Chemistry

Single correct answer type:

1. With what velocity should an α-particle travel towards the nucleus of a copper atom to arrive at a distance of $10^{-13}m$ from the nucleus of the copper atom?

$(K = 9 \times 10^9\, Nm^2/C^2$ Mass of $\alpha -$ particle $= 6.64 \times 10^{-27} kg)$

(A) $6.34 \times 10^6\, ms^{-1}$ (B) $6.34 \times 10^5\, ms^{-1}$

(C) $5.34 \times 10^6\, ms^{-1}$ (D) $5.34 \times 10^5\, ms^{-1}$

Solution: (A)

The potential energy of the α-particle at a distance of $10^{-13}m$ from the nucleus of the copper atom is

$$e = \frac{Kq_1\, q_2}{r}$$

$K = 9 \times 10^9\ N.m^2/C^2$

$q_1 = 29 \times 16 \times 10^{-19}$ Coulomb (For copper atom)

$q_2 = 2 \times 16 \times 10^{-19}$ Coulomb (For α-particles)

$r = 10^{-13}\, m$

$$E = \frac{9 \times 10^9 \times 29 \times 16 \times 10^{-19} \times 2 \times 16 \times 10^{-19}}{10^{-13}}$$

$= 1.336 \times 10^{-13}\, N.M$

The α-particle must have such kinetic energy.

$\therefore \quad K.E = E$

or $\frac{1}{2}mv^2 = 1.336 \times 10^{-13}$

or $v^2 = \frac{2 \times 1.336 \times 10^{-13}}{6.64 \times 10^{-27}}$

or $v = 6.34 \times 10^6 ms^{-1}$

2. What is the ratio of the velocities of CH_4 and O_2 molecules so that they are associated with de-Broglie waves of equal wavelengths?

(A) $1:2$ (B) $2:1$ (C) $3:2$ (D) $1:3$

Solution: (B)

According to de-Broglie equation, $\lambda = \frac{h}{mv}$

For methane (CH_4)

$$\lambda_{CH_4} = \frac{h}{m_{Ch_4} \times v_{CH_4}}$$

For oxygen (O_2),

$$\lambda_{O_2} = \frac{h}{m_{C_2} \times v_{O_2}}$$

Since, the wavelength of CH_4 and O_2 is equal hence,

$$\frac{h}{m_{CH_4} \times v_{CH_4}} = \frac{h}{m_{O_2} \times v_{O_2}}$$

$$\Rightarrow \quad \frac{v_{CH_4}}{v_{O_2}} = \frac{m_{O_2}}{m_{CH_4}} = \frac{32}{16} = \frac{2}{1} = 2:1$$

3. What is the value of the spin quantum number of the last electron for d^9-configuration?

(A) 0 (B) $-\frac{1}{2}$ (C) $\frac{1}{2}$ (D) 1

Solution: (B)

The value of the spin quantum number (s) can be $+\frac{1}{2}$ or $-\frac{1}{2}$, because an electron can rotate along its axis either in clockwise or in anticlockwise direction. But one quantum number depicts are electron and thus its values will be $-\frac{1}{2}$ for d^9-configuration.

4. Nitrogen forms stable N_2 molecule, but phosphorus is converted to P_4 from P_2 because

(A) $p\pi - p\pi$ boding is strong in phosphorus

(B) $p\pi - p\pi$ bonding is weak in phosphorus

(C) Double bond is present in phosphorus

(D) Single P – P bond is weaker than N – N bond

Solution: (B)

$p\pi - p\pi$ bonding is weak in phosphorus $p\pi - p\pi$ bonding in nitrogen is strong. Hence, it can form triple bond with another N. Single N – N is weaker than P – P bond due to high interionic repulsion of non-bonding electrons. Hence, $N \equiv N$ is table and P_2 is not stable molecule.

5. An amorphous solid (X) burns in air to form a gas (Y) which turns lime water milky. This gas decolarises aqueous solution of acidified $KMnO_4$. gas (Y) reacts with oxygen to give another gas (Z) which is responsible for acid rain. X, Y and Z are

(A) $\begin{matrix} X & Y & Z \\ C & CO & CO_2 \end{matrix}$ (B) $\begin{matrix} X & Y & Z \\ S & SO_2 & SO_3 \end{matrix}$

(C) $\begin{matrix} X & Y & Z \\ P & P_2O_3 & P_2O_5 \end{matrix}$ (D) $\begin{matrix} X & Y & Z \\ S & SO_3 & H_2SO_4 \end{matrix}$

Solution: (B)

6. A black power when heated with conc. HCl gives a greenish yellow gas. The gas acts as an oxidizing and a bleaching agent. When it is passed are slaked lime, a white power is formed which is a ready source of gas. The black powder and white power respectively are

(A) $KClO_3$ and $NaClO_3$ (B) MnO_2 and $CaCOCl_2$

(C) $MnO_2$and $KClO_3$ (D) $MnCl_4$ and $COCl_2$

Solution: (B)

$Cl_2 + H_2O \rightarrow 2HCl + [O]$

Coloured matter $+ [O] \rightarrow$ Colourless matter

7. The compound that is both paramagnetic and coloured is

(A) $K_2Cr_2O_7$ (B) $(NH_4)_2\,[TiCl_6]$

(C) V_0SO_4 (D) $K_3[Cu(CN)_4]$

Solution: (C)

$K_2Cr_2O_7$ contains $Cr^{6+}(3d)$ ion which is diamagnetic and coloured due to charge transfer. $(NH_4)_2, [TiCl_6]$ contains $Ti^{4+}\ (3d)$ which is diamagnetic and colourless. V_0SO_4 contains $V^{4+}(3d^1)$ which is paramagnetic and coloured.

$K_3[Cu(CN)_4]$ contains $Ca^{2+}(3d^{10})$ which is diamagnetic and colourless.

8. A solution of $KMnO_4$ is reduced to a various products depending upon its pH. At pH > 7, it is reduced to a colourless solution (A), at pH = 7 it forms a brown precipitate (B) and at pH > 7, it gives a green solution (C). $(A), (B)$ and (C) are

(A) $\underset{Mn^{2+}}{A}\quad \underset{MnO_2}{B}\quad \underset{MnO_4^{2-}}{C}$ (B) $\underset{MnO_2}{A}\quad \underset{Mn^{2+}}{B}\quad \underset{MnO_4^{2-}}{C}$

(C) $\underset{Mn^{2+}}{A}\quad \underset{MnO_4^{2-}}{B}\quad \underset{MnO_2}{C}$ (D) $\underset{MnO_4^{2-}}{A}\quad \underset{Mn^{2+}}{B}\quad \underset{MnO_2}{C}$

Solution: (A)

At $pH < 7$, in acidic medium

At $pH = 7$, in neutral medium

At $pH > 7$, in alkaline medium

9. Although zirconium belongs to 4d and hafnium belongs to 5d transition series even they show similar physical and chemical properties because both

(A) Belong to d-block

(B) Have same number of electrons

(C) Belongs to the same group of the periodic table

(D) Have similar atomic radius

Solution: (D)

This is because the atomic radii of 4d and 5d transition elements are nearly same. This similarity in size $(zr = 160, Hf = 159\ pm)$. Due to tanthanoid contraction, because of this contraction the radii of Hf becomes nearly to that of Zr and as the properties of an element depends on its atomic radii they show similar properties.

10. Which of the following good reducing agent?

(A) Yb^{2+} (B) Ce^{4+} (C) Tb^{4+} (D) La^{3+}

Solution: (A)

Yb^2

$Yb^2 \rightarrow [Xe]\ 4f^{14}\ 5d^0 6s^0$

$Ce^{4+} \rightarrow [Xe]\ 4f^0\ 5d^0\ 6s^0$

$Tb^{4+} \rightarrow [Xe]\ 4f^7\ 5d^0\ 6s^0$

$La^{3+} \rightarrow 5d^1\ 6s^2$

Only Yb^{2+} can lose e^- and act as reducing agent

$Yb^{3+} \rightarrow [Xe]\ 4f^{13}\ 5d^0\ 6s^0$

11. Which of the following will not give tests for free transition metal ion in solution?

(A) $K_2[Ni(CN)_4]$ (B) $FeSO_4\ .K_2SO_4.24H_2O$

(C) Both of the above (D) None of the above

Solution: (A)

9n solution, $K_2[Ni(CN)_4]$ dissociates as

$K_2[Ni(CN)_4] \rightarrow K^+ + [Ni(CN)_4]^{2-}$

12. Which of the following is an organometallic compound?

(A) Lithium methoxide (B) Lithium acetate

(C) Lithium dimethylamide (D) Methyl lithium

Solution: (D)

Those compounds in which metal atom is directly bonded to carbon atom are called organometallic compounds.

13. Among the following metal carbonyls, the $C-O$ bond order is lowest in

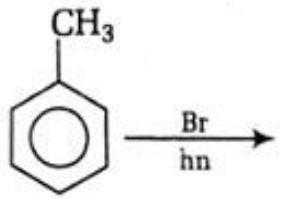
(A) $[Mn(CO)_6]^+$ (B) $[Fe(CO)_5]$

(C) $[Cr(CO)_6]$ (D) $[V(CO)_6]^-$

Solution: (D)

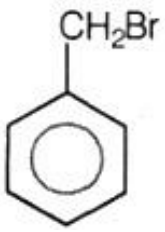
$[V(CO)_6]^-$, the anionic carbonyl complex can delocalize more electron density to anti bonding π = orbital ($d\pi - p\pi$ back bonding) of CO and thus lower the bond order.

14. The major product obtained in the reaction

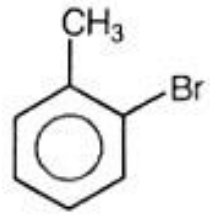


is

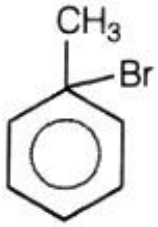
(A)



(B)

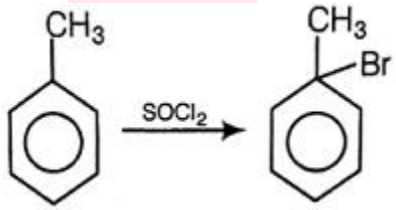


(C)



(D)

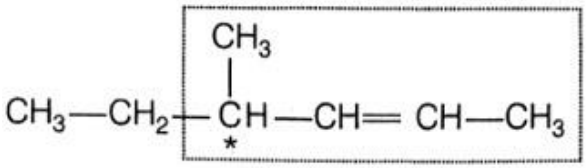
Solution: (C)



Ease of substitution of hydrogen is $3^o > 2^o > 1^o$.

15. Which of the following compounds can exhibit both geometrical isomerism and enantiomerism?

Solution: (B)



16. The unit cell length of sodium chloride crystal is 564 pm. Its density would be

(A) $1.082\ g\ cm^{-3}$ (B) $2.165\ g\ cm^{-3}$

(C) $3.247\ g\ cm^{-3}$ (D) $4.330\ g\ cm^{-3}$

Solution: (B)

In sodium chloride unit cell, there are four Na^+ and four Cl^- ions.

Hence,

$$\text{density} = \frac{\text{mass of atoms in a unit cell}}{\text{volume of a unit cell}} = \frac{M_2}{a^3 N_a}$$

Each unit cell of $NaCl$ has

$4Na^-$ and $4\ Cl^-\ 2\ ions \rightarrow Z = 4$

$$= \frac{4(23 + 35.5) g\ mol^{-1}}{(6.023 \times 10^{23} mol^{-1}) \times (564 \times 10^{-12}\ cm)^3}$$

$$= 2.165\ g\ cm^{-3}$$

17. Zinc oxide loses oxygen on heating according to the reaction

$$ZnO \xrightarrow{\text{Heat}} Zn^{2+} + \frac{1}{2} O_2 + 2\bar{e}$$

It becomes yellow on heating because

(A) Zn^{2+} ions and electrons move too interstitial site and F – centres are created

(B) Oxygen and electrons move at the crystal and ions become yellow

(C) Zn^{2+} again combine with oxygen to give yellow oxide

(D) Zn^{2+} are replaced by oxygen

Solution: (A)

Zn^{2+} ions and electrons move to interstitial sites and F-centres are created which impart yellow colour to ZnO.

18. In which of the following reactions will ΔU be equal to ΔH?

(A) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$

(B) $H_2(g) + l_2(g) \rightarrow 2Hl(g)$

(C) $N_2O_4(g) \rightarrow 2NO_2(g)$

(D) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

Solution: (B)

$H_2(g) + l_2(g) \rightarrow 2Hl(g)$

$\Delta n = 2 - (1 + 1) = 0$

$\Delta H = \Delta U + \Delta nRT$

$\Delta H = \Delta U + (0)\, RT$

$\therefore \quad \Delta H = \Delta U$

19. Which of the following reactions depict the oxidizing behavior of H_2SO_4?

(A) $2PCl_5 + H_2SO_4 \rightarrow 2POCl_3 + 2HCl + SO_2Cl_2$

(B) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(C) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

(D) $2Hl + H_2SO_4 \rightarrow l_2 + SO_2 + 2H_2O$

Solution: (D)

l_2 is liberated by loss of electron and gain by SO_4^{2-} in H_2SO_4.

$SO_4^{2-} \rightarrow SO_2$

20. When 96.5C of electricity is passed through a solution of silver nitrate (at wt. of Ag = 107.87 ≃ 108), the amount of silver deposted is

(A) $5.8\,mg$ (B) $10.8\,mg$ (C) $15.8\,mg$ (D) $20.8\,mg$

Solution: (B)

$$W_{Ag} = \frac{E_{Ag} + Q}{96500}$$

$$= \frac{108 \times 9.65}{96500}$$

$$1.08 \times 10^{-2} g = 10.8\,mg$$

21. The standard reduction potentials at 298 K for the following half reactions are given against each

$$Zn^{2+}(aq) + 2\bar{e} \rightleftharpoons Z(s) - 0.762\,V$$

$$Cr^{3+}(aq) + 2\bar{e} \rightleftharpoons Cr(s) - 0.740\,V$$

$$2H^{+}(aq) + 2\bar{e} \rightleftharpoons H_2(s) 0.000\,V$$

$$Fe^{3+}(aq) + 2\bar{e} \rightleftharpoons Fe^{2+}(aq) 0.770\,V$$

Which is the strongest reducing agent?

(A) $Zn(s)$ (B) $Cr(s)$ (C) $Hg(g)$ (D) $Fe^{2+}(aq)$

Solution: (A)

More the negative the value of reduction potential, stronger is the reducing property, i.e., power to accept electrons.

22. For the reaction, $2NO_2 + F_2 \rightarrow 2NO_2F$, following mechanism has been provided.

$$NO_2 + F_2 \xrightarrow{\text{Slow}} NO_2F + F$$

$$NO_2 + F \xrightarrow{\text{Fast}} NO_2F$$

Thus, rate expression of the above reaction can be written as

(A) $r = k[NO_2]^2\,[F_2]$ (B) $r = k\,[NO_2]\,[F_2]$

(C) $r = k\,[NO_2]$ (D) $r = k\,[F_2]$

Solution: (B)

Slowest step is the rate determining step.

$r = k[NO_2]\,[F_2]$

23. For a reaction, $I^- + OCl^- \rightarrow IO^- + Cl^-$ in an aqueous medium, the rate of reaction is given by:

$$\frac{d[IO^-]}{dt} = k\frac{[I^-]\,[OCl^-]}{[OH^-]}$$

The overall order of reaction is

(A) -1 (B) 0 (C) 1 (D) 2

Solution: (C)

$$\frac{dt[O^-]}{dt} = \frac{k[O^-]^1\,[OCl^-]^1}{[OH^-]^{-1}}$$

Order of reaction $= 1 + 1 - 1 = 1$

24. Give the IUPAC name of $m - ClCH_2C_6H_4CH_2C(CH_3)_3$

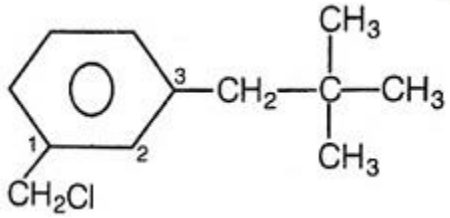
(A) 1 – (3 – chloro – 3 – methylphenyl) - 2, 2 – diethyl propane

(B) 2 – (3 – chloromethyl propyl) – 2, 2 – dimethyl propane

(C) 1 – (3 – chloromethyl phenyl) – 3, 3 – dimethyl propane

(D) 1 – chloromethyl – 3 – (2, 2 – dimethyl propyl) benzene

Solution: (D)



25. The reaction of toluene with chlorine in presence of ferric chloride gives predominatly

(A) Benzoyl chloride (B) m – chlorotoluene

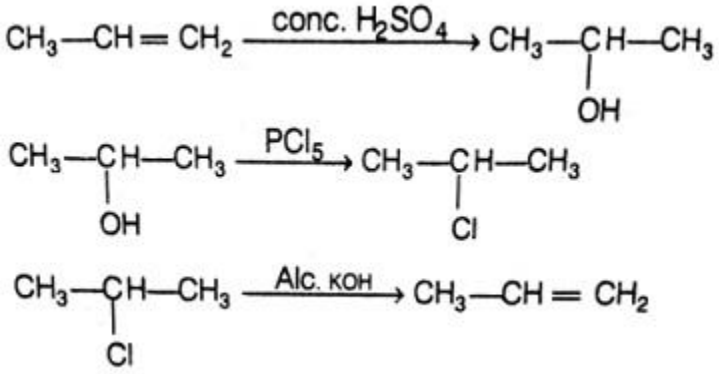
(C) Benzyl chloride (D) o – and p – chlorotoluene

Solution: (D)

Since, $-CH_3$ group is o and p-directing group, so o-and p-chlorotoluene are obtained.

26. Identify (D) in the following reaction series:

Solution: (C)



27. Phenol is functional compound because

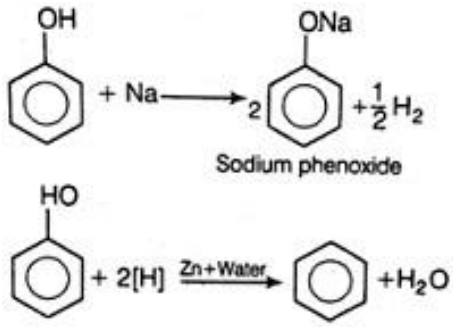
(A) It is acidic and contain – OH

(B) It reacts with Na to give phenoxide

(C) It reacts with both Na and Zn to give phenoxide and benzene respectively

(D) Both (It is acidic and contain – OH) and (It reacts with both Na and Zn to give phenoxide and benzene respectively)

Solution: (B)



28. Which of the following has lowest boiling point?

(A) p – nitrophenol (B) m – nitrophenol

(C) o – nitrophenol (D) Phenol

Solution: (C)

o-nitrophenol has intramolecular H-bonding.

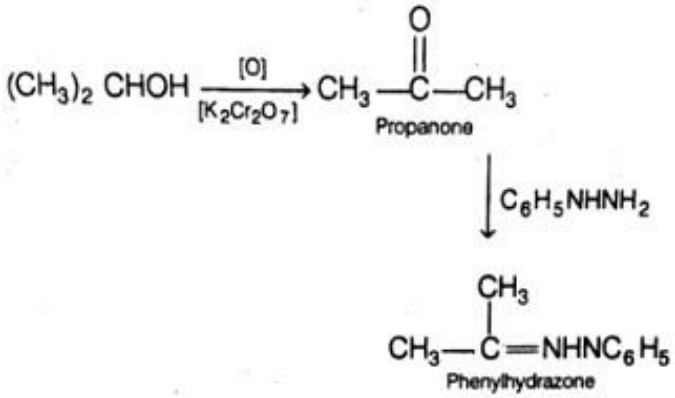
29. An organic compound X is oxidized by using acidified $K_2Cr_2O_7$. The product obtained reacts with phenyl hydrazine, but does not answer silver mirror test. The possible structure of X is

(A) CH_3COCH_3 (B) $(CH_3)_2CHOH$ (C) CH_3CHO (D) CH_3CH_2OH

Solution: (B)

The oxidation product of X reacts with phenyl hydrazine, thus it contains $> C = 0$ group. The same product does not (give) silver mirror test. Thus, it is a keton, because only aldehydes give silver mirror test.

Thus, the compound X must be 2^o alcohol, as only secondary alcohols give ketones on oxidation and hence, X is $(CH_3)_2CHOH$.



Propanone → Silver mirror not formed.

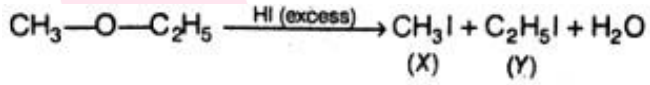
30. One mole of an organic compound A with the formula C_3H_6O reacts completely with two moles of HI to form X and Y. When Y is boiled with aqueous alkali, it form Z. Z answers the iodoform test. The compound A is

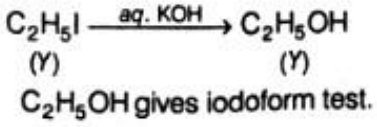
(A) propan – 2 – ol (B) propan – 1 – ol

(C) ethoxyethane (D) methoxyethane

Solution: (D)

If A reacts with Hl, it could be ether.





31. A compound (A) $C_4H_8\ Cl_2$ on alkaline hydrolysis to give compound (B) $C_4H_8\ O$ which gives an oxime and positive Tollen's reagent test. What is the structure of (A)?

(A) $CH_3CH_2CH_2CHCl_2$ (B) $CH_3CCl_2CH_2CH_3$

(C) $CH_3CH(Cl)CH(Cl)CH_3$ (D) $CH_2ClCH_2CH_2CH_2Cl$

Solution: (A)

Positive Tollen's test ⇒ B is an aldehyde. Compared A as hydrolysis gives aldehyde ⇒ A is a germinal dihalide with halogen atoms as terminal C-atom.

32. The increasing order of the rate of HCN addition to compound $A - D$ is

$A.\ HCHO$ $B.\ CH_3COCH_3$

$C.\ PhCOCH_3$ $D.\ PhCOPh$

(A) $A < B < C < D$ (B) $D < B < C < A$

(C) $D < C < B < A$ (D) $C < D < B < A$

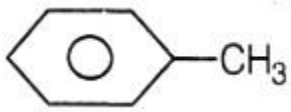
Solution: (C)

It is nucleophilic addition whose reactivity depends upon the elecgtrophilic character of carbonyl carbon and steric hindrance only. Hence, the ease of the reaction would be

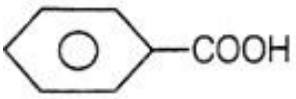
$$\underset{(A)}{HCHO} > \underset{(B)}{CH_3COCH_3} > \underset{(C)}{PhCOCH_3} > \underset{(D)}{PhCOPh}$$

33. Which of the following is highly acidic in nature?

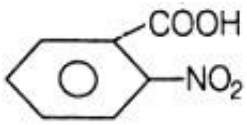
(A)



(B)



(C)



(D)

Solution: (D)

Methoxy benzoic acid is more acidic because of methoxy (CH_3O-) group.

34. What are the organic products formed in the following reaction?

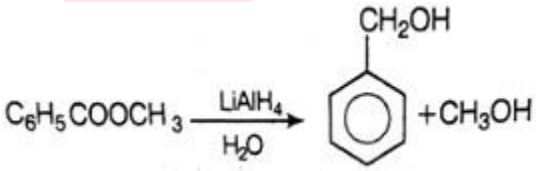
(A) C_6H_5-COOH and CH_4

(B) $C_6H_5-CH_2-OH$ and CH_4

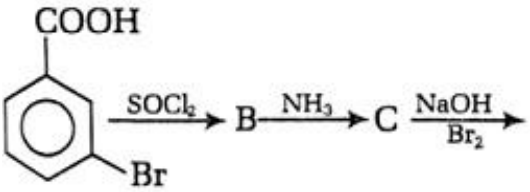
(C) $C_6H_5-CH_3$ and CH_3-OH

(D) $C_6H_5-CH_2-OH$ and CH_3-OH

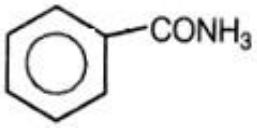
Solution: (D)



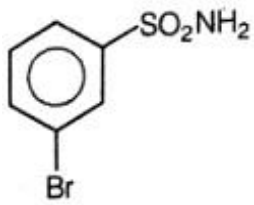
35. In a set of reactions m – bromobenzoic acid gave a product D. Identify the product D.



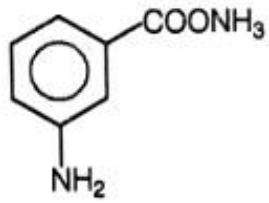
(A)



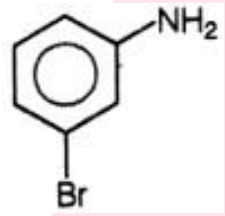
(B)



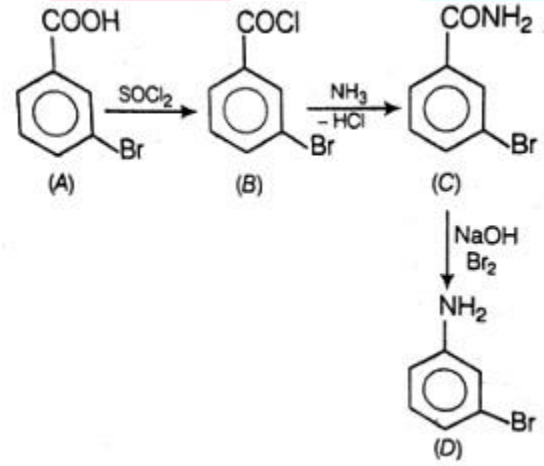
(C)



(D)



Solution: (D)



36. If $'A'$ is $C_2H_5NH_2$. $'B'$ is $(C_2H_5)NH$, $'C'$ is $(C_2H_5)_3N$, then order of solubility in water is

(A) $A > B > C$ (B) $B < A < C$ (C) $C < B < A$ (D) $C > B < A$

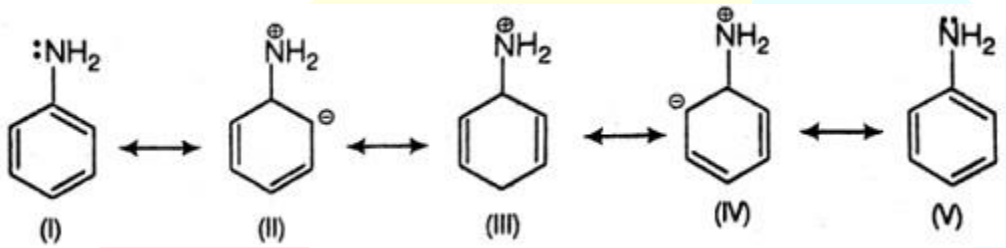
Solution: (C)

Primary amines has $-NH_2$ due to which H-bonding easily possible. Hence, the solubility order amines $3^o < 2^o < 1^o$.

37. Aniline is resonance hybrid of __ structures.

(A) 1 (B) 3 (C) 5 (D) 7

Solution: (C)



38. What is the conjugate base of $O\bar{H}$?

(A) O_2 (B) H_2O (C) O^- (D) O^{-2}

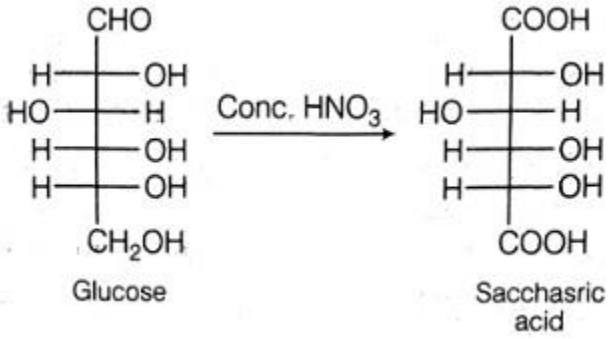
Solution: (D)

$OH^- \rightarrow O^{2-} + H^+$

39. Glucose when treated with conc. HNO_3 gives

(A) Acetic acid (B) Saccharic acid (C) Gluconic acid (D) Sorbitol

Solution: (B)



40. Which of the following is a peptide linkage?

(A) $-CO-NH$

(C) $-CO-NH_2$

(D) $-CO-O-NH_4$

Solution: (A)