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Chemical Kinetics

Conceptual MCQs

1. A reaction involving two different reactants can never be
(a) bimolecular reaction (b) second order reaction
(c) first order reaction (d) unimolecular reaction

2. Which of these does not influence the rate of reaction ?
(a) Nature of the reactants
(b) Concentration of the reactants
(c) Temperature of the reaction
(d) Molecularity of the reaction

3. $3A \rightarrow 2B$, rate of reaction $\frac{d[B]}{dt}$ is equal to
(a) $-\frac{3}{2}\frac{d[A]}{dt}$ (b) $-\frac{2}{3}\frac{d[A]}{dt}$
(c) $-\frac{1}{3}\frac{d[A]}{dt}$ (d) $+2\frac{d[A]}{dt}$

4. $3A \rightarrow B + C$, it would be a zero order reaction when
(a) the rate of reaction is proportional to square of concentration of A.
(b) the rate of reaction remains same at any concentration of A.
(c) the rate remains unchanged at any concentration of B and C.
(d) the rate of reaction doubles if concentration of B is increased to double.

5. For nth order reaction, the half-life period $t_{1/2}$ is proportional to initial concentration as :
(a) $\frac{1}{a^{n-1}}$ (b) a^{n+1} (c) a^{n-1} (d) $\frac{1}{a^{n}}$

6. For a reaction $\frac{1}{2}A \rightarrow 2B$, rate of disappearance of 'A' is related to the rate of appearance of 'B' by the expression
(a) $-\frac{d[A]}{dt} = \frac{1}{2}\frac{d[B]}{dt}$ (b) $-\frac{d[A]}{dt} = \frac{1}{4}\frac{d[B]}{dt}$
(c) $-\frac{d[A]}{dt} = \frac{d[B]}{dt}$ (d) $-\frac{d[A]}{dt} = 4\frac{d[B]}{dt}$

7. Point out the wrong statement:
For a first order reaction
(a) time for half-change ($t_{1/2}$) is independent of initial concentration.
(b) change in the concentration unit does not change the rate constant (k).
(c) time for half-change × rate constant = 0.693.
(d) the unit of k is $mol^{-1}\ min^{-1}$.

8. If the rate of the reaction is equal to the rate constant, the order of the reaction is :
(a) 3 (b) 0 (c) 1 (d) 2

9. The half-life period of a first order reaction is 100 sec. The rate constant of the reaction is :
(a) $6.93 \times 10^{-3}\ s^{-1}$ (b) $6.93 \times 10^{-4}\ s^{-1}$
(c) $0.693\ s^{-1}$ (d) $69.3\ s^{-1}$

10. The rate constant of a reaction is $3.00 \times 10^{3}\ L\ mol^{-1}\ s^{-1}$. The order of this reaction will be:
(a) 0 (b) 1 (c) 2 (d) 3

11. If the rate of a gaseous reaction is independent of pressure, the order of reaction is:
(a) 0 (b) 1 (c) 2 (d) 3

12. For the reaction,
$CH_3COCH_3 + I_2 \xrightarrow{H^+}$ products.
The rate is governed by expression
$$\frac{dx}{dt} = k[\text{acetone}][H^+].$$
The order w.r.t. I_2 is:
(a) 1 (b) 0 (c) 3 (d) 2

13. Activation energy of a chemical reaction can be determined by
(a) evaluating rate constant at standard temperature.
(b) evaluating velocities of reaction at two different temperatures.
(c) evaluating rate constants at two different temperatures.
(d) changing concentration of reactants.

14. The reason for almost doubling the rate of reaction on increasing the temperature of the reaction system by 10 °C is:
(a) The value of threshold energy increases
(b) Collision frequency increases
(c) The fraction of the molecule having energy equal to threshold energy or more increases
(d) Activation energy decreases

15. In a reversible reaction the energy of activation of the forward reaction is 50 kcal. The energy of activation for the reverse reaction will be

(a) < 50 kcal

(b) either greater than or less than 50 kcal

(c) 50 kcal

(d) > 50 kcal

16. The slope in Arrhenius plot, is equal to:

(a) $-\frac{E_a}{2.303R}$ (b) $\frac{E_a}{R}$

(c) $-\frac{R}{2.303E_a}$ (d) None of these

17. For a reaction, activation energy (E_a) = 0 and rate constant is $3.2 \times 10^6\ s^{-1}$ at 300 K. What is the value of the rate constant at 310 K

(a) $3.2 \times 10^{-12}\ s^{-1}$ (b) $3.2 \times 10^6\ s^{-1}$

(c) $6.4 \times 10^{12}\ s^{-1}$ (d) $6.4 \times 10^6\ s^{-1}$

18. The rate constant is given by the equation $k = PZe^{-E/RT}$. Which factor should register a decrease for the reaction to proceed more rapidly

(a) T (b) Z (c) E (d) p

19. Which of the following statements is not true according to collision theory of reaction rates?

(a) Collision of molecules is a precondition for any reaction to occur.

(b) All collisions result in the formation of the products.

(c) Only activated collisions result in the formation of the products.

(d) Molecules which have acquired the energy of activation can collide effectively.

20. The ΔH value of the reaction $H_2 + Cl_2 \rightleftharpoons 2HCl$ is –44.2 k cal. If E_1 is the activation energy of the products, then for the above reaction

(a) $E_1 > E_2$

(b) $E_1 < E_2$

(c) $E_1 = E_2$

(d) ΔH is not related to E_1 and E_2

Application Based MCQs

21. For the reaction system :

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ volume is suddenly reduced to half its value by increasing the pressure on it. If the reaction is of first order with respect to O_2 and second order with respect to NO, the rate of reaction will

(a) diminish to one-eighth of its initial value

(b) increase to eight times of its initial value

(c) increase to four times of its initial value

(d) diminish to one-fourth of its initial value

22. For the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$, rate and rate constant are 1.02×10^{-4} mol $L^{-1}s^{-1}$ and $3.4 \times 10^{-5}\ s^{-1}$ respectively then concentration of N_2O_5 at that time will be

(a) 1.732 M (b) 3 M

(c) 3.4×10^5 M (d) 1.02×10^{-4} M

23. Select the rate law that corresponds to data shown for the following reaction

$A + B \longrightarrow$ products.

Exp.	[A]	[B]	Initial rate
1	0.012	0.035	0.1
2	0.024	0.070	0.8
3	0.024	0.035	0.1
4	0.012	0.070	0.8

(a) rate = $k\,[B]^3$ (b) rate = $k\,[B]^4$

(c) rate = $k\,[A]\,[B]^3$ (d) rate = $k\,[A]^2\,[B]^2$

24. A substance 'A' decomposes by a first order reaction starting initially with [A] = 2.00 M and after 200 min, [A] becomes 0.15 M. For this reaction $t_{1/2}$ is

(a) 53.72 min (b) 50.49 min

(c) 48.45 min (d) 46.45 min

25. Consider the reaction, 2A + B → products. When concentration of B alone was doubled, the half-life did not change. When the concentration of A alone was doubled, the rate increased by two times. The unit of rate constant for this reaction is

(a) s^{-1} (b) L $mol^{-1}\ s^{-1}$

(c) no unit (d) mol $L^{-1}\ s^{-1}$.

26. In a 1st order reaction, reactant concentration C varies with time t as :

(a) $\frac{1}{C}$ increases linearly with t

(b) log C decreases linearly with t

(c) C decreases with $\frac{1}{t}$

(d) log C decreases with $\frac{1}{t}$

27. A reaction proceeds by first order, 75% of this reaction was completed in 32 min. The time required for 50% completion is

(a) 8 min (b) 16 min (c) 20 min (d) 24 min

28. The rate constant of a first order reaction is $6.9 \times 10^{-3} s^{-1}$. How much time will it take to reduce the initial concentration to its 1/8th value?

(a) 100 s (b) 200 s (c) 300 s (d) 400 s

29. If a reaction follows the Arrhenius equation, the plot lnk vs $\frac{1}{(RT)}$ gives straight line with a gradient (– y) unit. The energy required to activate the reactant is:

(a) y/R unit (b) y unit

(c) yR unit (d) – y unit

30. The rate of a 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

(a) 0.383 min (b) 23.1 min

(c) 8.73 min (d) 7.53 min

31. 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 :

(a) 1.73×10^{-5} M/min (b) 3.47×10^{-4} M/min

(c) 3.47×10^{-5} M/min (d) 1.73×10^{-4} M/min

32. $t_{1/4}$ can be taken as the time taken for the concentration of a reactant to drop to $\frac{3}{4}$ of its initial value. If the rate constant for a first order reaction is k, the $t_{1/4}$ can be written as

(a) $0.75/k$ (b) $0.69/k$ (c) $0.29/k$ (d) $0.10/k$

33. A reaction rate constant is given by

$k = 1.2 \times 10^{14} e^{-(25000/RT)}$ sec^{-1}. It means

(a) log k versus log T will give a straight line with slope as –25000

(b) log k versus T will give a straight line with slope as –25000

(c) log k versus log 1/T will give a straight line with slope as –25000

(d) log k versus 1/T will give a straight line

34. 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 mol^{-1}K^{-1})

(a) 8 (b) 12 (c) 6 (d) 4

35. For the non - stoichimetric 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:

(a) $\frac{dc}{dt} = k[A][B]$ (b) $\frac{dc}{dt} = k[A]^2[B]$

(c) $\frac{dc}{dt} = k[A][B]^2$ (d) $\frac{dc}{dt} = k[A]$

36. For the reaction, 2A + B → products, when the concentrations 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?

(a) Total order of the reaction is 4

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

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

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

37. The rate law for a reaction between the substances A and B is given by Rate = $k\,[A]^n\ [B]^m$

On doubling the concentration of A and halving the concentration of B, the ratio of the new rate to the earlier rate of the reaction will be as

(a) (m+n) (b) (n−m) (c) $2^{(n-m)}$ (d) $\frac{1}{2^{(m+n)}}$

38. Hydrogenation of vegetable ghee at 27 °C reduces pressure of H_2 from 2 atm to 1.2 atm in 50 minutes. The rate of reaction in terms of molarity per second is –

(a) 1.08×10^{-5} (b) 1.9×10^{-5}

(c) 2.5×10^{-6} (d) 3.87×10^{-2}

39. 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)

(a) 53.6 kJ mol^{-1} (b) 48.6 kJ mol^{-1}

(c) 58.5 kJ mol^{-1} (d) 60.5 kJ mol^{-1}

40. A radioactive element gets spilled over the floor of a room. Its half-life period is 30 days. If the initial velocity is ten times the permissible value, after how many days will it be safe to enter the room?

(a) 100 days (b) 1000 days

(c) 300 days (d) 10 days.

41. A first order reaction is 20% complete in 10 minutes. What is the specific rate constant for the reaction?

(a) 0.0970 min.$^{-1}$ (b) 0.009 min.$^{-1}$

(c) 0.0223 min.$^{-1}$ (d) 2.223 min.$^{-1}$

42. Hydrolysis of DDT is a first order reaction, its half life is 10 years. Time to hydrolyse 10 *g* DDT to half is :

(a) 100 years (b) 50 years

(c) 5 years (d) 10 years

43. Consider a reaction $aG + bH \rightarrow$ Products. When concentration of both the reactants G and H is doubled, the rate increases by eight times. However, when concentration of G is doubled keeping the concentration of H fixed, the rate is doubled. The overall order of the reaction is:

(a) 0 (b) 1 (c) 2 (d) 3

44. Under the same reaction conditions, initial concentration of 1.386 mol dm^{-3} of a substance becomes half in 40 seconds and 20 seconds through first order and zero order kinetics, respectively. Ratio (k_1/k_0) of the rate constant for first order (k_1) and zero order (k_0) of the reaction is –

(a) 0.5 mol^{-1} dm^3 (b) 1.0 mol dm^{-3}

(c) 1.5 mol dm^{-3} (d) 2.0 mol^{-1} dm^3

45. The chemical reaction, $2O_3 \rightarrow 3O_2$ proceeds as

$O_3 \rightleftharpoons O_2 + [O]$ (fast)

$[O] + O_3 \rightarrow 2O_2$ (slow)

The rate law expression will be :

(a) Rate = $k[O][O_3]$ (b) Rate = $k[O_3]^2[O_2]^{-1}$

(c) Rate = $k[O_3]^2$ (d) Rate = $k[O_2][O]$

Skill Based MCQs

46. 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 hour. What is the time taken for conversion of 0.9 mole of A to produce 0.675 mole of B?

(a) 2 hr (b) 1 hr (c) 0.5 hr (d) 0.25 hr

47. Ethylene is produced by $C_4H_8 \xrightarrow{\Delta} 2C_2H_4$

The rate constant is 2.3×10^{-4} s^{-1}. Approximately in what time will the molar ratio of ethylene to cyclobutane in mixture attain the value equal to one ?

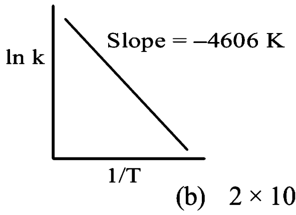
($\log 2 = 0.3, \log 3 = 0.47$)

(a) 1700 s (b) 1600 s (c) 2000 s (d) 1200 s

48. 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 :

(a) 9.0 h (b) 12.0 h (c) 18.0 h (d) 7.2 h

49. 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 :



(a) 10^{-6} s^{-1} (b) 2×10^{-4} s^{-1}
(c) 10^{-4} s^{-1} (d) 4×10^{-4} s^{-2}

50. 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 ?

(a) 4 hr (b) 0.5 hr (c) 0.25 hr (d) 1 hr

51. 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. $H_2S \rightleftharpoons H^+ + HS^-$ (fast equilibrium)
$Cl_2 + HS^- \rightarrow 2Cl^- + H^+ + S$ (Slow)

(a) B only (b) Both A and B
(c) Neither A nor B (d) A only

52. The half-life for radioactive decay of C–14 is 5730 years. An archaeological artifact containing wood had only 80% of the C–14 found in a living tree. The age of the sample is

(a) 1485 years (b) 1845 years
(c) 530 years (d) 4767 years.

53. The following results were obtained during kinetic studies of the reaction;

2A + 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:

(a) 5 (b) 10 (c) 1 (d) 100

54. 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 :

(a) 2 (b) 3 (c) 1 (d) 0

55. For a first order reaction A→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

(a) 1.0×10^6 s^{-1} and 9.2 kJ mol^{-1}

(b) 6.0 s^{-1} and 16.6 kJ mol^{-1}

(c) 1.0×10^6 s^{-1} and 16.6 kJ mol^{-1}

(d) 1.0×10^6 s^{-1} and 38.3 kJ mol^{-1}

ANSWER KEY

Conceptual MCQs																			
1	(d)	**3**	(b)	**5**	(a)	**7**	(d)	**9**	(a)	**11**	(a)	**13**	(c)	**15**	(b)	**17**	(b)	**19**	(b)
2	(d)	**4**	(b)	**6**	(b)	**8**	(b)	**10**	(c)	**12**	(b)	**14**	(b)	**16**	(a)	**18**	(c)	**20**	(a)
Application Based MCQs																			
21	(b)	**24**	(a)	**27**	(b)	**30**	(b)	**33**	(d)	**36**	(b)	**39**	(a)	**42**	(d)	**45**	(b)		
22	(b)	**25**	(b)	**28**	(c)	**31**	(b)	**34**	(d)	**37**	(c)	**40**	(a)	**43**	(d)				
23	(a)	**26**	(b)	**29**	(b)	**32**	(c)	**35**	(d)	**38**	(a)	**41**	(c)	**44**	(a)				
Skill Based MCQs																			
46	(b)	**47**	(a)	**48**	(c)	**49**	(c)	**50**	(c)	**51**	(d)	**52**	(b)	**53**	(a)	**54**	(a)	**55**	(d)