

Q. 1. Which one of the following is the correct statement?

- Chlorides of both beryllium and aluminium have bridged chloride structures in solid phase.
- $B_2H_6 \cdot 2NH_3$ is known as 'inorganic benzene'.
- Boric acid is a protonic acid.
- Beryllium exhibits coordination number of six.

Sol: $BeCl_2$ and $AlCl_3$ both have bridged structure in solid phase.

$B_3N_3H_6$ is known as inorganic benzene.

Boric acid is Lewis acid.

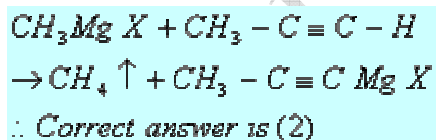
Beryllium exhibits coordination number of 4

Answer is (i)

Q. 2. The treatment of CH_3MgX with $CH_3C \equiv C - H$ produce

- $CH_3 - C \equiv C - CH_3$
- CH_4
- $CH_3 - CH = CH_2$
- $CH_3C \equiv C - CH_3$

Sol:



Q. 3. The correct decreasing order of priority for the functional groups of organic compounds in the IUPAC system of nomenclature is

- $-CHO, -COOH, -SO_3H, -CONH_2$
- $CONH_2 - CHO, -SO_3H - COOH,$
- $-COOH, -SO_3H, -CONH_2 - CHO,$
- $-SO_3H, -COOH, , -CONH_2 - CHO,$

Sol: The correct decreasing order of priority for the functional group of organic compounds in the IUPAC system of nomenclature is:

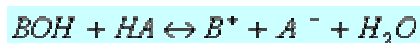
$-CO_2H, -SO_3H, -CONH_2, -CHO$.

∴ Correct answer is (3)

Q. 4. The pK_a of a weak acid, HA is 4.80. The pK_b of a weak base, BOH, is 4.78. The pH of an aqueous solution of the corresponding salt, BA, will be

- 7.01
- 9.22
- 9.58
- 4.79

Sol:



$$p^H = \frac{1}{2} pK_w + \frac{1}{2} pK_a - \frac{1}{2} pK_b$$

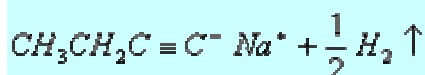
$$= \frac{1}{2} (14 + 4.80 - 4.78) = 7.01$$

∴ Correct answer is (1)

Q. 5. The hydrocarbon which can react with sodium in liquid ammonia is

- $CH_3CH=CHCH_3$
- $CH_3CH_2C \equiv CCH_2CH_3$
- $CH_3CH_2C \equiv CCH_2CH_2CH_3$
- $CH_3CH_2C \equiv CH$

Sol:



∴ Correct answer is (4)

Q. 6.

Given $E_{Cr^{3+}/Cr}^0 = -0.72V$, $E_{Fe^{2+}/Fe}^0 = -0.42V$. The potential for the cell

$Cr | Cr^{3+} (0.1M) || Fe^{2+} (0.01 M) | Fe$ is

- 0.339 V
- 0.26 V
- 0.26 V
- 0.339 V

Sol:



The potential for the cell

$$= E_{Fe^{2+}/Fe}^0 - E_{Cr^{3+}/Cr}^0$$

$$- \frac{0.059}{6} \log \frac{[Cr^{3+}]^2}{[Fe^{2+}]^3}$$

$$= -0.42 - (-0.720) - \frac{0.059}{6} \log \frac{(0.1)^2}{(0.01)^3}$$

$$= 0.3 - 0.039 = 0.26V.$$

\therefore Correct answer is (3)

Q. 7. Amount of oxalic acid present in a solution can be determined by its titration with $KMnO_4$ solution in the presence of H_2SO_4 . The titration gives unsatisfactory result when carried out in the presence of HCl , because HCl

- reduces permanganate to Mn^{2+} .
- oxidises oxalic acid to carbon dioxide and water.
- gets oxidised by oxalic acid to chlorine.
- furnishes H^+ ions in addition to those from oxalic acid.

Sol: $KMnO_4$ can oxidise HCl along with oxalic acid into Cl_2 and itself gets reduced to Mn^{2+} .

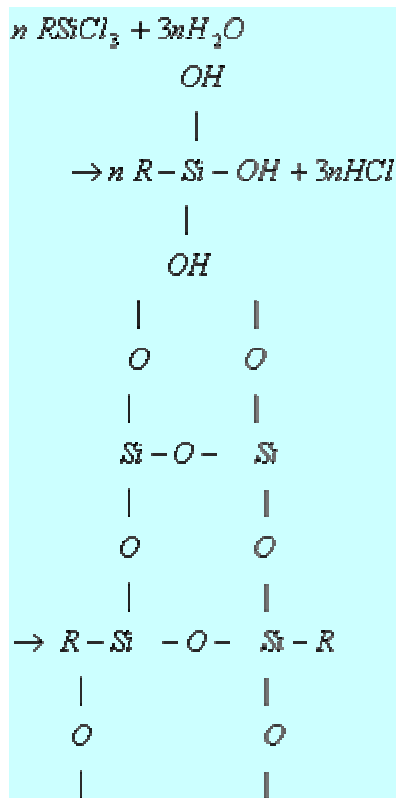
Answer is (i)

Q. 8. Among the following substituted silanes the one which will give rise to cross linked silicone polymer on hydrolysis is

- R_2SiCl_2
- R_3SiCl

- iii. R_4Si
- iv. $RSiCl_3$

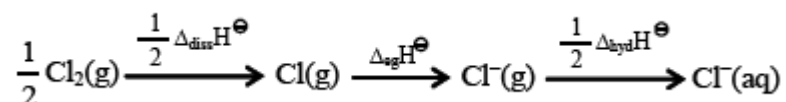
Sol:



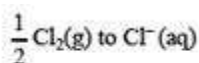
Cross linked silicon polymer.

Answer is (iv)

Q. 9. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below:



The energy involved in the conversion of



(using the data, $\Delta_{\text{diss}} H_{\text{Cl}_2}^\ominus = 240 \text{ kJ mol}^{-1}$, $\Delta_{\text{eg}} H_{\text{Cl}}^\ominus = -349 \text{ kJ mol}^{-1}$, $\Delta_{\text{hyd}} H_{\text{Cl}^-} = -381 \text{ kJ mol}^{-1}$) will be

- -850 kJ mol^{-1}
- $+120 \text{ kJ mol}^{-1}$
- $+152 \text{ kJ mol}^{-1}$
- -610 kJ mol^{-1}

Sol:

Energy involved =

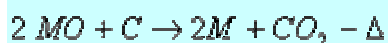
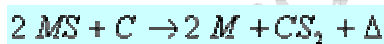
$$\begin{aligned} &= \frac{1}{2} (240) + (-349) + (-381) \\ &= 120 - 730 \\ &= -610 \text{ KJ mol}^{-1} \end{aligned}$$

∴ Correct answer is (4)

Q. 10. Which of the following factors is of no significance for roasting sulphide ores to the oxides and not subjecting the sulphide ores to carbon reduction directly?

- Metal sulphides are less stable than the corresponding oxides.
- CO_2 is more volatile than CS_2 .
- Metal sulphides are thermodynamically more stable than CS_2 .
- CO_2 is thermodynamically more stable than CS_2 .

Sol:



Hence, CO_2 is more stable than CS_2 while Ms are more stable than MO.

Answer is (i)

Q. 11. Four species are listed below:

- HCO_3^-
- H_3O^+
- HCO_4^-

iv. HSO_3F

Which one of the following is the correct sequence of their acid strength?

(1) (i) < (iii) < (ii) < (iv) (2) (iii) < (i) < (iv) < (ii) (3) (iv) < (ii) < (iii) < (i) (4) (ii) < (iii) < (i) < (iv)

Sol: The increasing order of acidic strength is



i.e. (i) < (iii) < (ii) < (iv)

∴ Correct answer is (1)

Q. 12. Which one of the following constitutes a group of the isoelectronic species?

- CN^- , N_2 , O_2^{2-} , C_2^{2-}
- N_2 , O_2^- , NO^+ , CO
- C_2^{2-} , O_2^{2-} , CO , NO
- NO^+ , C_2^{2-} , CN^- , N_2

Sol: Isoelectronic species have same number of electrons

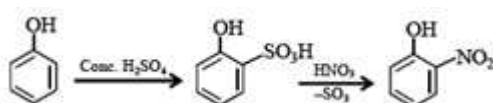
NO^+ , C_2^{2-} , CN^- and N_2 each have 14 electrons.

∴ Correct answer is (4)

Q. 13. Phenol, when it first reacts with concentrated sulphuric acid and then with concentrated nitric acid, gives

- p-nitrophenol
- nitrobenzene
- 2,4,6-trinitrobenzene
- o-nitrophenol

Sol:



As, temperature is not mentioned, o- nitrophenol is the only stable product.

Answer is (iv)

Q. 14. The ionization enthalpy of hydrogen atom is $1.312 \times 10^6 \text{ J mol}^{-1}$. The energy required to excite the electron in the atom from $n = 1$ to $n = 2$ is

- i. $7.56 \times 10^5 \text{ J mol}^{-1}$
- ii. $9.84 \times 10^5 \text{ J mol}^{-1}$
- iii. $8.51 \times 10^5 \text{ J mol}^{-1}$
- iv. $6.56 \times 10^5 \text{ J mol}^{-1}$

Sol:

$$E_2 = \frac{-1.312 \times 10^6 \times (1)^2}{(2)^2} = -3.28 \times 10^5 \text{ J mol}^{-1}$$
$$E_1 = -1.312 \times 10^6 \text{ J mol}^{-1}$$
$$\therefore \Delta E = E_2 - E_1$$
$$= -3.28 \times 10^5 - (-1.312 \times 10^6)$$
$$= 9.84 \times 10^5 \text{ J mol}^{-1}$$

\therefore Correct answer is (2)

Q. 15. The organic chloro compound, which shows complete stereochemical inversion during a S_N2 reaction, is

- i. $(\text{CH}_3)_2\text{CHCl}$
- ii. CH_3Cl
- iii. $(\text{C}_2\text{H}_5)_2\text{CHCl}$
- iv. $(\text{CH}_3)_3\text{CCl}$

Sol: Primary halides show inversion during S_N2 reaction more than secondary while secondary show more than tertiary.

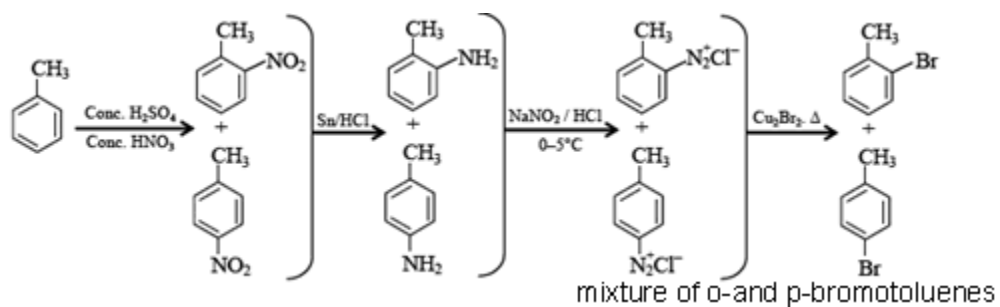
Answer is (ii)

Q. 16. Toluene is nitrated and the resulting product is reduced with tin and hydrochloric acid. The product so obtained is diazotized and then heated with cuprous bromide. The reaction mixture so formed contains

- i. mixture of o-; and p-bromoanilines
- ii. mixture of o- and m-bromotoluenes

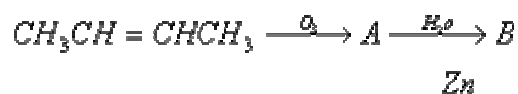
- iii. mixture of o- and p-bromotoluenes
- iv. mixture of o- and p-dibromobenzenes

Sol:



Answer is (iii)

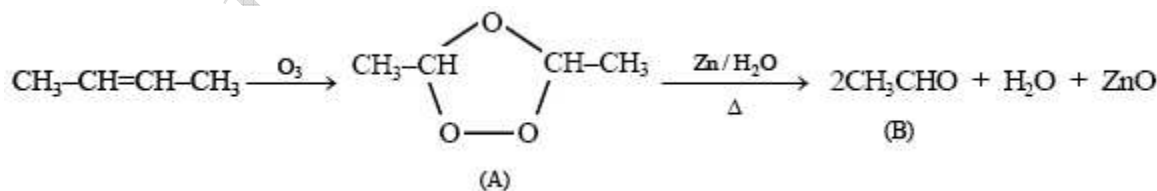
Q. 17. In the following sequence of reactions, the alkene affords the compound 'B'



The compound B is

- i. $\text{CH}_3\text{CH}_2\text{COCH}_3$
- ii. CH_3CHO
- iii. $\text{CH}_3\text{CH}_2\text{CHO}$
- iv. CH_3COCH_3

Sol:



∴ Answer is (ii)

Q. 18. Which one of the following pairs of species have the same bond order?

- i. O_2^- and CN^-
- ii. NO^+ and CN^+
- iii. CN^- and NO^+
- iv. CN^- and CN^+

Sol: The species which have the same number of total electrons will have the same bond order.

CN^- and NO^+ each have 14 electrons and they will have same bond order.

Answer is (iii)

Q. 19. At 80°C , the vapour pressure of pure liquid 'A' is 520 mm Hg and that of pure liquid 'B' is 1000 mm Hg. If a mixture solution of 'A' and 'B' boils at 80°C and 1 atm pressure, the amount of 'A' in the mixture is (1 atm = 760 mm Hg)

- i. 48 mol percent
- ii. 50 mol percent
- iii. 52 mol percent
- iv. 34 mol percent

Sol:

Let amount of A in the mixture be x_A & B be x_B .

$$P_T = 760 = P_A^0 \times x_A + P_B^0 \times x_B$$

$$\text{or, } 760 = 520 x_A + 1000 (1 - x_A)$$

$$\text{or, } 480 x_A = 240$$

$$\text{or, } x_A = \frac{1}{2} \text{ or } 50 \text{ mol percent}$$

\therefore Correct answer is (2)

Q. 20. 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

- i. $-\frac{d[A]}{dt} = \frac{d[B]}{dt}$
- ii. $-\frac{d[A]}{dt} = 4 \frac{d[B]}{dt}$

$$\text{iii. } -\frac{d[A]}{dt} = \frac{1}{2} \frac{d[B]}{dt}$$

$$\text{iv. } -\frac{d[A]}{dt} = \frac{1}{4} \frac{d[B]}{dt}$$

Sol:

Rate of reaction with respect to A = $-\frac{2d[A]}{dt}$

Rate of reaction with respect to B = $\frac{1}{2} \frac{d[B]}{dt}$

$$-\frac{2d[A]}{dt} = \frac{1}{2} \frac{d[B]}{dt}$$

$$\Rightarrow -\frac{d[A]}{dt} = \frac{1}{4} \frac{d[B]}{dt}$$

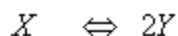
∴ Correct answer is (4)

Q. 21. The equilibrium constants K_{p1} and K_{p2} for the reactions
 $X \leftrightarrow 2Y$ and $Z \leftrightarrow P + Q$ respectively are in the ratio of 1 : 9. If the degree of dissociation of X and Z be equal then the ratio of total pressures at these equilibria is

- i. 1 : 3
- ii. 1 : 9
- iii. 1 : 36
- iv. 1 : 1

Sol:

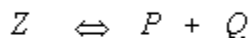
Let initial moles of X be a and that of Z be b .



$$a(1-\alpha) \quad 2a\alpha$$

Moles at equilibrium.

$$\therefore K_{P1} = \frac{(2a\alpha)^2 P_{T1}}{a(1-\alpha)a(1+\alpha)} \quad (i)$$



$$b(1-\alpha) \quad b\alpha \quad B\alpha$$

Moles at equilibrium

$$\therefore K_{P2} = \frac{(b\alpha)^2 P_{T2}}{B(1-\alpha)b(1+\alpha)} \quad (ii)$$

$$\therefore \frac{K_{P1}}{K_{P2}} = \frac{4 P_{T1}}{P_{T2}} = \frac{1}{9}$$

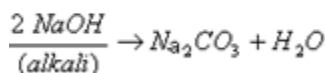
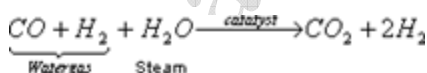
$$\therefore \frac{P_{T1}}{P_{T2}} = \frac{1}{36}$$

\therefore Correct answer is (3)

Q. 22. In context with the industrial preparation of hydrogen from water gas ($\text{CO} + \text{H}_2$), which of the following is the correct statement?

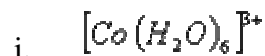
- H_2 is removed through occlusion with Pd.
- CO is oxidised to CO_2 with steam in the presence of a catalyst followed by absorption of CO_2 in alkali.
- CO and H_2 are fractionally separated using differences in their densities.
- CO is removed by absorption in aqueous Cu_2Cl_2 solution.

Sol:



\therefore Correct answer is (2)

Q. 23. In which of the following octahedral complexes of Co (atomic number 27), will the magnitude of Δ_o be the highest?



- ii. $[Co(NH_3)_6]^{3+}$
- iii. $[Co(CN)_6]^{3-}$
- iv. $[Co(C_2O_4)_3]^{3-}$

Sol: Magnitude of Δ_0 will be highest with the strongest ligand. In the given context CN^- is the strongest ligand and would lead to a greater separation between t_{2g} and e_g orbitals.

Answer is (iii)

Q. 24. The coordination number and the oxidation state of the element 'E' in the complex $[E(en)_2(C_2O_4)]NO_2$ (where (en) is ethylene diamine) are, respectively,

- i. 4 and 3
- ii. 6 and 3
- iii. 6 and 2
- iv. 4 and 2

Sol: Ethyldiamine and oxalate ion are both bidentate ligands. Co-ordination number of E in the complex.

$$= (2 \times 2) + (1 \times 2) = 6$$

$$\text{Oxidation state of E is } x + (-2) = +1$$

$$\Rightarrow x = +3$$

\therefore Correct answer is (2)

Q. 25. Identify the wrong statement in the following:

- i. Ozone layer does not permit infrared radiation from the sun to reach the earth.
- ii. Acid rain is mostly because of oxides of nitrogen and sulphur.
- iii. Chlorofluorocarbons are responsible for ozone layer depletion.
- iv. Greenhouse effect is responsible for global warming.

Sol: Ozone layer does not permit the ultraviolet radiation from the sun to the earth.

Answer is (i)

Q. 26. Larger number of oxidation states are exhibited by the actinoids than those by lanthanoids, the main reason being

- i. more energy difference between 5f and 6d than between 4f and 5d orbitals.

- ii. more reactive nature of the actinoids than the lanthanoids.
- iii. 4f orbitals more diffused than the 5f orbitals.
- iv. lesser energy difference between 5f and 6d than between 4f and 5d orbitals.

Sol: The energy difference between 5f and 6d is very less than that between 4f and 5d orbitals. Therefore, in actinoids, the electron can be removed from 5f and 6d both. So, they exhibit more number of oxidation state.

Answer is (iv)

Q. 27. In a compound, atoms of element Y form ccp lattice and those of element X occupy $\frac{2}{3}$ of tetrahedral voids. The formula of the compound will be

- i. X_2Y
- ii. X_3Y_4
- iii. X_4Y_3
- iv. X_2Y_3

Sol:

Number effective Y in a unit cell = 4.

$$\text{Number of effective X in a unit cell} = 8 \times \frac{2}{3} = \frac{16}{3}$$

\therefore Formula of the compound

$$= X_{\frac{16}{3}} Y_4$$

$$= X_{\frac{4}{3}} Y_{\frac{1}{4}}$$

$$= X_4 Y_3$$

\therefore Correct answer is (3)

Q. 28. Gold numbers of protective colloids (A), (B), (C) and (D) are 0.50, 0.01, 0.10 and 0.005, respectively. The correct order of their protective powers is

- i. (A) < (C) < (B) < (D)
- ii. (B) < (D) < (A) < (C)
- iii. (D) < (A) < (C) < (B)
- iv. (C) < (B) < (D) < (A)

Sol: If the gold number of a protective colloid is less then its protective power is good.

$$0.005 < 0.01 < 0.10 < 0.50$$

or, (A) < (C) < (B) < (D)

Answer is (i)

Q. 29. The vapour pressure of water at 20°C is 17.5 mm Hg. If 18 g of glucose (C₆H₁₂O₆) is added to 178.2 g of water at 20°C, the vapour pressure of the resulting solution will be

- 16.500 mm Hg
- 17.325 mm Hg
- 17.675 mm Hg
- 15.750 mm Hg

Sol:

$$\text{Moles of glucose} = \frac{18}{180} = 0.1$$

$$\text{Moles of water} = \frac{178.2}{18} = 9.9$$

$$\frac{\text{Moles of glucose}}{\text{Moles of water}} = \frac{P_o - P_s}{P_s}$$

$$\text{or, } \frac{0.1}{9.9} = \frac{17.5 - P_s}{P_s}$$

$$\text{or, } P_s = 99(17.5 - P_s)$$

$$\text{or, } 100P_s = 99 \times 17.5$$

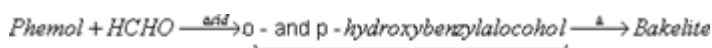
$$\text{or, } P_s = 17.325 \text{ mm Hg.}$$

∴ Correct answer is (2)

Q. 30. Bakelite is obtained from phenol by reacting with

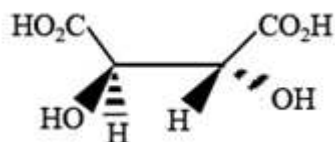
- CH₃COCH₃
- HCHO
- (CH₂OH)₂
- CH₃CHO

Sol:



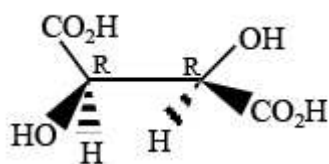
∴ Correct answer is (2)

Q. 31. The absolute configuration of is



- i. R, S
- ii. S, R
- iii. S, S
- iv. R, R

Sol: The absolute configuration is



Answer is (iv)

Q. 32. For the following three reactions a, b, c, equilibrium constants are given:

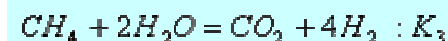
- a. $CO(g) + H_2O(g) \leftrightarrow CO_2(g) + H_2(g); K_1$
- b. $CH_4(g) + H_2O(g) \leftrightarrow CO(g) + 3H_2(g); K_2$
- c. $CH_4(g) + 2H_2O(g) \leftrightarrow CO_2(g) + 4H_2(g); K_3$

Which of the following relations is correct?

- i. $K_3 = K_1 K_2$
- ii. $K_3 \cdot K_2^3 = K_1^3$
- iii. $K_1 \sqrt{K_2} = K_3$
- iv. $K_2 K_3 = K_1$

Sol:

Adding a and b we get c



$$\therefore K_3 = K_1 K_2$$

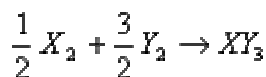
\therefore Correct answer is (1)

Q. 33. Standard entropy of X_2 , Y_2 and XY_3 are 60, 40 and $50 \text{ JK}^{-1}\text{mol}^{-1}$, respectively.

For the reaction, $\frac{1}{2} X_2 + \frac{3}{2} Y_2 \rightarrow XY_3$, $\Delta H = -30 \text{ KJ}$, to be at equilibrium, the temperature will be

- i. 750 K
- ii. 1000 K
- iii. 1250 K
- iv. 500 K

Sol:



$$\therefore \Delta S = 50 - \left[\left(60 \times \frac{1}{2} \right) - \left(4 \times \frac{3}{2} \right) \right]$$

$$= -40 \text{ JK}^{-1}$$

$$\Delta H = -30 \text{ KJ}$$

$$\therefore \Delta G = \Delta H - T \Delta S$$

At equilibrium, $\Delta G = 0$

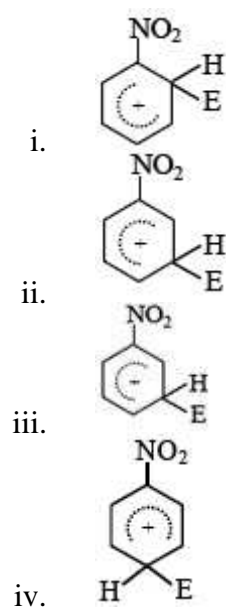
$$\therefore \Delta H - T \Delta S = 0$$

$$\Rightarrow T = \frac{\Delta H}{\Delta S} = \frac{-30000 \text{ J}}{-40 \text{ JK}^{-1}}$$

$$= 750 \text{ K}$$

Correct answer is (1)

Q. 34. The electrophile, E^+ attacks the benzene ring to generate the intermediate σ^- complex. Of the following, which σ^- complex is of lowest energy?



Sol: σ^- complex formed by the attack of electrophile on benzene is the more stable than that formed by the attack of electrophile on nitrobenzene at any one of the three given positions.

Answer is (iv)

Q. 35. α -D-(+)-glucose and β -D-(+)-Glucose are

- anomers
- enantiomers
- conformers
- epimers

Sol: Answer is (i)