Section A

1. **(d)** Lactose
Explanation:
Lactose

2. **(a)** ethyl iodide
Explanation:
ethyl iodide

3. **(c)** All of these
Explanation:
Phenol reacts with sodium hydroxide solution to give a colourless solution containing sodium phenoxide. In this reaction, the hydrogen ion has been removed by the strongly basic hydroxide ion in the sodium hydroxide solution.

4. **(c)** Methanamine (CH_3NH_2)
Explanation:
$CH_3Cl + NH_3 \rightarrow CH_3NH_2 + HCl$
Ammonia molecule is a nucleophile in nature as it has unpaired electrons. This nucleophile attacks the chloromethane CH_3Cl molecule and forms methylamine or methenamine by a nucleophilic substitution reaction mechanism. The carbon atom is partially positive in the molecule, due to the electronegativity of the halide attached which is partially negative. The electron-rich nucleophile attacks the positive ion, causing the halide ion to be separated from the molecule.

5. **(d)** Zn
Explanation:
Zn metal of 3d series has the lowest melting point.

6. **(d)** (a) - (iv), (b) - (ii), (c) - (i), (d) - (iii).
Explanation:
(a) - (iv), (b) - (ii), (c) - (i), (d) - (iii).

7. **(c)** CH_3COCH_3
Explanation:
CH_3COCH_3 will not give a silver mirror test (Tollens Test). Tollens test is given by aldehydes only and HCOOH is the only acid that gives tollen's test. Ketones do not give tollen's test.

8. **(d)** size and solubility of the aldehyde and ketone molecule.
Explanation:
Size and solubility of aldehyde and ketone determine fragrance. For example, aldehyde C-10 is used in floral blends like rose, jasmine, etc. While aldehyde C-11 has a strong citrus smell and aldehyde C-16 has a strong strawberry smell.

9.

(b) One

Explanation:

ln R = ln R_O – kT, slope = –k, slope = –1.46, so k = 1.46 sec–1 unit of k in first order is sec–1 so this is first order reaction.

10. **(a)** increases with increase in temperature.

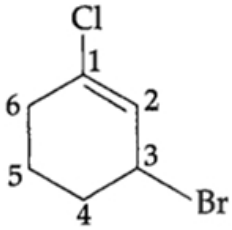
Explanation:

Value of henry constant increases with increase in temperature.

11.

(b) 3-bromo-1-chlorocyclohexene

Explanation:



IUPAC name: 3-bromo 1-chlorocyclohexene

12.

(d) Primary amines

Explanation:

In Gabriel Phthalimide reaction, the sodium or potassium salt of phthalimide is N-alkylated with a primary alkyl halide to give the corresponding *N*-alkylphthalimideis for producing primary amines. This is because of the reaction of sodium or potassium salt of phthalimide with alkyl halide impure SN_2 reaction.

13. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Both A and R are true and R is the correct explanation of A.

14.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

Both A and R are true but R is not the correct explanation of A.

15. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

The addition of HCN to carbonyl compounds involves the addition of CN^- in rate determining step which are supplied easily by NaCN and thus addition becomes fast.

16.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

As the size of the alkyl groups increases, the S_N2 reactivity decreases, further C - Cl bond is stronger and more difficult to cleave than C - Br bond. So CH_3Br is more reactive than $(CH_3)_2CHCl$.

Section B

17. Mn^{2+} compounds are less readily converted to its +3 oxidation state (Mn^{3+}) as compared to Fe^{2+} because Mn^{2+} ($3d^5$) is more stable than Mn^{3+} ($3d^4$) due to stable half filled d-orbital electronic configuration. Whereas Fe^{3+} ($3d^5$) is more stable than Fe^{2+} ($3d^6$) due to half filled d-orbitals therefore Fe^{2+} gets easily converted to Fe^{3+}

18. Answer the following:

(i) a. $t_{1/2} = \frac{0.693}{k}$

b. The number of collisions per second per unit volume of the reaction mixture.

(ii) Unit of rate = mol $L^{-1}s^{-1}$

Unit of rate constant (k) = $\frac{\text{Unit of rate}}{\text{Unit of } \left[A^2\right] \times \text{Unit of } [B]}$

$= \frac{molL^{-1}s^{-1}}{(molL^{-1})^2(molL^{-1})}$

$= mol^{-2}L^2s^{-1}$

19. Molecular mass of glucose

$M_B = 72 + 12 + 96 = 180\, g\, mol^{-1}$

$\Delta T_f = \frac{K_f \times w_B \times 1000}{M_B \times w_A}$

$= \frac{1.86 \times 54 \times 1000}{180 \times 250} = 2.23$ K

Freezing point of solution = $T^0_f - \triangle Tf = 273 - 2.23 = 270.77K$

OR

Mass percentage: The mass percentage of a component in a given solution is defined as the mass of the component per 100g of the solution.

Mass % of a component $= \frac{\text{Mass of the component in the solution}}{\text{Total mass of the solution}} \times 100$

OR

Structure of A, B, C and D are deduced in the following manner.

$$\underset{(A)}{CH_3 - CO - CH_3} \xrightarrow[\text{Reduction}]{LiAlH_4} \underset{(B)}{CH_3CH(OH)CH_3}$$

$$\underset{(B)}{CH_3CH(OH)CH_3} + HBr \rightarrow \underset{(C)}{CH_3CH(Br)CH_3}$$

$$\underset{(C)}{CH_3CH(Br)CH_3} + KOH(alc.) \rightarrow \underset{(D)}{CH_3 - CH = CH_2} + KBr + H_2O$$

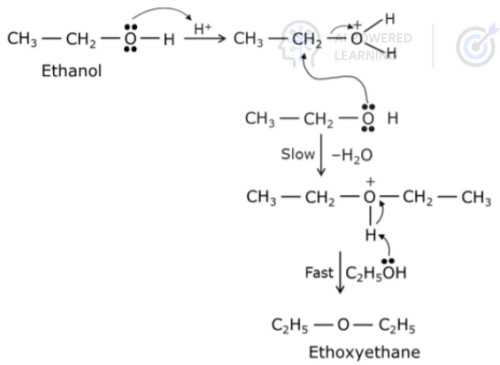
20. i. $K_2[Zn(OH)_4]$

ii. $K_3[Al(C_2O_4)_3]$

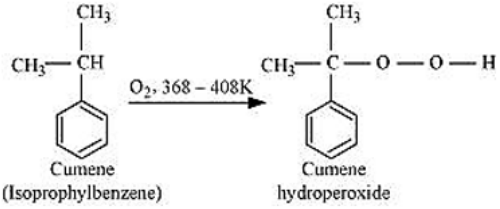
iii. $[CoCl_2(en)_2]^+$

Section C

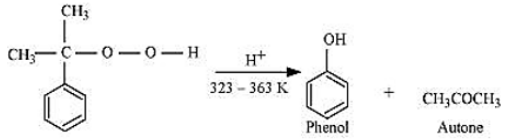
21. i. $2CH_3CH_2OH \xrightarrow[413K]{H^+} CH_3CH_2OCH_2CH_3 + H_2O$



ii. To prepare phenol, cumene is first oxidized in the presence of air of cumene hydro-peroxide.



Then, cumene hydroxide is treated with dilute acid to prepare phenol and acetone as by-products.



OR

i. $CH_3 - \underset{\underset{2-propanone}{}}{\overset{\overset{}{\|}}{C}} - CH_3 + CH_3MgBr \xrightarrow[addition]{dry\ ether} \left[CH_3 - \underset{OMgBr}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}} - CH_3\right] \xrightarrow{H_2O/H^+} CH_3 - \underset{2-methyl-2-propanol}{\overset{CH_3}{\overset{|}{\underset{OH}{\underset{|}{C}}}}} - CH_3$

ii. n-Propyl alcohol to hexane

$CH_3CH_2CH_2OH + PCl_5 \rightarrow CH_3CH_2CH_2Cl + POCl_3 + HCl$

$\underset{1-Chloropropane}{2CH_3CH_2CH_2Cl} + 2Na \xrightarrow[either]{Dry} \underset{n-Hexane}{CH_3CH_2CH_2C_2CH_3} + 2NaCl$

22. **Kohlrausch law of independent migration of ions:** It states that limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anion and cation of the electrolyte. If $\lambda^o Na^+$ and $\lambda^o Cl^-$ are limiting molar conductivity for sodium chloride is given by

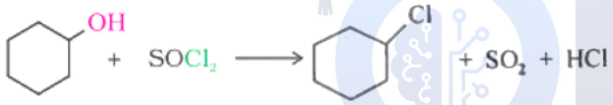
$\lambda_m^0\ (NaCl) = \lambda^o Na + \lambda^0 Cl^-$

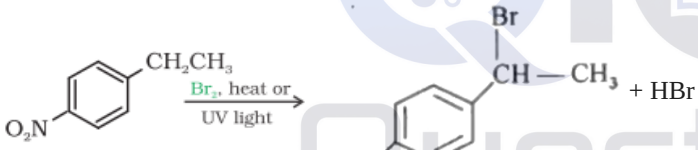
Calculation of degree of dissociation of weak electrolyte like acetic acid. The degree of dissociation α is given by:

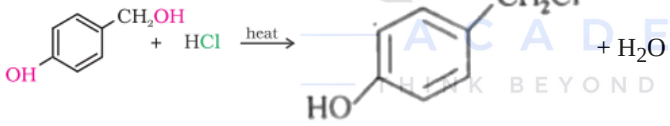
$\alpha = \frac{\lambda_m}{\lambda_m^0}$

where λ_m be molar conductivity and λ_m^0 be the limiting molar conductivity.

23. Major monohalo product are as follows:

i. 

ii. 

iii. 

24. Consider the order of the reaction with respect to A is x and with respect to B is y.

Therefore, $r_0 = k[A]^x[B]^y$

$5.07 \times 10^{-5} = k[0.20]^x[0.30]^y$ ..... (i)

$5.07 \times 10^{-5} = k[0.20]^x[0.10]^y$ ..... (ii)

$1.43 \times 10^{-4} = k[0.40]^x[0.05]^y$ ..... (iii)

Dividing equation (i) by (ii), we obtain

$\frac{5.07\times10^{-5}}{5.07\times10^{-5}} = \frac{k[0.20]^x[0.30]^y}{k[0.20]^x[0.10]^y}$

$1 = \frac{[0.30]^y}{[0.10]^y}\left(\frac{0.30}{0.10}\right)^0 = \left(\frac{0.30}{0.10}\right)^y$

y = 0

Dividing equation (iii) by (ii), we obtain

$\frac{1.43\times10^{-4}}{5.07\times10^{-5}} = \frac{k[0.40]^x[0.05]^y}{k[0.20]^x[0.30]^y}$

$\frac{1.43\times10^{-4}}{5.07\times10^{-5}} = \frac{[0.40]^y}{[0.20]^y}\ \ [Since\, y = 0,\ [0.05]^y = [0.30]^y = 1]$

$2.821 = 2^x$

$\log 2.821 = x \log 2\ (Taking\ \log\ on\, both\ sides) x = \frac{\log 2.821}{\log 2}$

= 1.496

= 1.5 (approximately)

Hence, the order of the reaction with respect to A is 1.5 and with respect to B is 0.

25. $$\begin{array}{l} Mg(s) \longrightarrow Mg^{2+}(aq) + 2e^- \\ 2\,Ag^+(aq) + 2e^- \longrightarrow 2\,Ag(s) \\ \hline Mg(s) + 2Ag^+(aq) \longrightarrow Mg^{2+}(aq) + 2Ag(s) \end{array}$$

applying nernst equation

$E_{cell} = E^0_{cell} - \frac{0.0591}{2}\log\frac{[Mg^{2+}]}{[Ag^{2+}]}$

$E^0(Ag^+/Ag) - E^0(Mg^{2+}/Mg) - \frac{0.0591}{2}\log\frac{0.2}{(10^{-3})^2}$

$= +0.80V - (-2.37V) - \frac{0.0591}{2}\log(2 \times 10^5)$

$= +3.17V - \frac{0.0591}{2}[\log 2 + \log 10^5]$

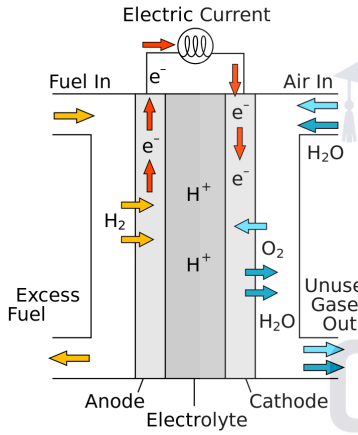
$= +3.17V - \frac{0.0591}{2} \times 5.3010$

= +3.17V - 0.1566V

= 3.0134 V

26. **Fuel cells :** Those galvanic cells in which chemical energy of combustion of fuels like hydrogen, methane, etc. is converted into electrical energy are called fuel cells.

H_2-O_2 fuel cell: The cell consists of three compartments separated by a porous electrode. Hydrogen gas is introduced into one compartment and oxygen into another compartment. These gases then diffuse slowly through the electrode and react with an electrolyte that is in the central part of the cell. The electrodes are made of porous carbon and electrolyte is a resin containing concentrated aqueous sodium hydroxide solution. Hydrogen is oxidized at anode and oxygen is reduced at the cathode.



The electrode reactions involved in the working of the H_2-O_2 fuel cell are as:

At cathode,

$O_2(g) + 2H_2O(l) + 4e^- \longrightarrow 4OH^-(aq)$

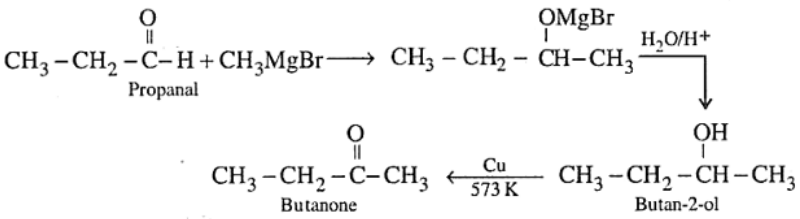
At anode,

$2H_2(g) + 4OH^-(aq) \longrightarrow 4H_2O(l) + 4e^-$

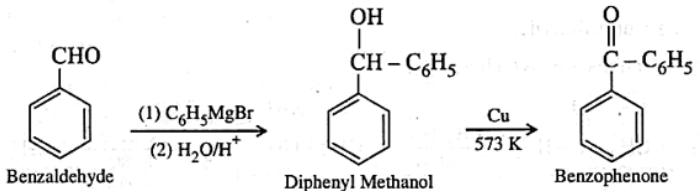
Overall cell reaction: $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$

27. The following steps are involved in the conversions:

i. Propanal to butanone



ii. Benzaldehyde to Benzophenone



iii. Benzoyl Chloride to Benzonitrile

$$\underset{\text{Benzoyl chloride}}{C_6H_5COCl} \xrightarrow[\text{Heat}]{NH_3} \underset{\text{Benzamide}}{C_6H_5CONH_2} \xrightarrow[\text{heat}]{P_2O_5} \underset{\text{Benzonitrile}}{C_6H_5C \equiv N}$$

Section D

28. i. It is due to presence of most number of unpaired electrons and there is more frequent metal-metal bonding in 5d series than 3d and 4d series.

ii. Zinc has lowest enthalpy of atomisation due to weak metallic bond which is due to absence of unpaired electrons.

iii. It is due to larger size, absence of unpaired electron and weak interatomic attraction and weaker metallic bond.

OR

It is due to smaller atomic size and higher ionisation enthalpies.

29. i. People experience water retention in tissue cells and intercellular spaces due to osmosis.

ii. Through the process of osmosis, a bacterium on salted meat or candid fruit loses water, shrivels and dies.

iii. The pure solvent flows out of the solution through the semi permeable membrane due to reverse osmosis. It is used in desalination of sea water.

OR

During intravenous injection, the concentration of the solution should be same as that of blood so that they are isotonic. Because if the solution concentration is hypertonic than blood cell will shrink and if it is hypotonic than blood cell will swells/burst.

Section E

30. Attempt any five of the following:

(i) Native state of protein is the sequence in which the amino acids are linked together with the help of peptide bond.

(ii) a. Polysaccharides contain a large number of monosaccharide units joined together by glycosidic linkages.

b. Sugar + Phosphate + base / Nucleoside linked to a phosphate group.

(iii)Vitamin C

(iv) a. n-hexane is formed

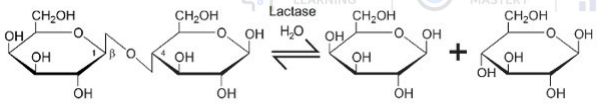
$$\begin{matrix}CHO\\|\\(CHOH)_4\\|\\CH_2OH\end{matrix} \xrightarrow{HI\ ,\ \triangle} CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$$

b. Saccharic acid is formed

$$\begin{matrix}CHO\\|\\(CHOH)_4\\|\\CH_2OH\end{matrix} \xrightarrow{Oxidation} \begin{matrix}COOH\\|\\(CHOH)_4\\|\\COOH\end{matrix}$$

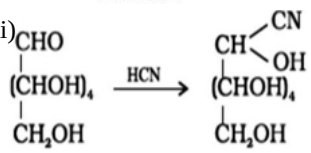
(v) Lactose

(vi)Hydrolysis of Lactose gives D-galactose and D-glucose.



Lactose D-galactose D-glucose

(vii)



Confirms the presence of aldehydic/carbonyl group.

31. a. i. Loss of proton from amines give ion whereas loss of a proton from alcohol gives an alkoxide ion.

Since O is more electronegative than N, therefore, RO^- can accommodate the -ve charge more easily than RNH^-.

Consequently, RO^- is more stable than RNH^-. Thus, alcohols are more acidic than amines.

ii. Primary amines (RNH_2) have two hydrogen atoms on the N atom and therefore, form intermolecular hydrogen bonding.

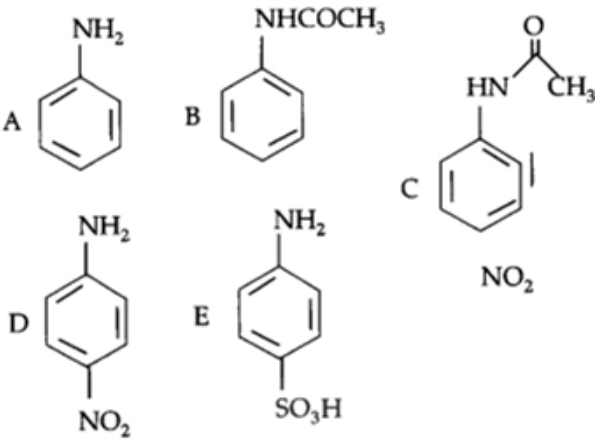
Tertiary amines (R_3N) donot have hydrogen atoms on the N atom and therefore, these donot form hydrogen bonds. As a result of hydrogen bonding in primary amines, they have higher boiling points than tertiary amines of comparable molecular mass.

iii. Both arylamines and alkylamines are basic in nature due to the presence of lone pair on N-atom. But arylamines are less basic than alkylamines.

b. i. $C_6H_5N_2Cl + C_2H_5OH \xrightarrow{Reduction} \underset{Benzene}{C_6H_6} + \underset{Ethanal}{CH_3CHO} + N_2 + HCl$

ii. $C_6H_5NH_2 + (CH_3CO)_2O \xrightarrow{CH_3COOH} \underset{Acetanilide}{C_6H_5CONHCH_3} + CH_3COOH$

OR

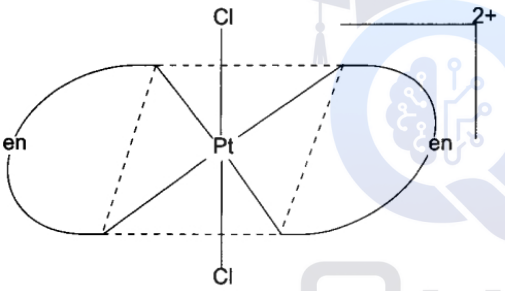


32. a. i. Hexaaminenickel (II) chloride

ii. Potassium hexacyanidoferrate (III)

iii. Tris(ethane-1,2-diamine)cobalt (III) ion

b.



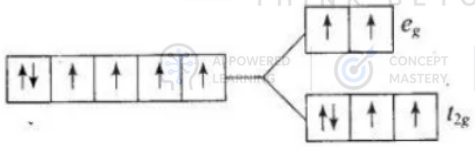
trans-$[Pt(en)_2Cl_2]^{2+}$

IUPAC Name of the entity:

Dichloridobis (ethane-1,2-diamine platinum

OR

i. $[CoF_6]^{3-}$:

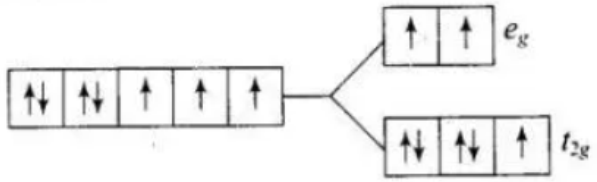


$Co^{2+} = 3d^7$

Number of unpaired electrons = 4

Magnetic moment = $\sqrt{n(n+2)} = \sqrt{4(4+2)}$ = 4.9 B.M

$[Co(H_2O)_6]^{2+}$:

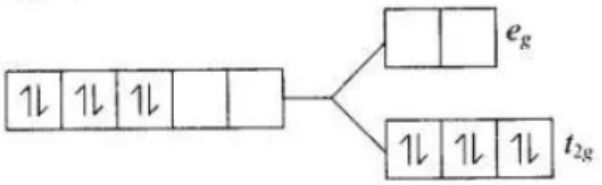


$Co^{2+} = 3d^7$

Number of unpaired electrons = 3

Magnetic moment = $\sqrt{3(3+2)}$ = 3.87 B.M

$[Co(CN)_6]^{3-}$:

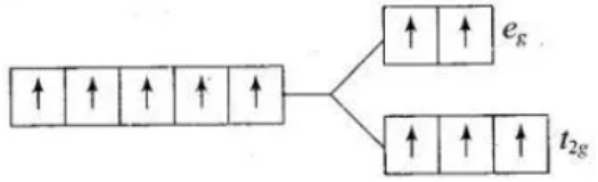


$Co^{3+} = 3d^6$

Number of unpaired electrons = 0

Diamagnetic in nature.

ii. FeF_6^{3-} :



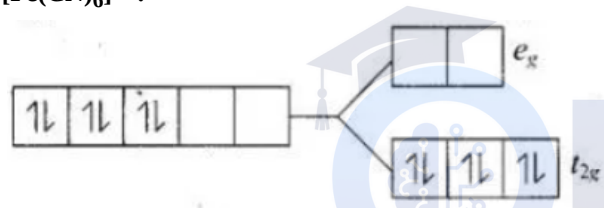
$Fe^{2+} = 3d^6$

$[Fe(H_2O)_6]^{2+} : t^4_{2g}\ e_g^2$

Number of unpaired electrons = 4

Magnetic moment = $\sqrt{4(4+2)}$ = 4.9 B.M

$[Fe(CN)_6]^{4-}$:



$Fe^{2+} = 3d^6$

Diamagnetic in nature.