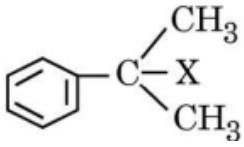
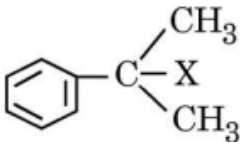
Section A

1. **(c)** 

Explanation:



2. **(c)** A

Explanation:

A

3. **(d)** $2CH_3$ - I

Explanation:

$2CH_3$ - I

4. **(b)** C_6H_5CHO

Explanation:

C_6H_5CHO

5. **(c)** Concentration of reactants keep on changing

Explanation:

Rate of reaction is dependent on the concentration of reactants if the concentration of reactants change then the rate of reaction become non-uniform.

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

Explanation:

(a) - (ii), (b) - (iv), (c) - (i), (d) - (iii).

7. **(b)** $CH_2 = \underset{\underset{Br}{|}}{C} - CH_3$

Explanation:

$CH_2 = \underset{\underset{Br}{|}}{C} - CH_3$ belongs to vinyl halides

8.

(d) $3d^5$

Explanation:

The greater the number of the unpaired electrons, the higher will be its value of the magnetic moment. Since $3d^5$ has 5 unpaired electrons hence highest magnetic moment as compared to others.

$\mu = \sqrt{5(5+2)}$

$= \sqrt{35}$

= 5.95 BM

9.

(c) 2

Explanation:

As initial concentration has increased half-life is decreasing so the order of the reaction is 2.

for second-order reaction, $rate \propto \frac{1}{[R]}$

10.

(d) 1, 1 dichloroethane

Explanation:

$CH_3CHCl_2 + OH^- \rightarrow CH_3CH(OH)_2 \rightarrow CH_3CHO + H_2O$

Gem diols like ($CH_3CH(OH)_2$) are generally not stable. The 2 -OH group attached to the same C removes H_2O and forms carbonyl compounds.

11.

(b) $(CH_3)_2CH\text{-}OH + CH_3\text{-}I$

Explanation:

$(CH_3)_2CH\text{-}OH + CH_3\text{-}I$

12.

(b) Ethanolic NaCN

Explanation:

KCN is used to increase the number of carbon atoms.

$RX + NaCN \rightarrow RCN + KX$

$R - CN + 4H \xrightarrow{H_2/Raney\ Ni} RCH_2NH_2$

13.

(d) A is false but R is true.

Explanation:

A is false but R is true.

14.

(c) A is true but R is false.

Explanation:

The boiling points of carbonyl compounds are higher than corresponding alkanes due to dipole-dipole attraction between polar carbonyl groups.

15.

(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).

16. **(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.

Section B

17. isotonic solutions will have same osmotic pressure .Solutions having same concentrations will have same osmotic pressure. So,

$M_{sucrose} = M_{unknown}$

$\frac{3}{342} \times \frac{1000}{100} = \frac{3}{x} \times \frac{1000}{10}$

$x = \frac{3 \times 342}{4}$

$= 256.5\, g\, mol^{-1}$

OR

i. Phenol - Partially soluble in water

ii. Toluene - Insoluble in water

iii. Formic acid - Soluble in water

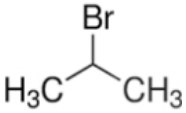
iv. Ethylene glycol - Soluble in water

v. $CHCl_3$ - Insoluble in water

vi. Pentanol - Partially soluble in water

18. Compound

a. (A) = CH_3-CH=CH_2,

(B) = 

b. (A) = $CH_3 - \underset{\underset{OH}{|}}{CH} - CH_3$, (B) = $CH_3 - \underset{\underset{Cl}{|}}{CH} - CH_3$, (B) = $CH_3 - \underset{\underset{CH_3-CH-CH_3}{|}}{CH} - CH_3$

19. a. At + 3 oxidation state, Stable d^0 is obtained

b. Absence of unpaired electron / no d-d transition occurs

c. MnO has Mn in +2 Oxidation State

Mn_2O_7 has Mn in +7 Oxidation State. Higher the Oxidation State, Higher is the acidic character.

20. Answer the following:

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

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

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

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

(ii) Half-life of a reaction is the time in which the concentration of a reactant is reduced to half of its original value.

21. On heating with NaOH+ I_2 or [NaOI], propan-2-one being a methyl ketone forms yellow ppt of iodoform, whereas pentan-3-one does not.

$CH_3 - \overset{O}{\overset{\|}{C}} - CH_3 + 3NaOI \rightarrow CH_3CO\overset{-}{O}Na^{+} + \underset{\text{(yellow ppt)}}{CHI_3} \downarrow + 2NaOH$

$CH_3CH_2 - \overset{O}{\overset{\|}{C}} - CH_2CH_3 \xrightarrow{NaOI}$ No yellow ppt of iodoform

Section C

22. Adding the two half reactions, e.m.f. comes out to positive.

emf = $E_{cathode}$ - E_{anode}

emf = 1.82 - 1.23 = +0.59

This means that Co (III) in aqueous solution has the tendency to change to Co (II). Hence, Co (III) is not stable in aqueous solution.

23. i. First order reaction

ii. Rate constat (k) of reaction

iii. The unit of rate constant is time^{-1}

24. i. Toluene to benzyl alcohol

a. Chlorine, sunlight

b. aq KOH, heat

ii. Benzene to 4-bromonitrobenzene

a. Bromine, ferric bromide,

b. Conc. HNO_3 + conc. H_2SO_4

iii. Benzyl alcohol to 2-phenylethanoic acid

a. Thionyl chloride

b. alc KCN (c) H^+/water

OR

The addition of borane followed by oxidation is known as the hydroboration-oxidation reaction.

For example, propan-1-ol is produced by the hydroboration-oxidation reaction of propene. In this reaction, propene reacts with diborane $(BH_3)^2$ to form trialkyl borane as an addition product. This addition product is oxidized to alcohol by hydrogen peroxide in the presence of aqueous sodium hydroxide.

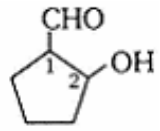
25. i. $\propto -$ methoxypropionaldehyde

$$CH_3 - \overset{\overset{CH_3}{|}}{\underset{|}{\overset{O}{|}}}{C}\ H - CHO$$

ii. 3-Hydroxylbutanol

$$\underset{4}{CH_3} - \underset{3}{\overset{\overset{OH}{|}}{C}H} - \underset{2}{CH_2} - \underset{1}{\overset{\overset{O}{||}}{C}} - H$$

iii. 2-Hydroxycylopentane carbaldehyde



iv. 4-Oxopentanal

$$\underset{5}{CH_3} - \underset{4}{\overset{\overset{O}{||}}{C}} - \underset{3}{CH_2}\,\underset{2}{CH_2} - \underset{1}{\overset{\overset{O}{||}}{C}} - H$$

v. Di-Sec, butyl ketone

$$CH_3 - CH_2 - \overset{\overset{CH_3}{|}}{CH} - \overset{\overset{O}{||}}{C} - \overset{\overset{CH_3}{|}}{CH} - CH_2 - CH_3$$

26. i. Cell 'B' will act as an electrolytic cell because the electrode potential of 'B' is less than that of 'A'. Electrode process in the cell 'B' may be given as

$Zn^{2+} + 2e^- \longrightarrow Zn(s)$ (at Cathode)

$Cu(s) \longrightarrow Cu^{2+} + 2e^-$ (at Anode)

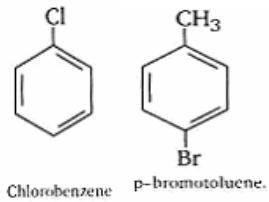
ii. Cell 'B' at higher potential will act as the galvanic cell. The electrode process may be given as,

At anode: $Zn(s) \longrightarrow Zn^{2+} + 2e^-$

At Cathode $Cu^{2+} + 2e^- \longrightarrow Cu(s)$

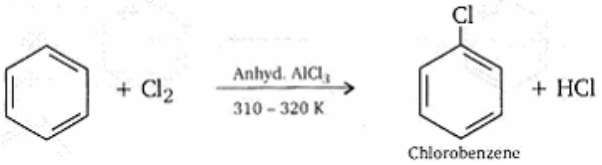
27. **Haloarenes:** The replacement of hydrogen atoms in a aromatic hydrocarbon by halogen atoms results in the formation of aryl halide (haloarene). Haloarenes contain halogen atoms attached to sp^2 hybridized carbon atoms of an aryl group. They are classified as:

i. **Nuclear halogen derivatives:** Halogen derivatives of aromatic hydrocarbons in which the halogen atom (F, Cl, Br, or I) is directly attached to an aromatic ring are called nuclear halogen derivatives. Some examples are:



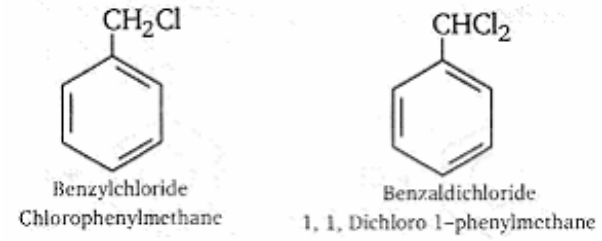
Chlorobenzene p-bromotoluene.

It is prepared by the direct chlorination of aromatic hydrocarbon.



Chlorobenzene

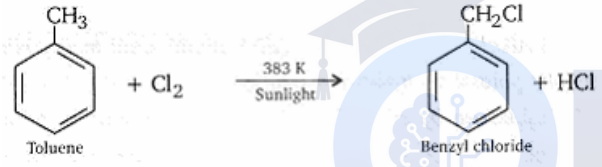
ii. **Side chain halogen derivatives:** Halogen derivatives of aromatic hydrocarbons in which the halogen atom is linked to one of the carbon atoms of the side chain carrying the aryl group are called side chain halogen derivatives. For example,



Benzylchloride
Chlorophenylmethane

Benzaldichloride
1, 1, Dichloro 1-phenylmethane

Preparation: By the direct halogenation of a suitable arenes.



Toluene

Benzyl chloride

28. a. $Zn(s) + 2Ag^{+}(aq) \longrightarrow Zn^{2+}(aq) + 2Ag(s)$

The number of moles of electrons transferred (n) is 2, as two moles of electrons are involved in the reduction of two moles of $Ag^{\wedge}$ + ions.

Now, you are given ΔG° = -300 $\frac{kJ}{mol}$, but you need to convert it to joules (J) by multiplying by 1000 (since 1 kJ = 1000 J):

ΔG° = -300 $\frac{kJ}{mol}$ $\times 1000\ \frac{J}{kJ}$ = -300,000 $\frac{J}{mol}$

$\Delta G^{\circ} = -nFE^{\circ}$

Now, plug in the values into the equation and solve for E^{o}:

-300,000 $\frac{J}{mol}$ = -(2 mol $\times$ 96500 $\frac{C}{mol}$) $\times$ E^{o}

Given the cell reaction:

Let's calculate E^{o}:

$E^{o} = \frac{-300{,}000\frac{J}{mol}}{-(2\ mol \times 96500\frac{C}{mol})} \approx 3.11\ V$

So, the standard cell potential E^{o} for the given cell reaction is approximately 3.11 V.

b. $MgCl_2 \longrightarrow Mg^{2+} + 2Cl^{-}$

$\Lambda_m^0(MgCl_2) = \lambda_m^0(Mg^{2+}) + 2\lambda_m^0(Cl^{-})$

$\Lambda_m^0(MgCl_2)$ = 106S $\cdot \frac{cm^2}{mol}$ + 2 $\times$ 76.3S $\cdot \frac{cm^2}{mol}$ = 258.6S $\cdot \frac{cm^2}{mol}$

The limiting molar conductivity of $MgCl_2$ is 258.6 S $\cdot \frac{cm^2}{mol}$

Section D

29. a. Due to their ability to show multiple oxidation states and to form complexes / provide large surface area.

b. Due topoor shielding effect of 4f orbital.

c. The overall decrease in atomic and ionic radii from La to Lu is known as lanthanoid contraction. Atomic radii of second and third transition series are very similar.

OR

c. Cr^{2+} is stronger reducing agent than Fe^{2+}

Reason: $d^4 \rightarrow d^3$ occurs in case of Cr^{2+} to Cr^{3+}

But $d^6 \rightarrow d^5$ occurs in case of Fe^{2+} to Fe^{3+}

In a medium (like water) d^3 is more stable as compared to d^5

30. i. We know, $x = \frac{i-1}{n-1}$

Where, n = 5 and x = 0.6 ($\because$ 60% = $\frac{60}{100}$ = 0.6 ionized)

So, $0.6 = \frac{i-1}{5-1}$

$0.6 \times 4 = i - 1$

$2.4 = i - 1$

$2.4 + 1 = i$

$i = 3.4$

ii. Benzoic molecules exist as a dimer.

iii. $i = 1\frac{-\alpha}{2}$

OR

The properties of solutions that depend on the ratio of the number of solute particles to the number of solvent molecules in a solution and not on the nature of the chemical species is termed as colligative properties.

Section E

31. Attempt any five of the following:

(i) Polysaccharides are not sweet in taste & hence are called non-sugars.

(ii) Hydrogen bonding

(iii) In the helical structure of DNA, the two strands are held together by hydrogen bonds between specific pairs of bases. Cytosine forms hydrogen bond with guanine, while adenine forms hydrogen bond with thymine. As a result, the two strands are complementary to each other.

(iv) Starch

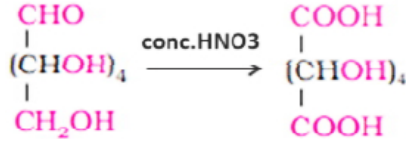
(v) a. **Primary structure:** Each polypeptide in a protein molecule having amino acids which are linked with each other in a specific sequence.

b. **Denaturation:** When a protein is subjected to physical change like change in temperature or chemical change like change in pH, protein loses its biological activity.

(vi) An anomeric carbon can be identified as the carbonyl carbon (of the aldehyde or ketone functional group) in the open-chain form of the sugar. It can also be identified as the carbon bonded to the ring oxygen and a hydroxyl group in the cyclic form.

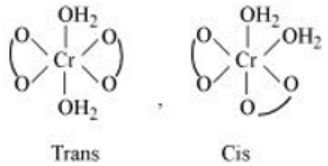
(vii)

a. 

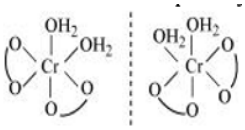
b. 

32. i. Both geometrical (cis-, trans-) isomers for k $[Cr(H_2O)_2(C_2O_4)_2]$ can exist. Also, optical isomers for cis-isomer exist.

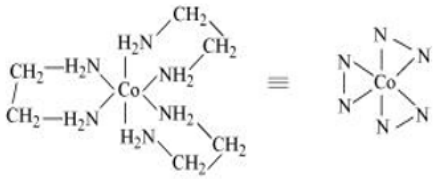
Geometrical isomers



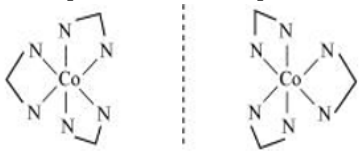
Trans-isomer is optically inactive. On the other hand, cis-isomer is optically active.



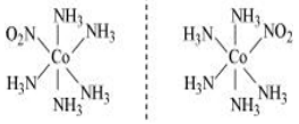
ii. Two optical isomers for $[Co(en)_3]Cl_3$ exist.



Two optical isomers are possible for this structure.

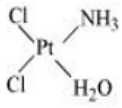


iii. $[CO(NH_3)_5\,(NO_2)]\,(NO_3)_2$ $[Co(NH_3)_5\,(NO_2)\,(NO_3)_2]$ A pair of optical isomers:

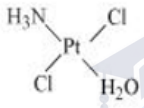


It can also show linkage isomerism. $[Co(NH_3)_5\,(NO_2)\,(NO_3)_2]$ and $[CO(NH_3)_5\,(ONO)]\,(NO_3)_2$ It can also show ionization isomerism. $[Co(NH_3)_5\,(NO_2)\,(NO_3)_2]$ $[CO(NH_3)_5\,(NO_3)]\,(NO_3)\,(NO_2)$

iv. Geometrical (cis-, trans-) isomers of $[Pt\,(NH_3)\,(H_2O)\,Cl_2$ can exist.



Cis



Trans

OR

a. i. $t_{2g}^4 e_g^0$

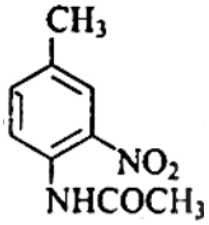
ii. sp^3d^2

iii. optical isomerism

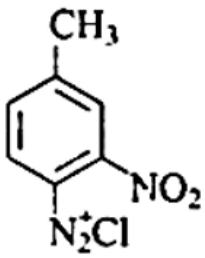
b. i. $[Co(NH_3)_4(H_2O)_2]CI$

ii. $[Pt\,Br_2(en)_2](NO_3)_2$

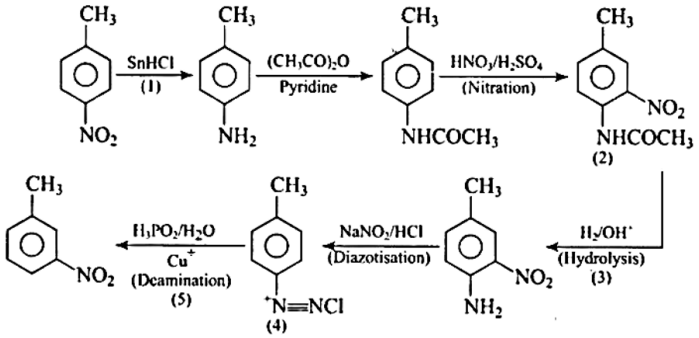
33. 1. Sn/HCl or Fe / HCl, H_2/Pd

2. 

3. OH^-/H^+

4. 

5. H_3PO_2/H_2O

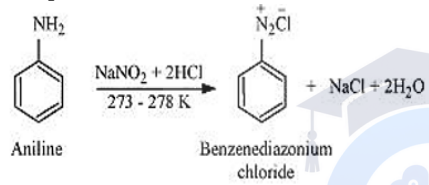


OR

i. **Carbylamine reaction:** Carbylamine reaction is used as a test for the identification of primary amines. When aliphatic and aromatic primary amines are heated with chloroform and ethanolic potassium hydroxide, carbylamines (or isocyanides) are formed. These carbylamines have very unpleasant odours. Secondary and tertiary amines do not respond to this test. For example,

$$\underset{Methanamine}{CH_3-NH_2} + CHCl_3 + 3KOH(alc.) \xrightarrow{\Delta} \underset{Methyl\ carbylamine}{CH_3-NC} + 3KCl + 3H_2O$$

ii. **Diazotisation:** Aromatic primary amines react with nitrous acid (prepared in situ from $NaNO_2$ and HCl) at 273 - 278 K to form diazonium salts. This conversion of aromatic primary amines into diazonium salts is known as diazotization. For example,

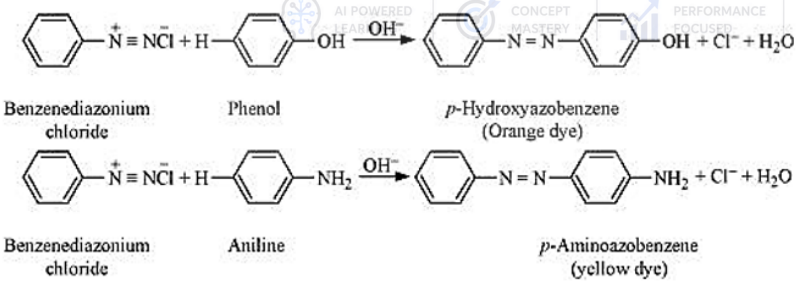


iii. **Hoffmann bromamide reaction:** When an amide is treated with bromine in an aqueous or ethanolic solution of sodium hydroxide, a primary amine with one carbon atom less than the original amide is produced. This degradation reaction is known as Hoffmann bromamide reaction. This reaction involves the migration of an alkyl or aryl group from the carbonyl carbon atom of the amide to the nitrogen atom. For example,

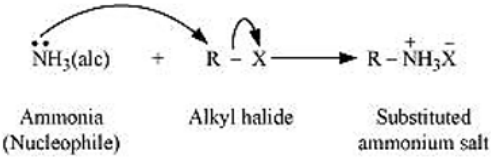
$$\underset{Ethanamide}{CH_3-\overset{O}{\overset{\|}{C}}-NH_2} + Br_2 + 4NaOH \rightarrow \underset{Methanamine}{CH_3-NH_2} + Na_2CO_3 + 2NaBr + 2H_2O$$

$$\underset{Benzamide}{C_6H_5-\overset{O}{\overset{\|}{C}}-NH_2} + Br_2 + 4NaOH \rightarrow \underset{Aniline}{C_6H_5-NH_2} + Na_2CO_3 + 2NaBr + 2H_2O$$

iv. **Coupling reaction:** The reaction of joining two aromatic rings through the - N = N - bond is known as coupling reaction. Benzene diazonium salt reacts with phenol or aromatic amines to form coloured azo compounds.



v. **Ammonolysis:** When an alkyl or benzyl halide is allowed to react with an ethanolic solution of ammonia, it undergoes nucleophilic substitution reaction in which the halogen atom is replaced by an amino $(-NH_2)$ (-NH_2) group. This process of cleavage of the carbon-halogen bond is known as ammonolysis.



When this substituted ammonium salt is treated with a strong base such as sodium hydroxide, amine is obtained.

$$R-\overset{+}{N}H_3\overset{-}{X} + NaOH \rightarrow \underset{Amine}{R-NH_2} + H_2O + NaX$$

Though primary amine is produced as the major product, this process produces a mixture of primary, secondary and tertiary

amines, and also a quaternary ammonium salt as shown.

$$\underset{(1^\circ)}{RNH_2} \xrightarrow{RX} \underset{(2^\circ)}{R_2NH} \xrightarrow{RX} \underset{(3^\circ)}{R_3N} \xrightarrow{RX} \underset{Quaternary\ ammonium\ salt}{R_4\overset{+}{N}\,\overset{-}{X}}$$