Board Paper of Class 12-Science 2023 Chemistry Delhi(Set 1) - Solutions

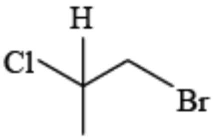
Total Time: 180

Total Marks: 70.0

Section A

Solution 1

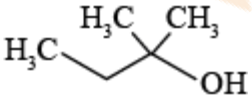
The asymmetry of the molecule along with non superimposability of mirror images is responsible for the optical activity in organic compounds. The objects which are non superimposable on their mirror image (like a pair of hands) are said to be chiral. If spatial arrangement of four groups (valencies) around a central carbon is tetrahedral and if all the substituents attached to that carbon are different, then it is chiral. The compound $CH_3C^*HClCH_2Br$ has four different groups- CH_3, H, Cl and CH_2Br and therefore, it is chiral.



Hence, the correct answer is option (b).

Solution 2

Oxidation of alcohols involves the formation of a carbon oxygen double bond with cleavage of an O-H and C-H bonds. Tertiary alcohols do not undergo oxidation reaction. Since 2-methylbutan-2-ol is a tertiary alcohol, it will not undergo oxidation reaction.



Hence, the correct answer is option (c).

Solution 3

The half cell with more positive standard reduction potential undergoes reduction while the half cell with less positive standard reduction potential undergoes oxidation. Therefore, Fe^{3+} gets reduced to Fe^{2+} while Sn gets oxidised to Sn^{2+}. The voltage of the cell can be calculated as follows:

$$E^0_{cell} = E^0_{red} - E^0_{oxi}$$

$$E^0_{cell} = E^0_{Fe^{3+}/Fe^{2+}} - E^0_{Sn^{2+}/Sn}$$

$$E^0_{cell} = 0.77 - (-0.14) = 0.91\ \mathrm{V}$$

Hence, the correct answer is option (b).

Solution 4

The reactions taking place during electrolysis of concentrated brine are as follows:

At anode:

$$2\,\mathrm{Cl^-}\left(\mathrm{l}\right) \rightarrow\ \mathrm{Cl(g)}\ +\ \mathrm{Cl(g)}\ +\ 2\mathrm{e^-}\ \ (\text{Primary Process})$$

$$\mathrm{Cl}\left(\mathrm{g}\right)\ +\ \mathrm{Cl}\left(\mathrm{g}\right) \rightarrow \mathrm{Cl_2}\left(\mathrm{g}\right)\ \left(\text{Secondary process}\right)$$

$$2\,\mathrm{Cl^-}\left(\mathrm{l}\right)\ \rightarrow\ \mathrm{Cl_2}\left(\mathrm{g}\right)\ + 2\mathrm{e^-}\ \left(\text{Overall oxidation reaction}\right)$$

At cathode:

$$\mathrm{2H^+(l) + 2e^- \rightarrow H_2(g)}$$

Therefore, reactions I and IV will occur during electrolysis of concentrated brine.

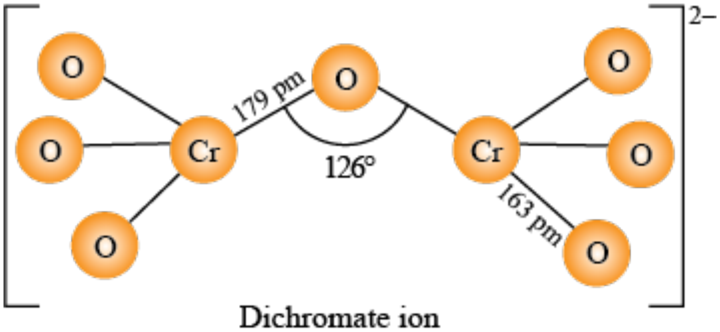
Hence, the correct answer is option (b).

Solution 5

The transition metals and their compounds exhibit catalytic activity. This activity is due to their ability to adopt multiple oxidation states and to form complexes.
Hence, the correct answer is option (d).

Solution 6

The dichromate ion consists of two tetrahedra sharing one corner with Cr–O–Cr bond angle of 126°. The six terminal Cr–O bonds are equal in length, i.e., 163 pm while the two bridging Cr–O bonds are equal in length, i.e., 179 pm.



Dichromate ion

Hence, the correct answer is option (b).

Solution 7

Total vapour pressure of solution = P_s = 40 torr
Vapour pressure of liquid A in solution =

$$P_A = P_A^0 X_A = P_A^0 \frac{n_A}{n_A+n_B}$$

$$P_A = 45 \times \frac{1}{3} = 15 \text{ torr}$$

Vapour pressure of liquid B in solution =

$$P_B = P_B^0 X_B = P_B^0 \frac{n_B}{n_A+n_B}$$

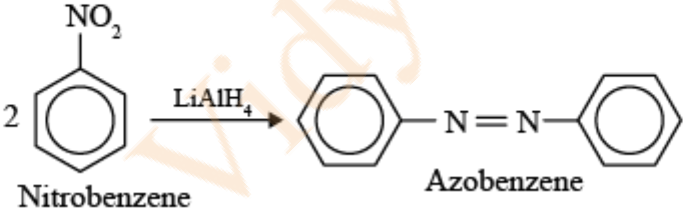
$$P_B = 30 \times \frac{2}{3} = 20 \text{ torr}$$

Since $P_s > P_A + P_B$, the above solution shows positive deviation.

Hence, the correct answer is option (b).

Solution 8

Hydrogen gas in the presence of Ni/Pt/Pd and metals like Fe and Sn in presence of HCl can reduce nitrobenzene to aniline. But $LiAlH_4$ converts nitrobenzene to azobenzene.



Hence, the correct answer is option (a).

Solution 9

Elevation of boiling point, $\Delta T_b = K_b m$
Where,
m = Molality
K_b = Proportionality constant known as Boiling Point Elevation Constant or Molal Elevation Constant or Ebullioscopic constant
The value of molal elevation constant is independent of molality and depends only on solvent.

Hence, the correct answer is option (d).

Solution 10

Sucrose is dextrorotatory but after hydrolysis gives dextrorotatory glucose and laevorotatory fructose. Since the laevorotation of fructose (–92.4°) is more than dextrorotation of glucose (+ 52.5°), the mixture is laevorotatory. Thus, hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (–) and the product is named as invert sugar. The process is known as inversion.
Hence, the correct answer is option (a).

Solution 11

Presence of electron withdrawing group decreases the electron density around oxygen and increases the acidic strength. −I effect of $-NO_2$ group is the strongest acid and 2–Nitroacetic acid is the strongest and has the lowest value of pK_a.
Order of acidic strength: $CH_3COOH < HCOOH < Cl\text{-}CH_2COOH < NO_2\text{-}CH_2COOH$

Hence, the correct answer is option (b).

Solution 12

The H_2-O_2 fuel cell was used for providing electrical power in the Apollo space programme. The water vapours produced during the reaction were condensed and added to the drinking water supply for the astronauts. In the cell, hydrogen and oxygen are bubbled through porous carbon electrodes into concentrated aqueous sodium hydroxide solution.

Hence, the correct answer is option (c).

Solution 13

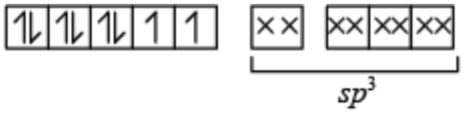
Let the rate law expression be:
$\text{Rate} = k[A]^m[B]^n$
Observations from experiments 2 and 3 show that the rate becomes four times when the concentration of 'A' is doubled.
So order of the reaction with respect to 'reactant 'A' is two.
$m = 2$
Observations from experiments 1 and 2 show that the rate is not affected when the concentration of 'B' is doubled.
So order of the reaction with respect to 'reactant 'B' is zero.
$n = 0$

Hence, the correct answer is option (c).

Solution 14

$[NiCl_4]^{-2}$
Oxidation state of 'Ni' = +2
Ni(Z = 28) : $[Ar]3d^84s^2$
Ni^{+2} : $[Ar]3d^84s^0$

Since Cl^- is a weak field ligand, $\Delta_t < P$. Therefore, no pairing takes place and Ni^{+2} ion has two unpaired electrons.



Magnetic moment can be calculated as follows:

$$\mu = \sqrt{\mathrm{n}\,(\mathrm{n}+2)} = \sqrt{2\,(2+2)}$$

$$\mu = \sqrt{8} = 2.82\ \mathrm{BM}$$

Hence, the correct answer is option (b).

Solution 15

(c) Assertion is true reason is false.
A tetrapeptide contains four amino acids held together by three peptide bonds.

Hence, the correct answer is option (c).

Solution 16

(a) Both assertion and reason are true and reason is the correct explanation of A.
For zero order reaction, Rate = $k[A]^0 = k$

Hence, the correct answer is option (a).

Solution 17

(b) Both assertion and reason are correct but reason is not the correct explanation of Assertion.
Formic acid does not have α H-atom, hence formic acid cannot be halogenated.
Acetic acid has electron donating group ($-CH_3$) which decreases the acidity by destabilising the conjugate base.

Hence, the correct answer is option (b).

Solution 18

Trans $\left[\mathrm{CrCl_2}\,(\mathrm{ox})_2\right]^{3-}$ is symmetrical and optically inactive.
So, assertion is a false but reason is a correct statement.

Hence, the correct answer is option (d).

Section B

Solution 19

(i) For a spontaneous redox reaction under standard conditions, sign for
$\mathrm{E^o_{cell}} = +\mathrm{ve} \quad \text{and} \quad \Delta\,\mathrm{G}^\circ = -\,\mathrm{ve}$
(ii) Faraday's first law of electrolysis:

It states that during electrolysis, the amount of chemical reaction that occurs at any electrode under the influence of electrical energy is proportional to the quantity of electricity passed through the electrolyte.

OR

The equation for given cell is

$$\mathrm{Fe(s)} + 2\mathrm{H}^+(1\mathrm{M}) \rightarrow \mathrm{Fe}^{2+}(0.01\mathrm{M}) + \mathrm{H}_2(1\ \mathrm{bar})$$

$$\text{Given } \mathrm{E}^{\mathrm{o}}_{\mathrm{Cell}} = 0.44\ \mathrm{V}$$

by using Nernst equation

$$\mathrm{E}_{\mathrm{cell}} = \mathrm{E}^{\mathrm{o}}_{\mathrm{cell}} - \frac{0.059}{2}\log\frac{[\mathrm{Fe}^{2+}]P_{H_2}}{[\mathrm{H}^+]^2}$$

$$= 0.44 - \frac{0.059}{2}\log\frac{0.01\times 1}{(1)^2}$$

$$= 0.499\ \mathrm{V}$$

Hence, emf of the given cell is 0.499 V.

Solution 20

Temperature dependence of rate constant is given by Arrhenius equation

$$k = A\mathrm{e}^{-(E_a/\mathrm{R}T)}$$

Where k = rate constant
A = Pre exponential factor
R = Universal gas constant
T = Temperature (in K)

As the temperature increases, rate constant will increase as more molecules will be able to cross activation energy barrier. Whereas activation energy depends upon the path of reaction so it remains same with increase of temperature.

Solution 21

(a) In order to act as a ligand a molecule or ion must have lone pair of electrons.
NH_4^+ cannot act as a ligand as it doesn't have lone pair of electrons.

(b) The given complex is $[Co(NH_3)_5(NO_2)]Cl_2$. Its linkage isomer will be $[Co(NH_3)_5(ONO)]Cl_2$ and its IUPAC name will be Pentaamminenitrito-O-cobalt(III) chloride.

Solution 22

Boiling point of ortho-dichlorobenzene is greater than para-isomer due to its greater polar nature.

P-dichlorobenzene has higher melting point than ortho isomer. This is due to greater symmetry of para-isomer that fits in the crystal better as compared to ortho- isomer.

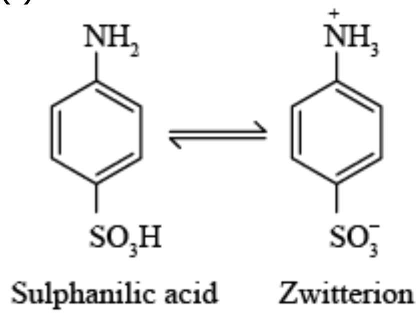
Solution 23

(a) Phenol is more acidic than cyclohexanol because the phenoxide ion is more stable than the alkoxide ion.

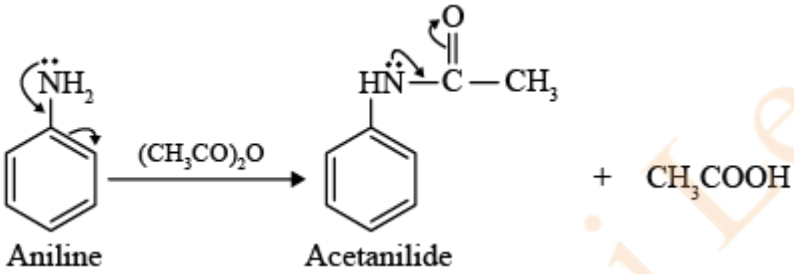
(b) Phenol and cyclohexanol can be distinguished by ferric chloride test. Phenol reacts to give violet colour solution with neutral $FeCl_3$ whereas, cyclohexanol does not give violet colour.

Solution 24

(i)

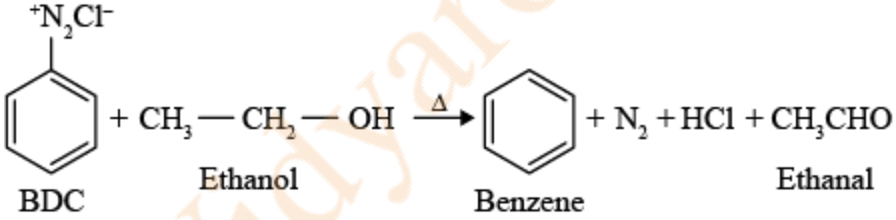


(ii) Electron donating effect of aniline is reduced by acetylation of aniline by reacting it with acetic acid anhydride.

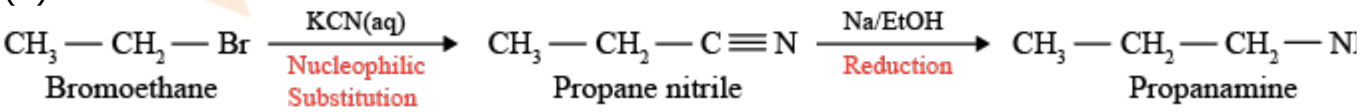


OR

(i)



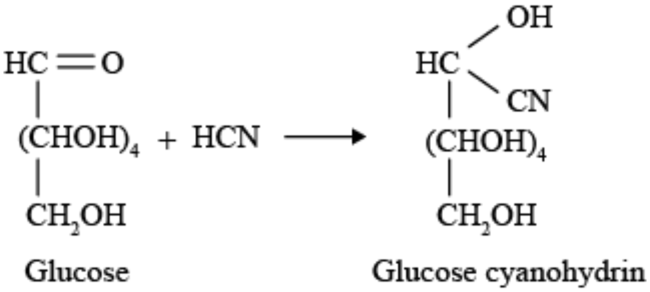
(ii)



$$CH_3-CH_2-Br \xrightarrow[\text{Nucleophilic Substitution}]{\text{KCN(aq)}} CH_3-CH_2-C\equiv N \xrightarrow[\text{Reduction}]{\text{Na/EtOH}} CH_3-CH_2-CH_2-N$$

Solution 25

Glucose reacts with HCN to produce cyanohydrin. The reaction confirms the presence of an aldehyde group in glucose.



Section C

Solution 26

(i) $2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$

$$\text{Rate} = \frac{-1}{2} \times \frac{\Delta[N_2O_5]}{\Delta t}$$

$$\text{Rate} = \frac{1}{2} \times 1.4 \times 10^{-3} = 7 \times 10^{-4}\ \text{m s}^{-1}$$

(ii) For a first order reaction

$$t = \frac{2.303}{k} \log \frac{[A]_0}{[A]_1}$$

$$t_{99\%} = \frac{2.303}{k} \log \frac{100}{1}$$

$$t_{99\%} = \frac{2.303}{k} \times 2 \quad \ldots. \left(\text{i}\right)$$

$$t_{90\%} = \frac{2.303}{k} \log \frac{100}{10}$$

$$t_{90\%} = \frac{2.303}{k} \quad \ldots. \left(\text{ii}\right)$$

divide $\left(\text{i}\right)$ by $\left(\text{ii}\right)$

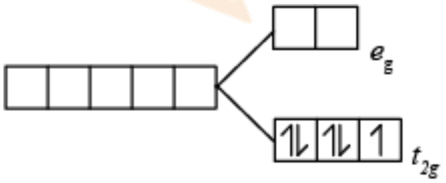
$$\frac{t_{99\%}}{t_{90\%}} = 2$$

$$t_{99\%} = 2 \times t_{90\%}$$

Solution 27

(a) For the formation of octahedral complexes in the presence of a strong field ligand, $\Delta_0 > P$

So the electrons get paired up and the configuration of a d^5 ion is: $t_2g^5\ e_g^0$

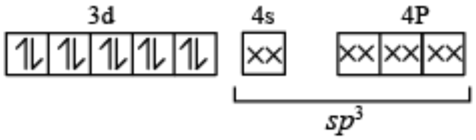


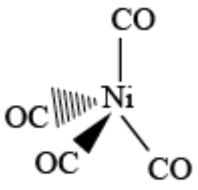
(b) In $[Ni(CO)_4]$

Oxidation state of Ni is zero

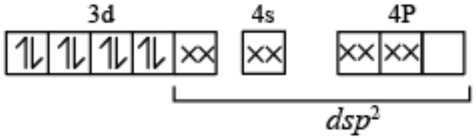
Ni(z = 28) : $[Ar]3d^84s^2$

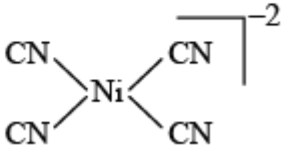
CO is a strong field ligand due to synergic effect of bonding.





Geometry : Tetrahedral
Since there is no unpaired electron, the complex is diamagnetic
In $[Ni(CN)_4]^{-2}$
Oxidation state of 'Ni' is +2
$Ni^{+2}[Ar]\ 3d^8 4s^0$
(CN^- is a strong field liquid and splitting energy is greater than pairing energy.

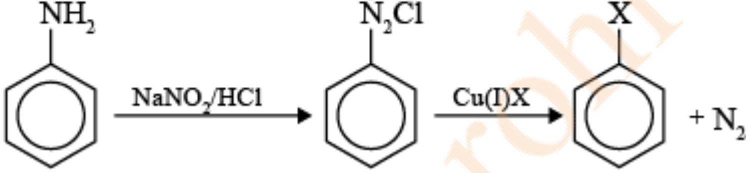




Hybridization dsp^2
Geometry square planar
Number of unpaired electrons = 0
Complex is diamagnetic

Solution 28

(a) Sandmeyer's reaction is substitution reaction used to synthesise aryl halides from aryl diazonium salts using Cu salts as reagents or catalysts.



(b) $(CH_3)_2$ NH is more basic than $(CH_3)_3$ N in aqueous solution. This is because conjugate acid from secondary amine makes two hydrogen bonds with H_2O molecules and hence are better solvated than tertiary amines.

Solution 29

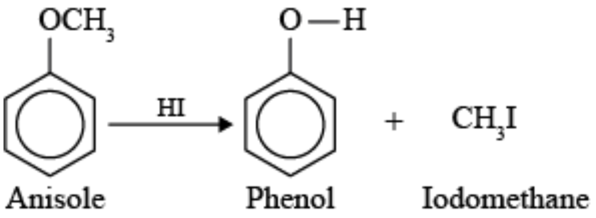
(a) Pentaacetate of glucose does not react with hydroxylamine due to the absence of free aldehyde group.
(b) Amino acids behave like salts due to the presence of both acidic (-COOH) and basic ($-NH_2$) groups in the same molecule.
(c) Water soluble vitamins are eliminated in urine, so they must be taken continuously in diet.
(d) Two strands of DNA are held together by hydrogen bonds between specific pairs of bases. Adenine forms hydrogen bond with thymine while cytosine forms hydrogen bond with guanine.
Therefore the two strands of DNA are complementary to each other.

Solution 30

(i) Due to resonance in phenol C − O bond acquires a partial double bond character as a result of which C − O bond length in phenol is smaller than C − O bond length in methanol.

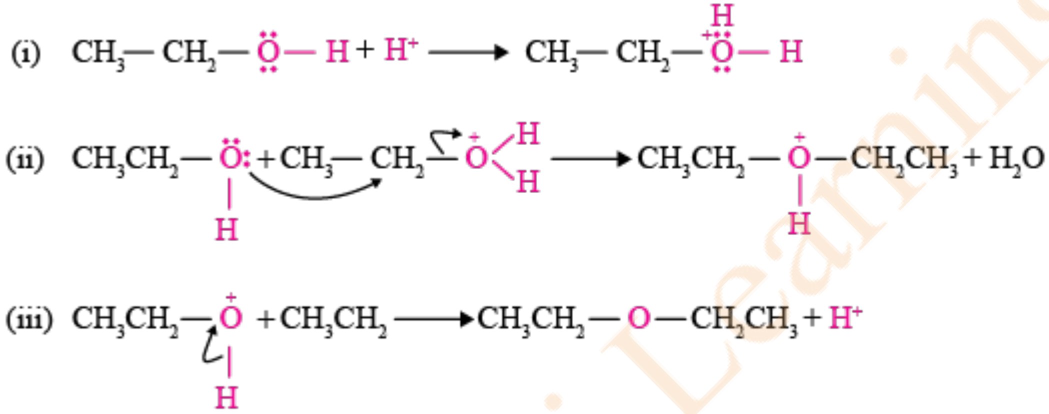
(ii) Order of increasing boiling point: n-butane < Ethoxyethane < Butanal < Butanol

(iii) Preparation of phenol from anisole can be achieved by reacting anisole with HI



OR

(i) The required mechanism is

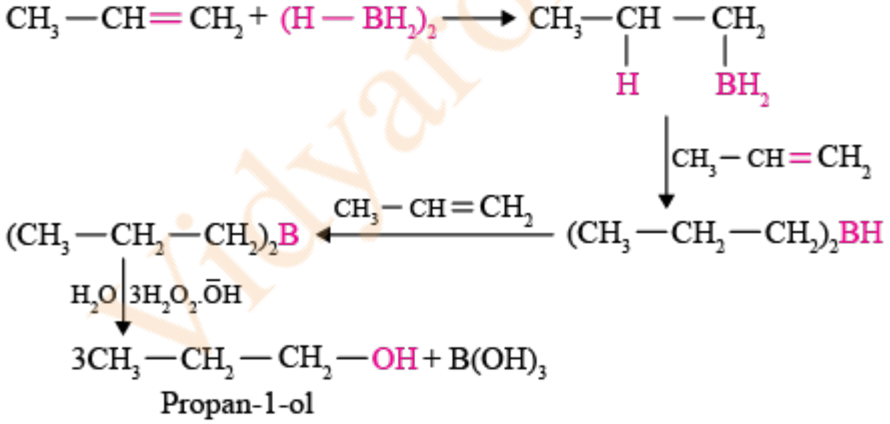


$$\text{(i)}\quad CH_3-CH_2-\ddot{\underset{\cdot\cdot}{O}}-H + H^+ \longrightarrow CH_3-CH_2-\overset{H}{\overset{+}{\underset{\cdot\cdot}{O}}}-H$$

$$\text{(ii)}\quad CH_3CH_2-\underset{H}{\ddot{O}}: + CH_3-CH_2-\overset{+}{O}\begin{smallmatrix}H\\H\end{smallmatrix} \longrightarrow CH_3CH_2-\underset{H}{\overset{+}{O}}-CH_2CH_3 + H_2O$$

$$\text{(iii)}\quad CH_3CH_2-\underset{H}{\overset{+}{O}} + CH_3CH_2 \longrightarrow CH_3CH_2-O-CH_2CH_3 + H^+$$

(ii) In hydroboration oxidation, diborane $(BH_3)_2$ reacts with alkenes to give trialkyl boranes as addition product. This is oxidised to alcohol by hydrogen peroxide in the presence of aqueous sodium hydroxide.



$$CH_3-CH=CH_2 + (H-BH_2)_2 \longrightarrow CH_3-\underset{H}{CH}-\underset{BH_2}{CH_2}$$

$$\xrightarrow{CH_3-CH=CH_2} (CH_3-CH_2-CH_2)_2BH \xrightarrow{CH_3-CH=CH_2} (CH_3-CH_2-CH_2)_3B$$

$$\xrightarrow{H_2O\,|\,3H_2O_2, \bar{O}H} 3CH_3-CH_2-CH_2-OH + B(OH)_3$$

Propan-1-ol

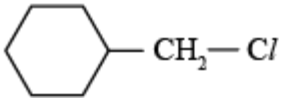
Section D

Solution 31

(a) In S_N1 reaction, carbocation is formed as an intermediate, which is planar. Due to this both retention and inversion of configuration takes place and hence, racemisation takes place.

(b) Ethanol is less polar than water because in case of ethanol, sp^3 hybridized carbon is attached with oxygen whereas in case of water, both sides are occupied by hydrogen. Thus, charge separation is more in water, resulting in stronger hydrogen bonding as compared to ethanol.

(c) (i) $CH_3—CH_2—I$

(ii) 

OR

(c) (i) 1-Bromopentane < 2-Bromopentane < 2-Bromo-2-methylbutane
(ii) 1-Bromo-3-methybutane < 2-Bromo-3-methylbutane < 2-Bromo-2-methylbutane

Solution 32

(a) On dilution the number of ions per unit volume that carry current in the solution decreases. Therefore, conductivity decreases.

(b) $\wedge_m^o$ of KCl = 150 S cm^2 mol^{-1}
Molarity = 0.01 M
$\wedge_m$ = 141 S cm^2 mol^{-1}
$\alpha = \frac{\wedge_m}{\wedge_m^o} = \frac{141}{150} = 0.94$
$\therefore$ Degree of dissociation = 0.94

(c) Since H^+ ion is smaller than K^+ ion, HCl will have greater molar conductivity than KCl.

OR

(c) Similarity - For both KCl and CH_3COOH, conductivity will decrease with dilution.
Difference- Molar conductivity of CH_3COOH increases steeply on dilution while that of KCl increases slowly.

Solution 33

(i) NaCl is a strong electrolyte and is completely dissociated in its aqueous solution.
$NaCl(s) + H_2O(l) \rightarrow Na^+ (aq) + Cl^-(aq)$
So, a solution of NaCl of the same concentration as glucose solution will have nearly double the number of ions and the change in colligative property will also be double. Therefore, 1M NaOH solution will have a higher b.pt than 1M glucose solution.
(ii) Let mass of the unknown solute, 'X' = w g
Molar mass of X = 50 g/mol
Number of moles of $'X' = \frac{w}{50}$
Mass of solvent (benzene) = 78 g
Molar mass of benzene = 78 g/mol
Number of moles of benzene $= \frac{(78\ g)}{78\ g/\ mol} = 1$
$P_{solution}$ = 90% of $P_A^0 = 0.9\, P_A^0$

$$\Delta P = P_A^0 - 0.9\,P_A^0 = 0.1\,P_A^0$$

$$\frac{(\Delta P)}{(P_A^0)} = nX / n_{\text{benzene}}$$

$\frac{w}{50}$ = 0.1

w = 5 g

(iii) Given mass of $MgCl_2(w_B)$ = 10 g

Molar mass of $MgCl_2(M_B)$ = 95 g/mol

Mass of $H_2O(w_A)$ = 200 g

K_b = 0.512 K kg mol^{-1}

Assuming $MgCl_2$ to be fully dissociated.

i = 3

$$\Delta T_b = i \times K_b \times m = i \times K_b \times \frac{w_{B \times 1000}}{M_B \times w_n}$$

$$\Delta T_b = 3 \times 0.512 \times \frac{10 \times 1000}{95 \times 200} = 0.808\ K$$

OR

(i) Two molecules of ethanoic acid associate to form a dimer

$$2\ CH_3COOH \rightleftharpoons (CH_3COOH)_2$$

$$i = 1 - \frac{\alpha}{2} \qquad \begin{array}{c} i = \text{Van't Hoff Factor} \\ \alpha = \text{Degree of dissociation.} \end{array}$$

For association *i* < 1

Due to this reason Van't Hoff factor for ethanoic acid in benzene is close to 0.5.

(ii) Mass of K_2SO_4 = 2.32×10^{-2} g

Molar mass of K_2SO_4 = 174 g mol^{-1}

$$\therefore \text{ Number of moles of } K_2SO_4 = \frac{2.32 \times 10^{-2}}{174} \text{ moles}$$

$$= 1.33 \times 10^{-4} \text{ moles}$$

$$K_2SO_4 \rightleftharpoons 2K^+ + SO_4^{2-}$$

Number of ions produced = 3.

∴ Van't Hoff factor i = 3

$$\text{Osmotic pressure } \pi = CRT \times i$$

$$= \frac{n}{V} RT \times i$$

$$\pi = \frac{1.33 \times 10^{-4}}{2} \times 0.0821 \times 298 \times 3$$

$$\pi = 48.8 \times 10^{-4} \text{ atm}$$

(iii) Let the formula of sulphur be S(*x*)

$$\Delta T_f = K_f \times \text{molality} \times i$$

$$0.512 = 5.12 \times \frac{25.6 \times 1000}{M_{solute} \times 1000} \qquad (i = 1)$$

$$M_{solute} = 256 \text{ g}$$

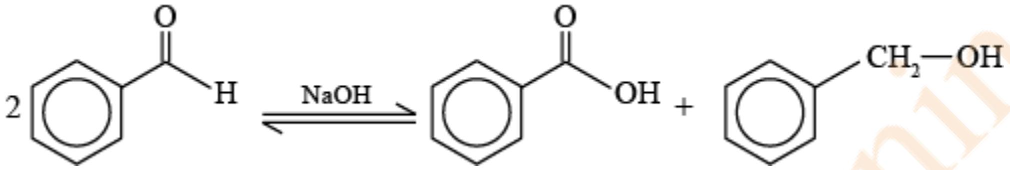
$$M_{S_{(x)}} = 256 = 32 \times x$$

$$\therefore x = \frac{256}{32} = 8$$

$$\therefore \text{ formula of sulphur} = S_8$$

Solution 34

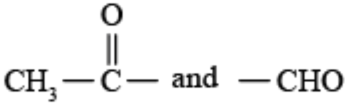
(i) Cannizaro reaction involves disproportionation reaction of two molecules of non-enolisable aldehyde to give primary alcohol and carboxylic acid.



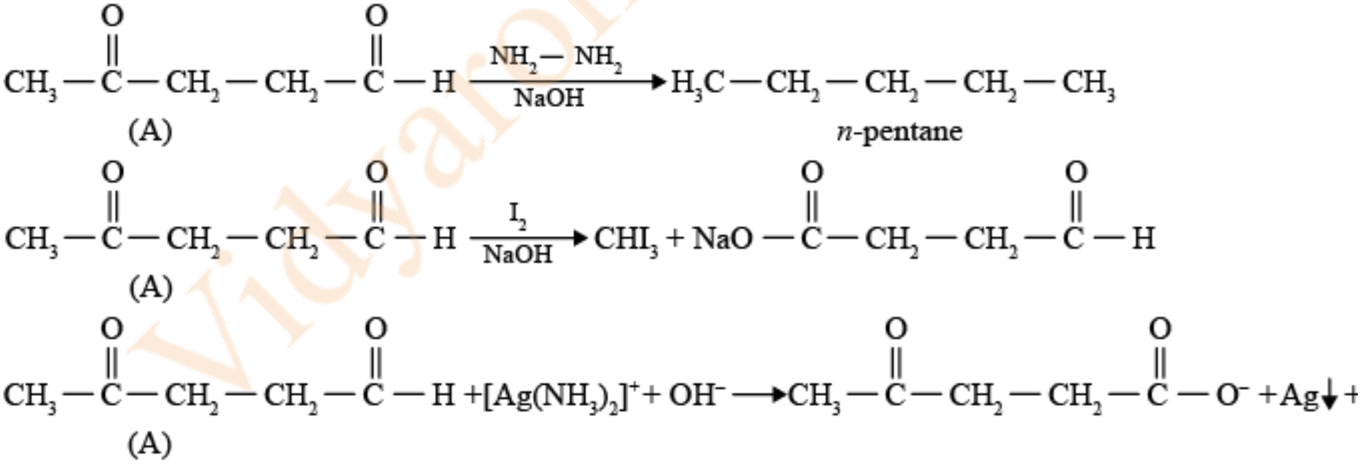
(ii) Carboxylic acids are associated by intermolecular H-bonding whereas aldehyde and ketone are not associated by H-bonding.

Due to this reason aldehyde and ketone have lower boiling point.

(iii) A gives positive iodoform test and positive tollens test, so, it must have



$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-$ and $-CHO$ group.



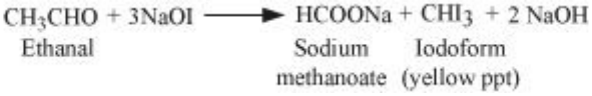
$$\underset{(A)}{CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H} \xrightarrow[NaOH]{NH_2-NH_2} \underset{n\text{-pentane}}{H_3C-CH_2-CH_2-CH_2-CH_3}$$

$$\underset{(A)}{CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H} \xrightarrow[NaOH]{I_2} CHI_3 + NaO-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H$$

$$\underset{(A)}{CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H} + [Ag(NH_3)_2]^+ + OH^- \longrightarrow CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-O^- + Ag\downarrow +$$

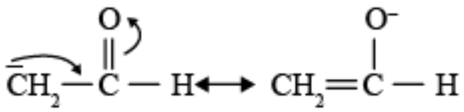
OR

(i) Iodoform test can be used to distinguish between ethanal and ethanoic acid. Ethanal will give iodoform test whereas ethanoic acid will not.



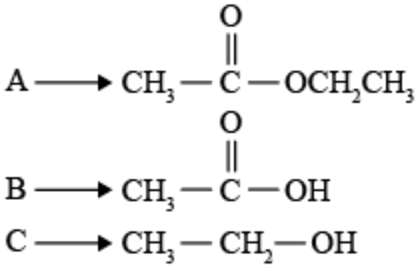
$$\underset{\text{Ethanal}}{CH_3CHO} + 3NaOI \longrightarrow \underset{\substack{\text{Sodium}\\\text{methanoate}}}{HCOONa} + \underset{\substack{\text{Iodoform}\\\text{(yellow ppt)}}}{CHI_3} + 2\,NaOH$$

(ii) 'α'-Hydrogen of ketones and aldehydes are acidic in nature because the conjugate base 'enolate ion' is resonance stabilized



$$\overset{-}{C}H_2-\overset{\overset{O}{\|}}{C}-H \longleftrightarrow CH_2=\overset{\overset{O^-}{|}}{C}-H$$

(iii) (1)



$$A \longrightarrow CH_3-\overset{\overset{O}{\|}}{C}-OCH_2CH_3$$

$$B \longrightarrow CH_3-\overset{\overset{O}{\|}}{C}-OH$$

$$C \longrightarrow CH_3-CH_2-OH$$

(2) Out of B and C, B will have a higher boiling point due to stronger intermolecular hydrogen bonding.

Solution 35

(a) Chemistry of actinoids is complicated to lanthanoids because the elements in actinoids show radioactivity and also due to less energy difference between 5f, 6d and 7s then show large number of oxidation states.

(b) Given equation is $3\,MnO_4^{2-} + 4H^{\oplus} \rightarrow \_\_ + \_\_ + 2H_2O$

In the presence of acidic medium MnO_4^{2-} changes to MnO_4^- and MnO_2.

∴ The required equation will be

$$3\,MnO_4^{2-} + 4H^{\oplus} \rightarrow 2\,MnO_4^- + MnO_2 + 2H_2O$$

Now, in this reaction oxidation number of Mn in MnO_4^{2-} is +6, whereas in MnO_4^- it is +7 and in MnO_2 it is +4.

This means Mn has undergone simultaneous oxidation and reduction, that's why this is an example of disproportionation reaction.

(c) Chromium has the highest melting point as it has 6 unpaired electron, one in 's' and five in 'd' orbital, due to involvement of these electrons in inter-atomic attraction metallic bond form is stronger. Whereas in Mn 's' orbital is completely filled although it has d^5 arrangement but these electrons are tightly held by the nucleus, this reduces the delocalisation of electron resulting in weaker metallic bonding.

That's why Mn has lower melting point.