogenation of vegetable oils

(4) Haber's process

16. For an elementary chemical reaction, $A_2 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2A$, the expression for $\frac{d[A]}{dt}$ is **[JEE (Main)-2019]**

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

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

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

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

17. If a reaction follows the Arrhenius equation, the plot $\ln k$ vs $\frac{1}{(RT)}$ gives straight line with a gradient (–y) unit. The energy required to activate the reactant is **[JEE (Main)-2019]**

(1) yR unit

(2) y/R unit

(3) –y unit

(4) y unit

18. The reaction $2X \rightarrow B$ is a zeroth order reaction. If the initial 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]**

(1) 12.0 h (2) 7.2 h

(3) 9.0 h (4) 18.0 h

19. The correct match between Item I and Item II is **[JEE (Main)-2019]**

Item I	Item II
(A) Allosteric effect	(P) Molecule binding to the active site of enzyme
(B) Competitive inhibitor	(Q) Molecule crucial for communication in thebody
(C) Receptor	(R) Molecule binding to a site other than the active site of enzyme
(D) Poison	(S) Molecule binding to the enzyme covalently

(1) (A) → (P); (B) → (R); (C) → (S); (D) → (Q)

(2) (A) → (R); (B) → (P); (C) → (Q); (D) → (S)

(3) (A) → (P); (B) → (R); (C) → (Q); (D) → (S)

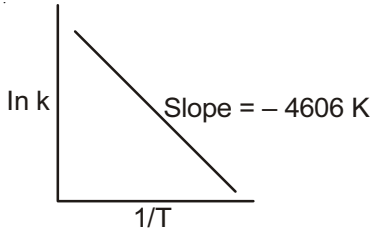
(4) (A) → (R); (B) → (P); (C) → (S); (D) → (Q)

20. 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]**

(1) 40 (2) 20

(3) 50 (4) 25

21. 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]

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

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

22. For the reaction $2A + B \rightarrow C$, the values of initial rate at different reactant concentrations are given in the table below. The rate law for the reaction is

[A](mol L^{-1})	[B](mol L^{-1})	Initial Rate (mol $L^{-1}s^{-1}$)
0.05	0.05	0.045
0.10	0.05	0.090
0.20	0.10	0.72

[JEE (Main)-2019]

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

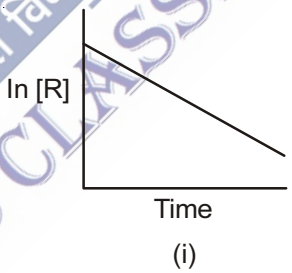
(3) Rate = $k[A]^2[B]$ (4) Rate = $k[A][B]^2$

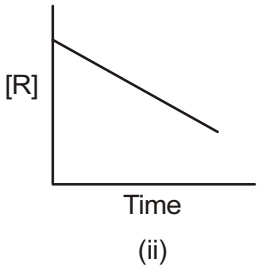
23. For a reaction scheme $A \xrightarrow{k_1} B \xrightarrow{k_2} C$, if the rate of formation of B is set to be zero then the concentration of B is given by : **[JEE (Main)-2019]**

(1) $k_1k_2[A]$ (2) $(k_1 - k_2)[A]$

(3) $\left(\frac{k_1}{k_2}\right)[A]$ (4) $(k_1 + k_2)[A]$

24. The given plots represent the variation of the concentration of a reactant R with time for two different reactions (i) and (ii). The respective orders of the reactions are





[JEE (Main)-2019]

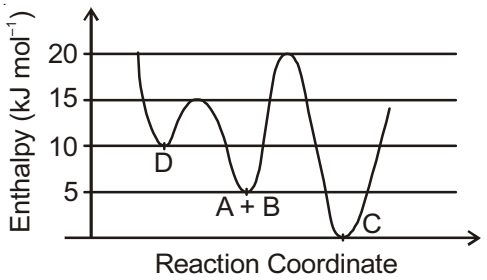
(1) 0, 1 (2) 1, 1

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

25. Consider the given plot of enthalpy of the following reaction between A and B.

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

Identify the incorrect statement.



[JEE (Main)-2019]

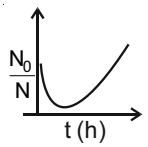
(1) Activation enthalpy to form C is 5 kJ mol^{-1} less than that to form D

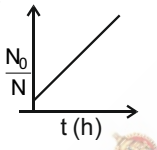
(2) D is kinetically stable product

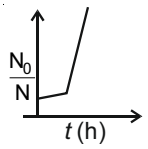
(3) Formation of A and B from C has highest enthalpy of activation

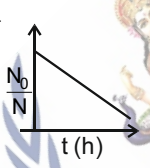
(4) C is the thermodynamically stable product

26. A bacterial infection in an internal wound grows as $N'(t) = N_0 \exp(t)$, where the time t is in hours. A dose of antibiotic, taken orally, needs 1 hour to reach the wound. Once it reaches there, the bacterial population goes down as $\frac{dN}{dt} = -5N^2$. What will be the plot of $\frac{N_0}{N}$ vs. t after 1 hour ? **[JEE (Main)-2019]**

(1) 

(2) 

(3) 

(4) 

27. For the reaction of H_2 with I_2, the rate constant is 2.5×10^{-4} dm^3 mol^{-1} s^{-1} at 327°C and 1.0 dm^3 mol^{-1} s^{-1} at 527°C. The activation energy for the reaction, in kJ mol^{-1} is : ($R = 8.314$ J K^{-1} mol^{-1}) **[JEE (Main)-2019]**

(1) 150 (2) 59

(3) 72 (4) 166

28. In the following reaction; $xA \rightarrow yB$

$$\log_{10}\left[-\frac{d[A]}{dt}\right] = \log_{10}\left[\frac{d[B]}{dt}\right] + 0.3010$$

'A' and 'B' respectively can be **[JEE (Main)-2019]**

(1) C_2H_4 and C_4H_8

(2) N_2O_4 and NO_2

(3) n-Butane and Iso-butane

(4) C_2H_2 and C_6H_6

29. NO_2 required for a reaction is produced by the decomposition of N_2O_5 in CCl_4 as per the equation, $2N_2O_5(g) \rightarrow 4\,NO_2(g) + O_2(g)$.

The initial concentration of N_2O_5 is 3.00 mol L^{-1} and it is 2.75 mol L^{-1} after 30 minutes. The rate of formation of NO_2 is **[JEE (Main)-2019]**

(1) 1.667×10^{-2} mol L^{-1} min^{-1}

(2) 4.167×10^{-3} mol L^{-1} min^{-1}

(3) 8.333×10^{-3} mol L^{-1} min^{-1}

(4) 2.083×10^{-3} mol L^{-1} min^{-1}

30. For the reaction

$$2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$$

the observed rate expression is,

rate = $k_f[NO]^2[H_2]$. The rate expression for the reverse reaction is : **[JEE (Main)-2020]**

(1) $k_b[N_2][H_2O]^2/[NO]$ (2) $k_b[N_2][H_2O]$

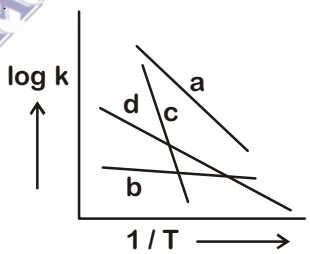
(3) $k_b[N_2][H_2O]^2$ (4) $k_b[N_2][H_2O]^2/[H_2]$

31. The rate of a certain biochemical reaction at physiological temperature (T) occurs 10^6 times faster with enzyme than without. The change in the activation energy upon adding enzyme is **[JEE (Main)-2020]**

(1) – 6RT (2) + 6RT

(3) + 6(2.303)RT (4) – 6(2.303)RT

32. Consider the following plots of rate constant versus $\frac{1}{T}$ for four different reactions. Which of the following orders is correct for the activation energies of these reactions?



[JEE (Main)-2020]

(1) $E_b > E_a > E_d > E_c$ (2) $E_c > E_a > E_d > E_b$

(3) $E_a > E_c > E_d > E_b$ (4) $E_b > E_d > E_c > E_a$

33. For following reactions

$$A \xrightarrow{700\ K} \text{Product}$$

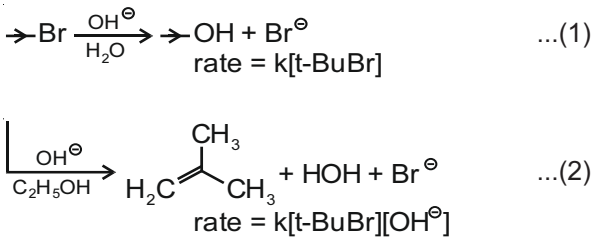
$$A \xrightarrow[\text{catalyst}]{500\ K} \text{Product}$$

it was found that the E_a is decreased by 30 kJ/ mol in the presence of catalyst. If the rate remains unchanged, the activation energy for catalysed reaction is (Assume pre exponential factor is same) **[JEE (Main)-2020]**

(1) 75 kJ/mol (2) 198 kJ/mol

(3) 105 kJ/mol (4) 135 kJ/mol

34. Consider the reaction sequence given below:



Which of the following statements is true?

[JEE (Main)-2020]

(1) Changing the concentration of base will have no effect on reaction (2)

(2) Changing the concentration of base will have no effect on reaction (1)

(3) Changing the base from $OH^{\ominus}$ to $^{\ominus}OR$ will have no effect on reaction (2)

(4) Doubling the concentration of base will double the rate of both the reactions

35. The results given in the below table were obtained during kinetic studies of the following reaction

$2A + B \rightarrow C + D$

Experiment	[A] / mol L^{-1}	[B] / mol L^{-1}	Initial rate / mol L^{-1} min^{-1}
I	0.1	0.1	6.00×10^{-3}
II	0.1	0.2	2.40×10^{-2}
III	0.2	0.1	1.20×10^{-2}
IV	X	0.2	7.20×10^{-2}
V	0.3	Y	2.88×10^{-1}

X and Y in the given table are respectively

[JEE (Main)-2020]

(1) 0.4, 0.3 (2) 0.3, 0.4

(3) 0.4, 0.4 (4) 0.3, 0.3

36. It is true that **[JEE (Main)-2020]**

(1) A zero order reaction is a single step reaction

(2) A zero order reaction is a multistep reaction

(3) A frist order reaction is always a single step reaction

(4) A second order reaction is always a multistep reaction

37. For the reaction $2A+3B+\frac{3}{2}C\rightarrow3P$, which statement is correct? **[JEE (Main)-2020]**

(1) $\frac{dn_A}{dt}=\frac{3}{2}\frac{dn_B}{dt}=\frac{3}{4}\frac{dn_C}{dt}$

(2) $\frac{dn_A}{dt}=\frac{dn_B}{dt}=\frac{dn_C}{dt}$

(3) $\frac{dn_A}{dt}=\frac{2}{3}\frac{dn_B}{dt}=\frac{4}{3}\frac{dn_C}{dt}$

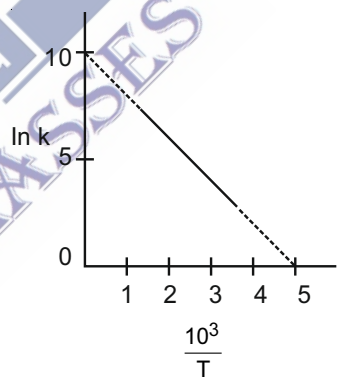
(4) $\frac{dn_A}{dt}=\frac{2}{3}\frac{dn_B}{dt}=\frac{3}{4}\frac{dn_C}{dt}$

38. A flask contains a mixture of compounds A and B. Both compounds decompose by first-order kinetics. The half-lives for A and B are 300 s and 180 s, respectively. If the concentrations of A and B are equal initially, the time required for the concentration of A to be four times that of B (in s) is : (Use ln 2 = 0.693) **[JEE (Main)-2020]**

(1) 120 (2) 300

(3) 180 (4) 900

39. The rate constant (k) of a reaction is measured at different temperatures (T), and the data are plotted in the given figure. The activation energy of the reaction in kJ mol^{-1} is (R is gas constant)



[JEE (Main)-2020]

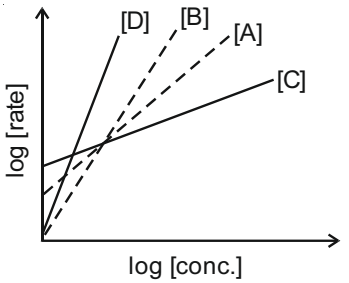
(1) 1/R (2) 2/R

(3) 2R (4) R

40. Consider the following reactions

$A \rightarrow P1$; $B \rightarrow P2$; $C \rightarrow P3$; $D \rightarrow P4$,

The order of the above reactions are a, b, c, and d, respectively. The following graph is obtained when log[rate] vs. log[conc.] are plotted



Among the following, the correct sequence for the order of the reactions is **[JEE (Main)-2020]**

(1) d > b > a > c (2) d > a > b > c

(3) a > b > c > d (4) c > a > b > d

41. During the nuclear explosion, one of the products is ^{90}Sr with half life of 6.93 years. If 1 μg of ^{90}Sr was absorbed in the bones of a newly born baby in place of Ca, how much time, in years, is required to reduce it by 90% if it is not lost metabolically _____. **[JEE (Main)-2020]**

42. A sample of milk splits after 60 min. at 300 K and after 40 min. at 400 K when the population of lactobacillus acidophilus in it doubles. The activation energy (in kJ/mol) for this process is closest to _____ . **[JEE (Main)-2020]**

(Given, R = 8.3 J $mol^{-1}K^{-1}$, $\ln\left(\frac{2}{3}\right) = 0.4$, $e^{-3} = 4.0$)

43. If 75% of a first order reaction was completed in 90 minutes, 60% of the same reaction would be completed in approximately (in minutes) _____.

(Take : log 2 = 0.30; log 2.5 = 0.40)

[JEE (Main)-2020]

44. The number of molecules with energy greater than the threshold energy for a reaction increases five fold by a rise of temperature from 27°C to 42°C. Its energy of activation inJ/mol is _____.

(Take In 5 = 1.6094; R = 8.314 J mol^{-1} K^{-1})

[JEE (Main)-2020]

45. The rate of a reaction decreased by 3.555 times when the temperature was changed from 40°C to 30°C. The activation energy (in kJ mol^{-1}) of the reaction is _____. Take; R = 8.314 J mol^{-1} K^{-1} ln 3.555 = 1.268 **[JEE (Main)-2020]**

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