CHEMICAL KINETICS-1

1. Among the following slowest reaction under identical conditions is

1) HCl (aq) +NaOH (aq) → NaCl (aq) + H_2 O (l)

2) $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$

3) $2H_2$ (g) + O_2 (g) → $2H_2O$ (l)

4) $C_2H_5OH_{(l)} + CH_3COOH_{(l)} \xrightarrow{H^+} CH_3COOC_2H_{5(l)} + H_2O_{(l)}$

2. In a chemical reaction, rate of a chemical reaction increases with temperature. The reason is due to

1) Number of collisions between molecules increases

2) Decreases in activation energy

3) Increase in the number of the molecules with activation energy

4) Kinetic energy of reactants increases

3) The rate of reaction for $N_2 + 3H_2 \rightarrow 2NH_3$ may be represented as

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

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

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

4) $r = -\frac{d[N_2]}{dt} = \frac{1}{3}\frac{d[H_2]}{dt} = +\frac{1}{2}\frac{d[NH_3]}{dt}$

4. K represents the rate constant of a reaction when log K is plotted against 1/T (T=temperature) the graph obtained is a

1) Curve

2) a straight line with a positive slope

3) a straight line with negative slope

4) a straight line with zero slope

5) The rate of a chemical reaction

1) Increases as the reaction proceeds

2) Decreases as the reaction proceeds

3) May increase or decrease during the reaction

4) Remains constant as the reaction proceeds

6. The chemical reaction occurring between covalent molecules involve

1) Rearrangement of ions 2) Rearrangement of bonds

3) Rearrangement of ions &bonds 4) none of these.

7. The rate of a reaction decreases with increase in

1) The concentration of the reactants 2) temperature of the reaction

3) Time of the reaction 4) with all the three

8. In a reaction 2A + B→ A_2B, the reactant 'A' will disappear at

1) Half the rate at which B disappears
2) The same rate at which B disappears
3) The same rate at which A_2B is formed
4) Twice the rate at which B disappears

Solution: Rate = -1/2 d [A]/dt = - d [B]/dt

9. The value of the rate constant of a reaction depends on

1) Time 2) activation energy 3) temperature 4) half-life value

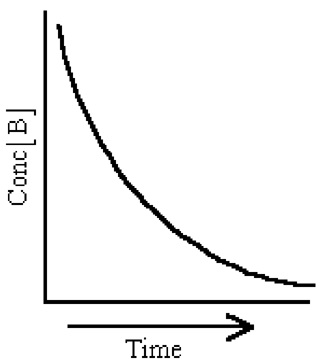
10. For an irreversible chemical reaction, the concentration of the products with time

1) Increases 2) decreases 3) does not change 4) can't be predicted

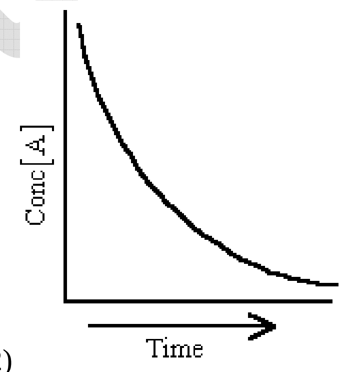
11. A catalyst

1) Increases the heat of the reaction
2) Decreases the heat of the reaction
3) Does not alter the heat of the reaction
4) Increases the activation energy.

12 For the reaction A →B; following curves represent reaction



1)



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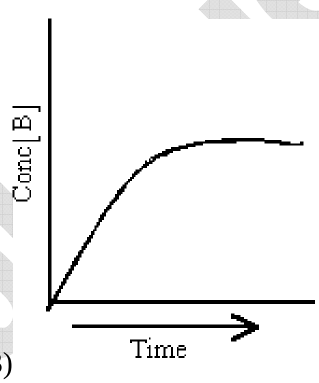

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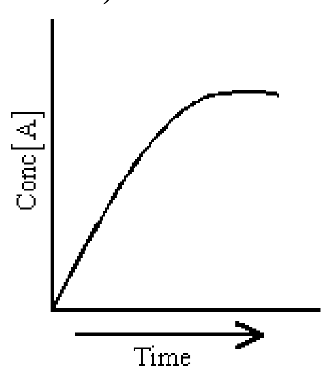


4)

The correct curves are

1) 1, 2 only 2) 2, 3 only
3) 1, 4 only 4) 3, 4 only

13. In which of the following cases, rate of disappearance of any reactant at a given instant equals to rate of appearance of any product

1) $H_2 + F_2 \rightarrow 2HF$ 2) $2CO + O_2 \rightarrow 2CO_2$

3) $PCl_3 + Cl_2 \rightarrow PCl_5$ 4) $N_2 + O_2$ 2NO

14 The rate of reaction that does not involve gases, is not dependent on

1) Temperature 2) concentration 3) pressure 4) catalyst

15. The specific rate constant of a reaction is independent of

1) Concentration of the reactant 2) time

3) Concentration of the product 4) all of these.

16. A catalyst increases the rate of reaction, because

1) It brings the reactants closer

2) It lowers the activation energy

3) It changes the heat of reaction

4) It increases the activation energy

17. The unit of rate constant depends on

1) Mass of reactants

2) Concentration of reactants

3) Order of reaction

4) Molecularity of reaction

18. The temperature coefficient of a reaction is

1) The rate constant at a fixed temperature

2) The ratio of rate constants at two temperatures

3) The ratio of rate constants at two different temperatures differing by 10°C

4) The ratio of rate constants at two pressures

19. If concentration of reactants is made 'x' times, the rate constant k becomes

1) kx 2) k/x 3) x/k 4) unchanged

Hint; K is independent of concentration of reactants

20. The temperature coefficient of most of the reactions lies between

1) 1 & 3 2) 2 & 3 3) 1 & 4 4) 2 & 4

21. For a reaction, $\frac{K_{t+10}}{K_t} = x$. When temperature is increased from 60^0C to 100^0C, rate constant (K) increased by a factor of 81. Then, value of x is

1) 1.5 2) 2.5 3) 3 4) 2

Solution: Final rate= Initial rate (Temperature coefficient)^n,

n= $(T_2 - T_1)/10$=100-60/10 =4, 81=$(3)^4$=(Temperature coefficient)^4

$\therefore$ (Temperature coefficient)=3

22. Increase of temperature will increase the reaction rate due to

1) Increase of number of effective collisions

2) Increase of mean free path

3) Increase of number of molecules

4) Increase of number of collisions

23. Activation energy of a reaction primarily depends on

1) Pressure of reactants 2) concentration of reactants

3) Concentration of product 4) nature of reactants

24 A catalyst in a chemical reaction does not change

1) Average energy of reactants or products 2) Enthalpy of the reaction

3) Activation energy of the reaction 4) Both 1 and 2

25. The effect of temperature on a reaction rate for which Ea is zero is given by
1) With increase of temperature rate increases
2) With increase of temperature rate decreases
3) Rate is independent of temperature
4) Reaction never occurs

26. The rate const ants of a reaction at 280K & 300K respectively are K_1&K_2.Then
1) $K_1=20K_2$ 2) $K_2=4K_1$ 3) $K_1=4K_2$ 4) $K_1=0.5\ K_2$

Solution: n=300-280/10=2, Final rate= Initial rate (Temperature coefficient)^n

i.e. $K_2 = K_1\ [2]^2 = 4\ K_1$

27. Activation energies for different reactions are given below
a) A→ products, Ea=32 K.Cal b) B→products, Ea=45 K.cal
c) C→products, Ea=28 K.Cal d) D→products, Ea=20K.cal
If the temperature increases by 10^0C for which reactions the temperature coefficients are maximum and minimum respectively.
1) a & b 2) b & c 3) b & d 4) d & b

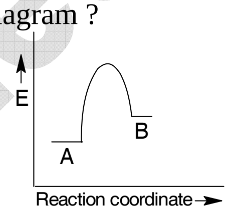
Hint: The temperature coefficient is maximum when E_a is highest and minimum when E_a is lowest.

28. For a reaction, $K=2X10^{13}\ e^{-30000/RT}$. When log K (y-axis) is plotted against 1/T (x - axis), slope of line will be ....Cal
1) $\frac{30000}{4.6}$ 2) $\frac{-30000}{4.6}$ 3) $\frac{-30000}{2.303}$ 4) $\frac{30000}{2.303}$

Solution; $K=Ae^{-E/RT}$, E_a=30000 , slope= $-E_a$/2.303R, R=2cal

29. The rate expression gives the relation between rate of reaction and
1) conc. of reactants 2) conc. of products
3) rate constant 4) rate law

30. For a reversible reaction, which one of the following statements is wrong from the given energy profile diagram ?



1) Activation energy of forward reaction is greater than that of backward reacton.
2) The threshold energy is less than that of activation energy
3) The forward reaction is endothermic
4) Activation energy of forward reaction is equal to the sum of heat of reaction and the activation energy of backward reaction.

31. Consider an endothermic reaction X→Y with the activation energies E_b and E_f for the backward and forward reactions, respectively. In general
1) $E_b < E_f$ 2) $E_b > E_f$
3) $E_b = E_f$ 4) no definite relation

32. An endothermic reaction A→B has activation energy as xKJ.mol^{-1} of A. If ΔH of the reaction is yKJ, the activation energy of the backward reaction is
1) - x 2) x - y 3) x + y 4) y - x

Solution; ΔH=Activation energy of forward (E_F) - Activation energy of backward(E_b)

33. The activation energy of a reaction can be determined by
1) increasing the concentration of reactants
2) evaluating rate constant at standard temperature
3) evaluating rate constants at two different temperatures
4) by decreasing conc. of reactants

34. Consider the following reaction $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$. The rate of the reaction in terms of N_2 at T (k) is $-\frac{d[N_2]}{dt} = 0.02$ mole. lit^{-1} sec^{-1} What is the value of $-\frac{d[H_2]}{dt}$ (in mole. lit^{-1}. sec^{-1}) at the same temperature?
1) 0.02 2) 50 3) 0.06 4) 0.04

Solution: rate= $-\frac{d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} \therefore \frac{d[H_2]}{dt} = 3X - \frac{d[N_2]}{dt}$

35. What is the rate of the reaction for $2A \rightarrow B$
1) $-\frac{d[A]}{dt}$ 2) $-\frac{d[B]}{dt}$ 3) $-\frac{1}{2}\frac{d[B]}{dt}$ 4) $-\frac{1}{2}\frac{d[A]}{dt}$

36. For the reaction $4NH_3+5O_2 \rightarrow 4NO + 6H_2O$, the rate of reaction with respect to NO is 2×10^{-3} Ms^{-1}. Then the rate of the reaction with respect to NH_3 is __ Ms^{-1}
1) 2×10^{-3} 2) 1.5×10^{-3} 3) 2.5×10^{-3} 4) 3×10^{-3}

Solution: rate= $-\frac{1}{4}\frac{d[NH_3]}{dt} = +\frac{1}{4}\frac{d[NO]}{dt} \therefore$ rate is same

37. Concentration of a reactant 'A' is changed from 0.044 M to 0.032M in 25 minutes, the average rate of the reaction during this interval is
1) 4.8 $X10^{-3}$ mole/lit/min
2) 4.8 $X10^{-4}$ mole/lit/sec
3) 4.8 $X10^{-4}$ mole/lit/min
4) 4.8 $X10^{-3}$mole/lit/sec

Solution: rate=d[C]/dt= 0.044-0.032/25= 4.8 $X10^{-4}$ mole/lit/min

38. In the reaction $A \rightarrow 2B$, the concentration of A falls from 1.0M to 0.94M in one minute what is the rate in moles $liter^{-1}$ sec^{-1}
1) $1.8X10^{-3}$ 2) $6X10^{-2}$ 3) $6X10^{-3}$ 4) $1.0X10^{-3}$

Solution: rate=d[C]/dt= 1.0-0.94/60= 10^{-3} mole/lit/sec

39. The rate of formation of SO_3 in the reaction $2SO_2+O_2 \rightarrow 2SO_3$ is 80 g min^{-1}. Hence, rate of disappearance of SO_2 is
1) 32 g min^{-1} 2) 40 g min^{-1} 3) 64 g min^{-1} 4) 80 g min^{-1}

Hint: The rate of formation of SO_3 = 80 g min^{-1}=80/80=1mol.min^{-1}

$$-\frac{1}{2}\frac{d[SO_2]}{dt} = +\frac{1}{2}\frac{d[SO_3]}{dt}, \frac{d[SO_2]}{dt} = 1mol.min^{-} ie64\,gm.min^{-1}$$

40.1lit of 1 M CH_3COOH is mixed with 1 lit of 1 M C_2H_5OH to form an ester. The decrease in the initial rate if each solution is diluted with an equal volume of water would be
1) 2 times 2) 4 times 3) 0.25 times 4) 0.5 times

Hint; rate=K [CH_3COOH] [C_2H_5OH], as equal volume is added the concentration of each becomes half. ∴ Rate decreased by 4 times.

41. The rate of reaction becomes 2 times for every 10ºC rise in temperature. How many times the rate of reaction will increase when temperature is increased from 300K to 330K

1) 6 2) 9 3) 8 4) 27

Solution: Final rate= Initial rate (Temperature coefficient)^n ,

n= (T_2- T_1)/10=330-300/10 =3, Final rate= Initial rate$(2)^3$=8 times to initial rate.

42. An endothermic reaction A → B has an activation energy 25 kcal/mole and the heat of reaction is -5 kcal/mole. The activation energy of the reaction B→ A is

1) 30 kcal/mole 2) 20 kcal/mole
3) 25 kcal/mole 4) 5 kcal/mole

Solution; ΔH=Activation energy of forward (E_F) - Activation energy of backward(E_b)

43. The activation energy of a reaction is 58.3 kJ/mole the ratio of the rate constants at 305K and 300K is about (R=8.3Jk^{-1}mol^{-1}) **(Antilog 0.1667=1.468)**

1) 1.25 2) 1.75 3) 1.5 4) 2.0

Hint; $\log \frac{k_2}{k_1} = \frac{E_0}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$

44.$2SO_2 + O_2 \rightarrow 2SO_3$, if the volume of the reaction vessel is doubled, the rate of forward reaction will be

1) 1/4 th of initial value 2) 1/8 th of initial value
3) 4 times of its initial value 4) 8 times of its initial value

Hint; Rate law is rate=k$[SO_2]^2$ [O_2], If volume is doubled, the concentration of each becomes half.∴ Rate decreased by 8 times.

45. The rate of reaction for A→ products is 10 mol. lit^{-1}.min^{-1} at time t_1=5 minutes. What will be the rate (in mol.lit^{-1}, min^{-1}) at time t_2 = 10 minutes?

1) > 10 2) < 10 3) 10 4) 20

Hint; rate decreases with increase of time.

46. **For the reaction $2NH_3 \rightarrow N_2 + 3H_2$, $-\frac{d[NH_3]}{dt} = K_1[NH_3]$; $\frac{d[N_2]}{dt} = K_2[NH_3]$; $\frac{d[H_2]}{dt} = K_3[NH_3]$.The correct relation between** K_1 ,K_2 and K_3 is

1) $K_1 = K_2 = K_3$ 2) $1.5K_1 = 3K_2 = K_3$ 3) $2K_1 = K_2 = 3K_3$ 4) $K_1 = 3K_2 = 2K_3$

Hint; $r = -\frac{1}{2}\frac{d[NH_3]}{dt} = \frac{d[N_2]}{dt} = \frac{1}{3}\frac{d[H_2]}{dt}$, i.e 1/2 **$K_1[NH_3]$= $K_2[NH_3]$=1/3 $K_3[NH_3]$**

$K_1/2 = K_2 = K_3/3$ ∴ $1.5K_1 = 3K_2 = K_3$

47 The rate constant of a reaction A→B is 1.8 x 10^{-2} s^{-1}. The concentration of reactant is 0.3 mol L^{-1}. The rate of reaction is (in mol L^{-1} s^{-1})

1) 1 x 10^{-2} 2) 1.8 x 10^{-2} 3) 5.4 x 10^{-3} 4) 6 x 10^{-2}

Hint; rate=K [A]

48. The rate law of a reaction is rate = K $[A]^2$ $[B]^3$. On tripling the concentration of A & doubling the concentration of B, the rate of reaction increases by

1) 8 times 2) 24 times 3) 48 times 4) 72 times

Hint: $rate_1$ = K $[A]^2$ $[B]^3$

$Rate_2$ =k $[3A]^2[2B]^3$=72 K$[A]^2$ $[B]^3$

$Rate_2$ = 72 $rate_1$

49. For the reaction xA + yB → zC, If $-\frac{d[A]}{dt} = -\frac{d[B]}{dt} = 1.5\frac{d[C]}{dt}$ then x, y & z are respectively.

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

Hint; rate= $-\frac{d[A]}{dt} = -\frac{d[B]}{dt} = 1.5\frac{d[C]}{dt}$ i.e. $-1/3\frac{d[A]}{dt} = -1/3\frac{d[B]}{dt} = 1/2\frac{d[C]}{dt}$

∴ X=3, y=3 and Z=2

50. What is the activation energy for the decomposition of as , $N_2O_5 \rightarrow 2NO_2 + \frac{1}{2}O_2$

if the values of the rate constants are 3.45×10^{-5} and 6.9×10^{-3} at $27\,^0C$ and 67 ^0C respectively?

1) 112.5 kJ 2) 200 kJ 3) 149.5 kJ 4) 11.25 kJ

Solution: $\log\frac{k_2}{k_1} = \frac{E_0}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$, $\log\frac{6.9\times10^{-3}}{3.45\times10^{-5}} = \frac{E_0}{2.303\times8.31}\left[\frac{340-300}{300\times340}\right]$ ∴ $E_a = 112.5\,kJ$

Assertion - Reason type

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true and (R) is not the correct explanation of A

3) (A) is true but (R) is false

4) Both (A) and (R) are false

51. (A): A catalyst increases the rate of a reaction.

(R): In presence of a catalyst, the activation energy of the reaction increases.

52. (A): Rate of reaction increases with increase in concentration of reactants.

(R): Number of effective collisions increases with increase in concentration of reactants.

53. (A): All collisions lead to chemical reaction

(R): All collisions are effective collisions

54. (A): Hydrolysis of an ester is a slow reaction

(R): Reactions between covalent species involve breaking and making of bonds.

55. (A): As time passes the rate of non zero order reaction w.r.t reactants (or) products decreases

(R): Rate of a reaction is directly proportional to $(\text{Concentration})^{\text{order}}$

ANSWERS

1) 3 2) 3 3) 1 4) 3 5) 2 6)2 7)3 8)4 9)3 10)1

11) 3 12)2 13)3 14)3 15) 4 16) 2 17) 3 18) 3 19) 4 20) 2

21) 3 22) 1 23) 4 24) 2 25) 3 26) 2 27) 3 28) 2 29) 1 30) 2

31) 1 32) 2 33) 3 34) 3 35) 4 36) 1 37) 3 38) 4 39)3 40)2

41) 3 42) 1 43) 3 44) 2 45) 2 46) 2 47)3 48)4 49)3 50)1

51) 3 52) 1 53) 4 54) 1 55) 1