

Section A

1.

(c) Wurtz - Fittig reaction

Explanation:

Wurtz - Fittig reaction
2.

(d) Acid catalysed hydrolysis of ethyl acetate

Explanation:

In acid catalysed the hydrolysis of ethyl acetate the water is in excess so it is pseudo 1st order reaction, as the does not change.
3.

(a) 2 – pentanamine

Explanation:

2-pentanamine will have a chiral centre, therefore it can be resolved into enantiomers.

$$\text{CH}_3\text{CH}_2\text{CH}_2\text{C}^*\text{HCH}_3\text{NH}_2$$

The C* in 2-pentan amine is the chiral center.
4.

(d) (a), (b), (c)

Explanation:

Asymmetric/chiral carbon atom is that in which all of its four valencies with four different groups or atoms (can not be superimpose). In molecules (i), (ii), and (ii), all have asymmetric carbon as each carbon has satisfied all four valencies with four different groups of atoms.
5.

(d) All of these

Explanation:

The addition of water to an alkene in the presence of a catalytic amount of strong acid leads to the formation of alcohols (hydroxy-alkanes).

$$\text{CH}_2 = \text{CH}_2 + \text{H}_2\text{O} \xrightarrow{\text{H}^+} \text{CH}_3\text{CH}_2\text{OH}$$

This reaction proceeds via a standard carbocation mechanism and follows the Markovnikov rule.

The mechanism for the addition of water to ethene follows.

 1. The hydrogen ion is attracted to the π bond, which breaks to form a σ bond with one of the double-bonded carbons. The second carbon of the original double-bonded carbons becomes a carbocation.
$$\begin{array}{c} \text{CH}_2 = \text{CH}_2 + \text{H}^+ \longrightarrow \text{CH}_3\text{CH}_2^+ \\ \text{ethene} \end{array}$$
 2. An acid-base reaction occurs between the water molecule and the carbocation, forming an oxonium ion.
$$\begin{array}{c} \text{CH}_3\text{CH}_2^+ + \text{H}-\ddot{\text{O}}-\text{H} \longrightarrow \text{CH}_3\text{CH}_2\text{OH}_2^+ \\ \text{water} \qquad \qquad \text{oxonium ion} \end{array}$$
 3. The oxonium ion stabilizes by losing a hydrogen ion, with the resulting formation of an alcohol.
$$\begin{array}{c} \text{CH}_3\text{CH}_2\text{OH}_2^+ \longrightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{H}^+ \\ \text{oxonium ion} \qquad \qquad \text{ethanol} \end{array}$$

6.

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

Explanation:

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

7. (a) 1

Explanation:

A chiral molecule is one that is not superimposable on its mirror image.

2-Butanol is a small molecule with a chirality center. It is the simplest alcohol containing an asymmetric carbon. For a better illustration, the four different substituents are shown in different colours.

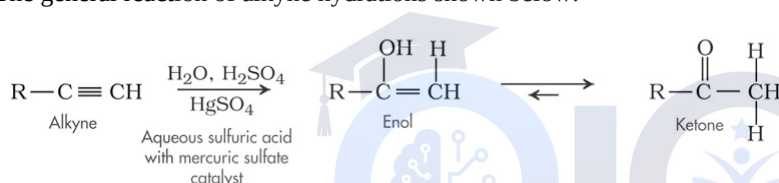
Carbon atom C-2 of 2-butanol carries four different substituents H, CH₃, OH, and CH₂CH₃. Exchange of any two of these substituents would yield the opposite enantiomer. However, such an exchange does not occur spontaneously because it requires a bond breakage. Therefore, enantiomers are different, stable, coexisting compounds.

8.

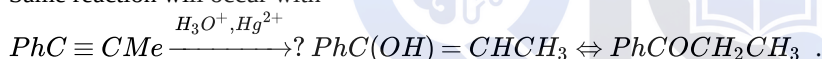
(c) PhCOCH₂CH₃**Explanation:**

Hydration of given alkyne will occur according to Markovnikoff's rule leading to the formation of enol which will tautomerise to give keto form.

The general reaction of alkyne hydrations shown below:



Same reaction will occur with



9.

(b) Mn₂O₇**Explanation:**

10.

(c) amylopectin

Explanation:

Starch is a polymer of α-glucose and consists of two components - Amylose and Amylopectin. Amylose is water-soluble component which constitutes about 15-20% of starch. Amylopectin is insoluble in water and constitutes about 80-85% of starch. Thus, Amylopectin is the major component of starch.

11.

(c) C₄H₈O₂**Explanation:**Its molecular formula is C₄H₈O₂ and its chemical formula is CH₃COOC₂H₅.

12.

(b) In photography

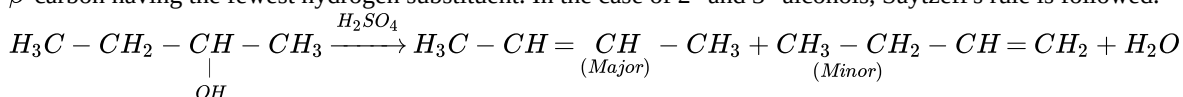
Explanation:

Photography is an example of photochemistry used in our daily life. Reaction takes place in the presence of light

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

Explanation:

Saytzeff's rule: The alkene formed in the greatest amount is the one that corresponds to the removal of the hydrogen from the β -carbon having the fewest hydrogen substituent. In the case of 2° and 3° alcohols, Saytzeff's rule is followed.



14.

- (c) A is true but R is false.

Explanation:

For the same alkyl group, the boiling point of haloalkanes decreases in the order $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$. This is due to the increase in van der Waals forces when the size and mass of the halogen atom increases. For isomeric haloalkanes, the boiling point decrease with an increase in branching.

15.

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

Explanation:

Enamel is the hardest substance in the human body and contains the highest percentage of minerals, with water and organic material composing the rest. The primary mineral is hydroxyapatite, which is crystalline calcium phosphate. Magnesium is not present in human enamel. However, magnesium is an essential mineral for human health. Magnesium is a cofactor for more than 300 enzyme systems and is involved in both aerobic and anaerobic energy generation and in glycolysis, either directly as an enzyme activator or as part of the magnesium-ATP complex. Magnesium is required for mitochondria to carry out oxidative phosphorylation. It plays a role in regulating potassium fluxes and in the metabolism of calcium.

16.

- (d) Both A and R are false.

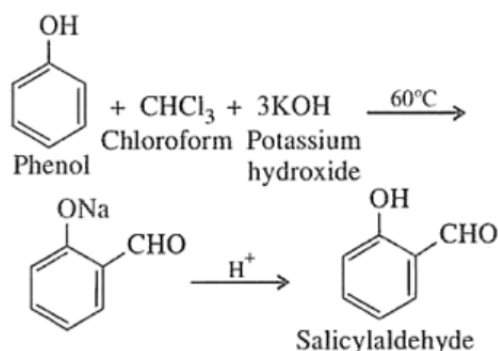
Explanation:

α -hydroxy aldehydes having a methyl or methylene group in the α -position or more correctly having at least one hydrogen atom in the α -position undergo dimerisation in presence of a base at low temperature to form β -hydroxy aldehydes called aldols.

Section B

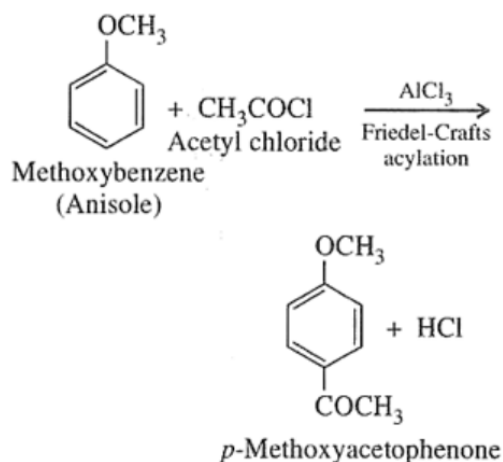
17. Homoleptic complexes are those in which only one type of ligand or donor group is present e.g. $[\text{Pt}(\text{NH}_3)_6]^{3+}$ has only NH_3 as ligand. Whereas heteroleptic complexes are those in which different types of ligands are present e.g. $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]^+$ has two types of ligands- NH_3 and Cl^- .

18. i.



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ii.



19. Answer the following:

- (i) The slope value obtained in the plot of $\frac{\log[R_o]}{[R_o]}$ Vs. time for a first-order reaction is $\frac{k}{2.303}$.
- (ii) It is first order with respect to N₂O₅.

20. a. Fe has higher melting point than Cu. This is because Fe (3d⁶4s²) has four unpaired electrons in 3d-subshell while Cu (3d¹⁰4s¹) has only one electron in the 4s-subshell. Hence, metallic bonds in Fe are much stronger than those in Cu.
- b. Co²⁺ has a configuration as [Ar]3d⁷, thus, Co²⁺ has 3 unpaired electron in d orbital while Ni²⁺ has a configuration as [Ar]3d⁸, Ni²⁺ has 2 unpaired electron. Thus, Ni²⁺ has lower magnetic moment than Co²⁺.
21. In pure alcohol and water, the molecules are held tightly by a strong hydrogen bonding. The interaction between the molecules of alcohol and water is weaker than alcohol-alcohol and water-water interactions. As a result, when alcohol and water are mixed, the inter-molecular interactions become weaker and the molecules can easily escape. This increases the vapour pressure of the solution, which in turn lowers the boiling point of the resulting solution.

22. The various quantities known to us are as follows:

$$p_1^0 = 0.850 \text{ bar}; p = 0.845 \text{ bar}; M_1 = 78 \text{ g mol}^{-1}; w_2 = 0.5 \text{ g}; w_1 = 39 \text{ g}$$

Substituting these values in equation of relative lowering of vapour pressure, we get

$$\frac{0.850 \text{ bar} - 0.845 \text{ bar}}{0.850 \text{ bar}} = \frac{0.5 \text{ g} \times 78 \text{ g mol}^{-1}}{M_2 \times 39 \text{ g}}$$

Therefore, M₂ = 170 g mol⁻¹

Section C

23. i. $R_{av} = -\frac{\Delta[Ester]}{\Delta t} = -\frac{(0.17-0.31)}{60-30}$

$$= 4.67 \times 10^{-3} \text{ s}^{-1}$$

ii. At t = 30 s, [R] = 0.31 M, [R]₀ = 0.55 M

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]} = \frac{2.303}{30} \log \left(\frac{0.55}{0.31} \right)$$

$$k = \frac{2.303}{30} \log(1.774) = \frac{2.303}{30} \times 0.2490$$

$$k = 1.91 \times 10^{-2} \text{ s}^{-1}$$

At t = 60 s, [R] = 0.17 M

$$k = \frac{2.303}{60} \log \left(\frac{0.55}{0.17} \right) = \frac{2.303}{60} \times 0.5099$$

$$= 1.96 \times 10^{-2} \text{ s}^{-1}$$

At t = 90 s, [R] = 0.085 M

$$k = \frac{2.303}{90} \log \left(\frac{0.55}{0.085} \right) = \frac{2.303}{90} \times (0.8109)$$

$$k = 2.07 \times 10^{-2} \text{ s}^{-1}$$

24. i. **Oxidation half cell reaction;** Ni(s) → Ni²⁺(aq) + 2e⁻ (At anode)

Reduction half cell reaction; 2Ag⁺(aq) + 2e⁻ → 2Ag(s) (At cathode)

Overall cell reaction; Ni(s) + 2Ag⁺(aq) → Ni²⁺(aq) + 2Ag(s); Therefore, $E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ} = +0.80 \text{ V} - (-0.25 \text{ V}) = 1.05 \text{ V}$

ii. By applying Nernst equation, we have;

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{0.0591}{2} \log \frac{[\text{Ni}^{2+}]}{[\text{Ag}^{+}]^2}$$

$$= E^{\circ}_{\text{cell}} - \frac{0.0591}{2} \log \frac{(0.1)}{(1)^2}$$

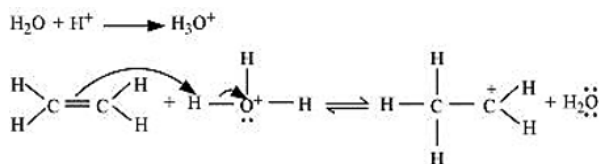
$$= 1.05 - \frac{0.0591}{2} \times (-1)$$

$$= 1.05 + 0.0295 = 1.0795 \text{ V.}$$

25. The mechanism of hydration of ethene to form ethanol involves three steps.

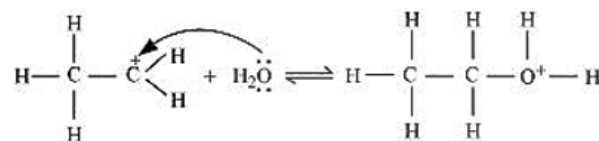
Step 1:

Protonation of ethene to form carbocation by electrophilic attack of H_3O^+ :



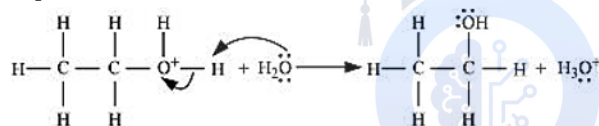
Step 2:

Nucleophilic attack of water on carbocation:



Step 3:

Deprotonation to form ethanol:



OR

i. 2-Chloropropane to 1-propanol

- alc. KOH heat,
- HBr peroxide
- alc. KOH, heat

ii. Isopropyl alcohol to iodoform

I_2/NaOH heat

iii. Chlorobenzene to p-nitrophenol

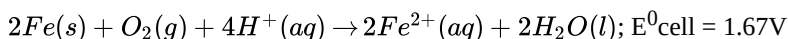
- Conc. HNO_3 + conc. H_2SO_4
- aq NaOH (15%), 433 K (c) dil. HCl

26. **At anode:** $2\text{Fe}(s) \rightarrow 2\text{Fe}^{2+} + 4e^-$

$$E^{\circ}(\text{Fe}^{2+}/\text{Fe}) = -0.44 \text{ V}$$

Cathode: $\text{O}_2(g) + 4\text{H}^+(aq) + 4e^- \rightarrow 2\text{H}_2\text{O}(l)$; $E^{\circ}_{\text{cell}}(\text{H}^+\text{O}_2/\text{H}_2\text{O}) = 1.23\text{V}$

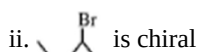
The overall reaction being:

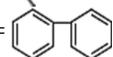


The ferrous ions are further oxidized by atmosphere oxygen to ferric ions which came out as rust in the form of hydrated ferric oxide ($\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$)

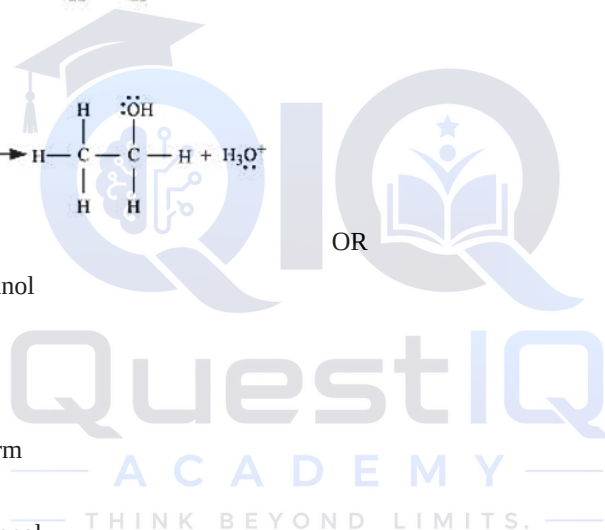
The method to prevent rusting of iron is by Barrier protection.

27. i. $(\text{CH}_3)_3\text{C} - \text{C}(\text{CH}_3) = \text{CHCH}_3$

ii.  is chiral

iii. A = 

B = $\text{C}_6\text{H}_5\text{MgBr}$



AI POWERED
LEARNING



CONCEPT
MASTERY



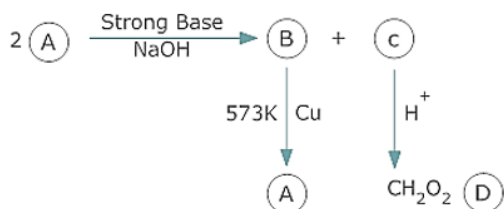
PERFORMANCE
FOCUSED



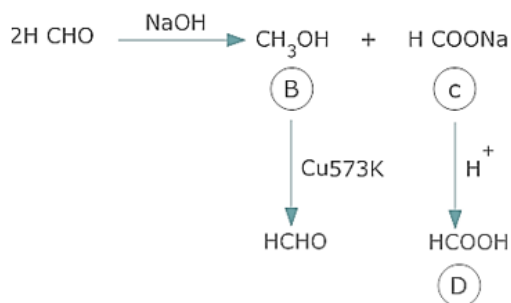
EXCELLENCE
DRIVEN

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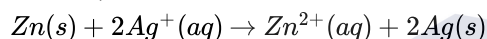
28.



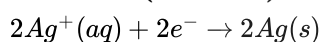
Since (D) is a carboxylic acid with one carbon only, it is HCOOH. As it is obtained from (C) acidification, (C) COONa and (A) is HCHO which on treatment with strong base (NaOH) gives CH₃OH & HCOONa. This is Cannizzaro reaction in which formaldehyde undergoes self oxidation and reduction (disproportion) on treatment with concentrated alkali. The reactions are as follows:-



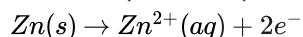
29. We have,



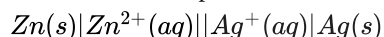
At Cathode (Reduction):



At Anode (Oxidation):



The cell will be represented as:



- i. From half cell reaction, Zinc acts as Anode, i.e. zinc electrode will be negatively charged.
- ii. The current will flow from silver to zinc in the external circuit and inside the solution, ions are responsible as shown in the half cell reaction. Zn²⁺ is formed in the anode container and goes to the cathode container, Ag⁺ goes from solution to the silver metal (cathode) and gets deposited. To maintain the concentration of ions in both the containers, salt bridge is used which contains an electrolyte i.e. KCl.
- iii. At anode: $\text{Zn}(s) \rightarrow \text{Zn}^{2+}(aq) + 2e^-$
At cathode: $\text{Ag}^+(aq) + e^- \rightarrow \text{Ag}(s)$

30. Read the text carefully and answer the questions:

Vapour pressure of a liquid or a solution is the pressure exerted by the vapour in equilibrium with the liquid or solution at a particular temperature. It depends upon the nature of the liquid and temperature. The non-volatile solute in solution reduces the escaping tendency of the solvent molecules in the vapour phase because some of the solute particles occupy the positions of the solvent molecules on the liquid surface. The relative lowering of the vapour pressure of a solution containing a non-volatile solute is equal to the mole fraction of the solute in the solution. This is also known as Raoult's law. However, for solutions of volatile solutes, the vapour pressure of a component in a solution at a given temperature is equal to the mole fraction of that component in the solution multiplied by the vapour pressure of that pure component. The solutions in which each component obeys Raoult's law is called an ideal solution. For ideal solutions ΔH_{mixing} and ΔV_{mixing} are also zero. Practically no solution is ideal. A non-ideal solution is that solution in which solute and solvent molecules interact with one another with a different force than the forces of interaction between the molecules of the pure components. There are two types of non-ideal solutions, showing positive deviations and negative deviations from ideal behaviour. If for the two components A and B, the forces of interaction between A and B molecules are less than the A-A and B-B interactions, the non-ideal solutions have positive deviations. On the other hand, if the forces of interaction between A and B molecules are more than the A-A and B-B interactions, the non-ideal solutions have negative deviations.

(i) $P_A = x_A \times P_A^\circ$

$32 = x_A \times 40$

$$x_A = \frac{32}{40}$$

$$x_A = 0.8$$

(ii) For pure octane, $x = 0$

$$\therefore p(\text{sol.})(\text{mm Hg}) = P(\text{octane}) = 35 + 65 \times 0 = 35 \text{ mm of Hg}$$

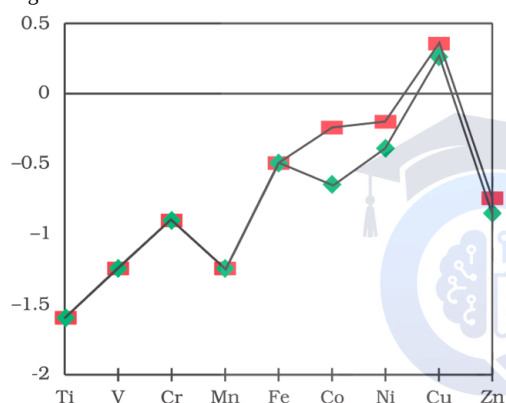
(iii) The value of ΔV_{mixing} and ΔH_{mixing} is negative.

OR

It is an example of Non-ideal solution.

31. Read the text carefully and answer the questions:

The unique behaviour of Cu, having a positive E° accounts for its inability to liberate H_2 from acids. Only oxidising acids (nitric and hot concentrated sulphuric) react with Cu, the acids being reduced. The stability of the half-filled d sub-shell in Mn^{2+} and the completely filled d^{10} configuration in Zn^{2+} are related to their E° values, whereas E° for Ni is related to the highest negative $\Delta_{\text{hyd}}H^\circ$. An examination of the $E^\circ_{(M^{3+}/M^{2+})}$ values the low value for Sc reflects the stability of Sc^{3+} which has a noble gas configuration. The comparatively high value for Mn shows that $\text{Mn}^{2+}(d^5)$ is particularly stable, whereas a comparatively low value for Fe shows the extra stability of $\text{Fe}^{3+}(d^5)$. The comparatively low value for V is related to the stability of V^{2+} (half-filled t_{2g} level).



(i) Due to the removal of an electron from the stable d^{10} configuration of Zn^{2+} .

OR

Transition metals despite having high E° oxidation, are poor reducing agents because of their high heat of vaporization, high ionisation energies and low heats of hydration.

(ii) Cr^{2+} is reducing as its configuration changes from d_4 to d_3 , the having a half-filled t_{2g} level. On the other hand, the change from Mn^{3+} to Mn^{2+} results in the half-filled (d_5) configuration which has extra stability.

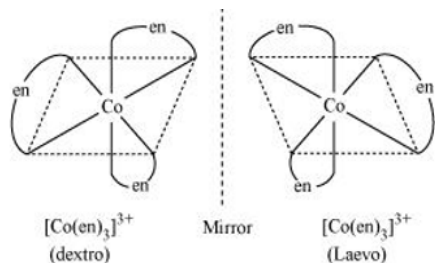
(iii) The Stability of Cu^{2+} is more than Cu^+ as stability depends on the hydration energy of the ions when they bond to the water molecules. The Cu^{2+} ion has a greater charge density than Cu^+ ion and thus forms much stronger bonds releasing more energy.

Section E

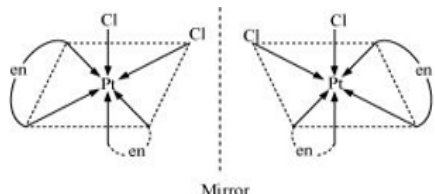
32. Attempt any five of the following:

- A starch has two components: amylose and amylopectin. Amylose is water soluble.
- Primary structure of proteins tells about the sequence in which various amino acids are linked with each other.
- Deficiency of A cause Xerophthalmia and E causes muscular weakness.
- Glucose and Fructose
- Lactose is present in milk as sugar. Two monosaccharide units (i.e., glucose and galactose) are present in it. Such oligosaccharides are called disaccharides.
- Glycosidic linkage:** It is the linkage which joins two monosaccharides through oxygen atom. It is present in carbohydrates.
Peptide Linkage: It is the linkage which joins two amino acids through - CO-NH- bond. It is present in proteins.
- Monosaccharide - Glucose, Fructose etc.
Disaccharide - Sucrose, maltose etc.
Polysaccharide - Cellulose, starch etc.

33. i. $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$



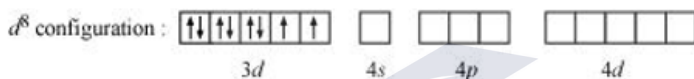
ii. $[\text{PtCl}_2(\text{en})_2]^{2+}$



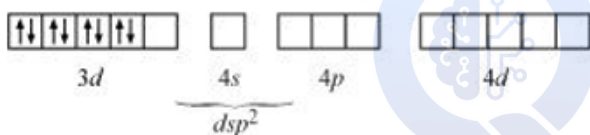
iii. $[\text{Cr}(\text{NH}_3)_2\text{Cl}_2(\text{en})]^+$

OR

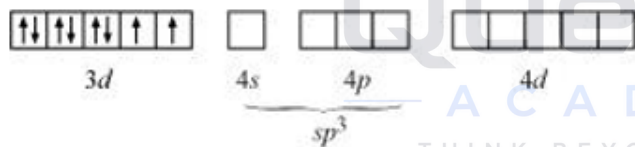
Ni is in the +2 oxidation state i.e., in d^8 configuration.



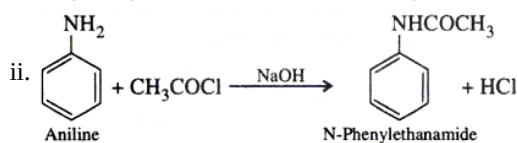
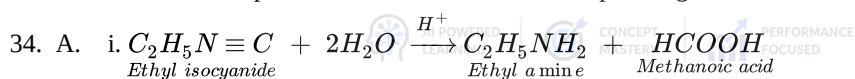
There are 4 CN^- ions. Thus, it can either have a tetrahedral geometry or square planar geometry. Since CN^- ion is a strong field ligand, it causes the pairing of unpaired 3d electrons.



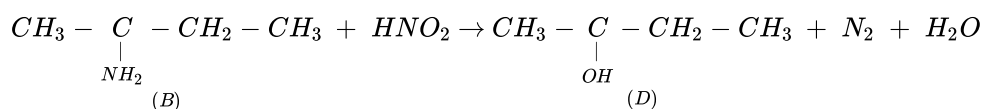
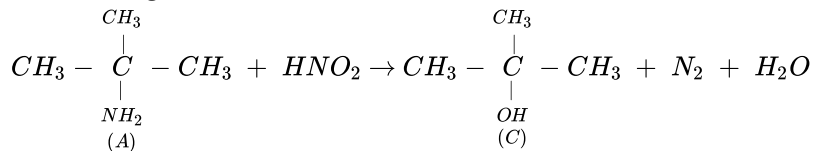
It now undergoes dsp^2 hybridization. Since all electrons are paired, it is diamagnetic. In case of $[\text{NiCl}_4]^{2-}$, CN^- ion is a weak field ligand. Therefore, it does not lead to the pairing of unpaired 3d electrons. Therefore, it undergoes sp^3 hybridization.

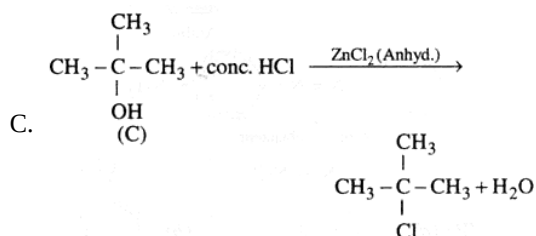


Since there are 2 unpaired electrons in this case, it is paramagnetic in nature.

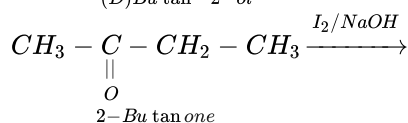
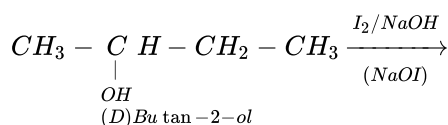
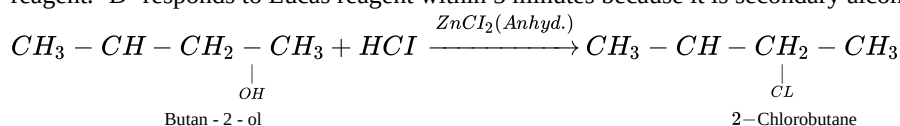


B. The following reactions lead to the identification of A and B:



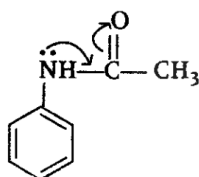


'C' is resistant to oxidation because tertiary alcohols do not undergo oxidation. It gives turbidity immediately with Lucas reagent. 'D' responds to Lucas reagent within 5 minutes because it is secondary alcohol and turbidity appears after 5 minutes.

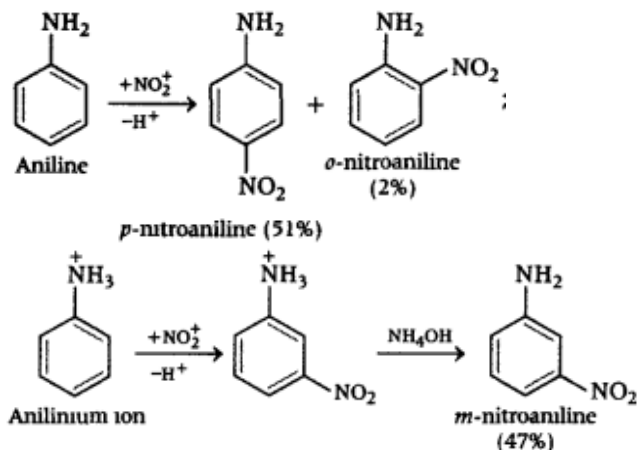


OR

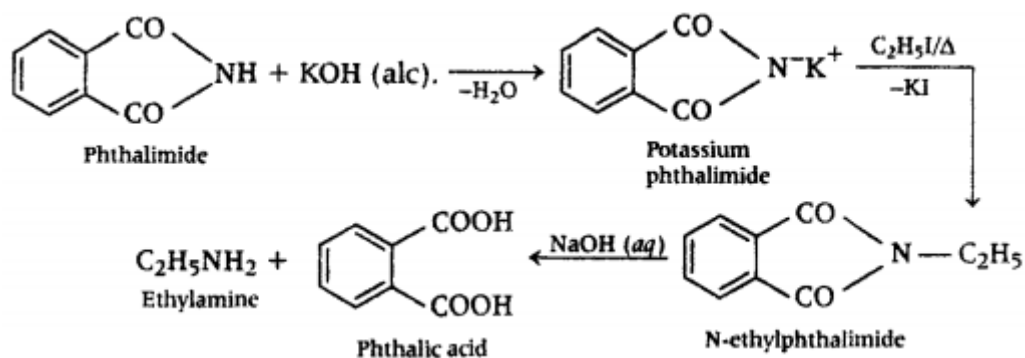
- a. i. Due to the electron-withdrawing effect of the acetyl group, the lone pair of electrons on N-atom is attracted by the acetyl group. As a result, the lone pair of electrons on N-atom is not exclusively available for donation to the benzene ring and hence, activating the effect of the -NH₂ group is reduced.



- ii. In aromatic amines, the lone pair of electrons present on nitrogen takes part in resonance and hence, not available for donation. Also aniline is more stable than anilinium ion. Hence aniline has a very little tendency to accept a proton to form anilinium ion. However, in aliphatic amines, the lone pair is easily available for donation. That's why aliphatic amines are more basic than aromatic amines.
- iii. Nitration is usually carried out with a mixture of conc. HNO₃ and conc. H₂SO₄. So in the presence of these acids, aniline gets protonated to form anilinium ion. Therefore, the reaction mixture consists of aniline + and anilinium ion. -NH₂ group in aniline is o,p-directing and activating, whereas the ⁺NH₃ group in anilinium ion is m-directing and deactivating. Now, nitration of aniline mainly gives p-nitroaniline due to steric hindrance at a-position and the nitration of anilinium ion gives m-nitroaniline.



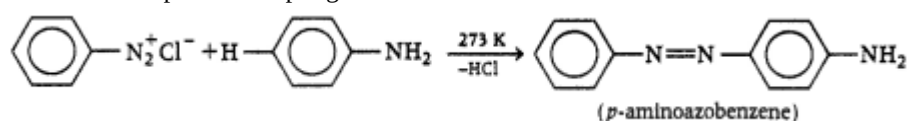
- b. i. Gabriel phthalimide reaction Phthalimide on treatment with ethanolic KOH gives potassium phthalimide which on heating with a suitable alkyl halide gives N-substituted phthalimide, which upon subsequent hydrolysis with alkali gives primary amines.



This reaction is called Gabriel phthalimide reaction.

- ii. Coupling reaction Arenediazonium salts react with highly reactive (i.e. electron-rich) aromatic compounds such as aniline, phenols to form brightly coloured azo compounds, Ar-N=N-Ar. This reaction is called a coupling reaction. e.g. Benzene diazonium chloride reacts with aniline in faintly acidic medium (pH 4-5) at 273-278K, in which the molecule at its para-position is coupled with the diazonium salt to form p-aminoazobenzene.

This is an example of a coupling reaction.



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