Section A

1. **(b)** $CH_3CH_2-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-OH$

Explanation:
Alkyl halides can be obtained by treating alcohol with haloacids. The reactivity of tertiary alcohols with the haloacids is the highest and primary alcohols are the lowest. Formation of alkyl chloride using primary and secondary alcohols requires the usage of a catalyst $ZnCl_2$, where dry hydrogen chloride gas is passed through a solution of alcohol or by heating a mixture of alcohol and concentrated aqueous halogen acid. Reaction with tertiary alcohols does not require a catalyst and can be carried out by using tertiary alcohols. the reaction is conducted by simply shaking with concentrated HCl at room temperature.

2. **(d)** preparing the uterus for implantation of fertilised egg.

Explanation:
The combination of ovum and sperm forms the fertilized egg which further gets implanted in the uterus. This is brought about by the hormone progesterone which prepares uterus for this process.

3. **(a)** both as nucleophiles and electrophiles.
Explanation:
Alcohols as nucleophile: The bond between O−H is broken when alcohol react as nucleophiles.
Alcohols as electrophile : The bond between C−O is broken when alcohol reacts as electrophiles

4. **(a)** Wolff – Kishner reduction
Explanation:
This is Wolff Kishner reduction of Carbonyls to alkanes. Wolff kishner reaction uses hydrazine (NH_2-NH_2) and conc base like NaOH or KOH for reduction of carbonyl to alkanes.

5. **(d)** Order with respect to $A_{(g)}$ - Second
Order with respect to $B_{(g)}$ - Zero

Explanation:
Order with respect to $A_{(g)}$ - Second
Order with respect to $B_{(g)}$ - Zero

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

7. **(b)** NaCl and NaClO
Explanation:
Chlorine reacts with cold and dilute NaOH to produce a mixture of sodium chloride (NaCl) and sodium hypochloride (NaOCl).
$2NaOH + Cl_2 \rightarrow NaCl + NaOCl + H_2O$

8.

(d) Cr

Explanation:

Oxygen combines with chromium to create a protective film of chromium oxide (Cr_2O_3) on the surface.

9.

(d) reduces to one-fourth

Explanation:

For a zero order reaction, reduce to one-fourth

10.

(b) I_2 and NaOH

Explanation:

I_2 and NaOH

11.

(d) Salicylic acid

Explanation:

Salicylic acid

12.

(c) The mixture of o, p, and m nitroaniline:

Explanation:

Mixture of ortho, meta, and para nitroaniline is formed because of the formation of anilinium ion which is formed by direct nitration of aniline.

13.

(d) A is false but R is true.

Explanation:

The primary structure of a protein gives only the nature of linkages of α-amino acids in a protein chain.

14.

(d) If both Assertion and Reason are false statements.

Explanation:

In an electrophilic substitution reaction, the nitro group strongly deactivates the benzene ring. Nitrobenzene does not undergo Friedel Craft acylation reaction.

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. Given, W_1 = 600 g, K_f = 1.86 K kg mol^{-1}

W_2 = 45 g, M_2 = 62.0 g mol^{-1}

T_f^o (water) = 273 k

i. $\Delta T_f = \frac{K_f \times W_2 \times 1000}{M_2 \times W_1}$

$= \frac{1.86 K kg mol^{-1} \times 45g \times 1000}{62 g mol^{-1} \times 600g}$

ΔT_f = 2.25 K

ii. $\Delta T_f = T_f^o - T_f$

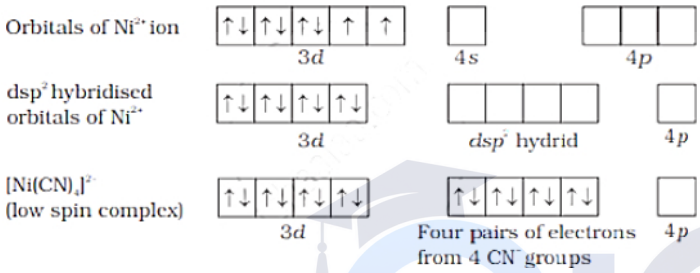
T_f = 273 K - 2.25 K = 270.75 K

OR

1 M KCl solution dissociates in solution to give K^+ and Cl^- ions. $KCl \rightarrow K^+ + Cl^-$ Therefore its osmotic pressure (which depends on number of solute particles) is higher than that of 1 M solutions of urea which does not dissociate or associate in solution.

18. a. If $\Delta_0 > P$, it becomes more energetically favourable for the fourth electron to occupy a t_{2g} orbital with electronic configuration $t_{2g}^5 e_g^0$. Ligands which produce this effect are known as strong field ligands and form low-spin complexes.

b. In $[Ni(CN)_4]^{2-}$, nickel is in a + 2 oxidation state and the ion has the electronic configuration $3d^8$. The hybridisation scheme is shown in the diagram.



Whereas in $[Ni(CO)_4]$, Ni has + 2 oxidation state and shows sp^2 hybridisation due to which its geometry is tetrahedral hence diamagnetic.

19. **Preparation of $KMnO_4$** It is prepared by the fusion of pyrolusite ore (MnO_2) with an alkali metal hydroxide and an oxidising agent like KNO_3. Dark green K_2MnO_4 is obtained which on disproportionation in neutral or acidic solution gives potassium permanganate.

$$\underset{Ppyrolusite}{2MnO_2} + 4KOH + O_2 \rightarrow \underset{\substack{Potassium\ manganate \\ (Green\ mass)}}{2K_2MnO_4} + 2H_2O$$

$$3K_2MnO_4 + 4HCl \rightarrow \underset{\substack{Potassium \\ permanganate}}{2KMnO_4} + MnO_2 + 2H_2O + 4KCl$$

Reaction between acidified $KMnO_4$ and oxalic acid: Oxalate ions or oxalic acid is oxidised.

$$5Cr_2O_4^{2-} + 2MnO_4^- + 16H^+ \longrightarrow 2Mn^{2+} + 8H_2O + 10CO_2$$

20. Answer the following:

(i) For zero order reaction, the rate of reaction does not decrease with time because it does not depend on concentration of reactants.

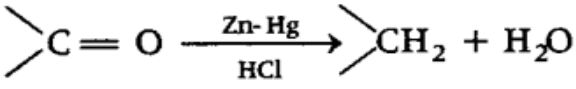
(ii) An elementary reaction is a chemical reaction in which one or more chemical species react directly to form a product.

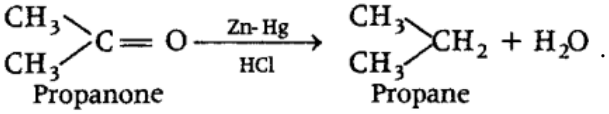
Rate = $k[A][B]^{3/2}$

Order = $1 + \frac{3}{2} = \frac{5}{2}$

The order of elementary reaction cannot be fractional.

21. **Clemmensen reduction:** The carbonyl group of aldehydes and ketones is reduced to $-CH_2$ group on treatment with zinc-amalgam and concentrated hydrochloric acid. This reaction is known as Clemmensen reduction.



e.g. 

Propanone Propane

Section C

22. For the button cell, chemical reactions are:

At anode:

$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$

At Cathode:

$Ag_2O(s) + H_2O(l) + 2e^- \rightarrow 2Ag(s) + 2OH^-(aq)$

Complete reaction is:

$Zn\,(s) + Ag_2O\,(s) + H_2O\,(l) \rightarrow Zn^{2+}\,(aq) + 2Ag\,(s) + 20H^-\,(aq)$, for this reaction, n=2 moles of electrons.

Now,

$E^{\Theta}_{cell} = E^{\Theta}_{Ag^+/Ag} - E^{\Theta}_{Zn^{2+}/Zn}$

= 0.80 - (-0.76) = 1.56V

We know that

$\Delta_r G^{\Theta} = -nFE^{\Theta}_{cell}$

Here, n = 2

F = 96500 C mol^{-1}

$\Delta G^{\Theta} = -2 \times 1.56\ V \times 96000\ C\ mol^{-1}$

= -301080 J mol^{-1}

= -301.08 kJ mol^{-1}

$\therefore \Delta G^{\Theta} = -308.08\ kJ\ mol^{-1}$

23. i. For a reaction, $H_2 + Cl_2 \xrightarrow{hv} 2HCl$

Rate= k, suggests that the reaction is of zero order. Further, the molecularity of a given reaction is 2 as two molecules are participating in the reaction.

Hence, order = zero and molecularity = two.

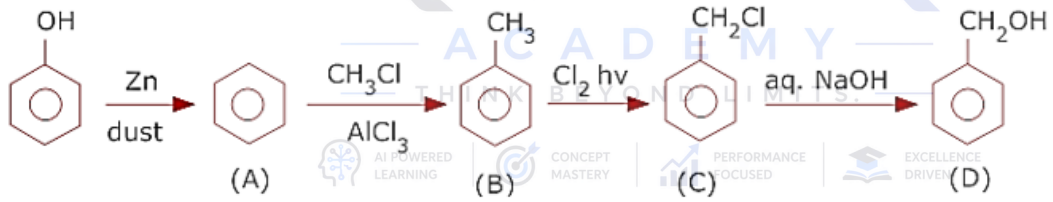
ii. The unit of k for zero order reaction is equal to the rate of a reaction which is mol $L^{-1}s^{-1}$.

Hence, the unit of k for the given reaction is mol $L^{-1}s^{-1}$.

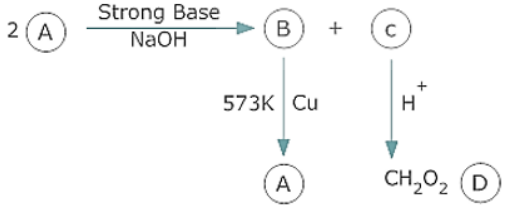
24. The nitro-group is an electron-withdrawing group. The presence of this group in the ortho position decreases the electron density in the O-H bond. As a result, it is easier to lose a proton. Also, the o-nitrophenoxide ion formed after the loss of protons is stabilized by resonance. Hence, ortho nitrophenol is a stronger acid.

On the other hand, methoxy group is an electron-releasing group. Thus, it increases the electron density in the O-H bond and hence, the proton cannot be given out easily. For this reason, ortho-nitrophenol is more acidic than ortho-methoxyphenol.

OR

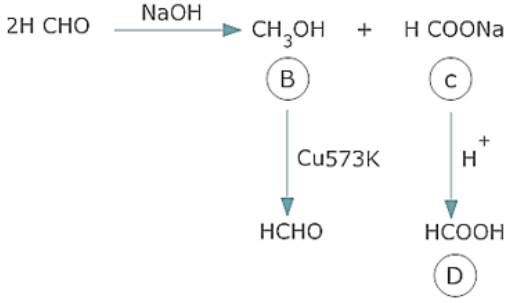


25.



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 CH_3OH & HCOONa. This is Cannizzaro reaction in which formaldehyde undergoes self oxidation and reduction(disproportion) on treatment with concentrated alkali. The reactions are as

follows:-



26. $E_{cell} = E^0_{cell} - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[H^+]^2}$

E^0_{cell} = 0.0 - (-0.76) = 0.76 V

$= 0.76 - \frac{0.059}{2}\log\frac{[0.001]}{[0.01]^2}$

= 0.76 - 0.0295 × 1

= 0.7305 V

27. i. But - 1 - ene to 1 - iodobutane

$CH_3CH_2CH = CH2 \xrightarrow{HBr/\text{ peroxide}}$

$CH3CH_2CH_2CH_2 - Br \xrightarrow{NaI/\text{ acetone}} CH_3CH_2CH_2CH_2 - I$

ii. Benzene to acetophenone

iii. $C_6H_6 \xrightarrow[AlCl_3]{CH_3COCl} C_6H_5COCH_3$

iv. Ethanol to propanenitrile

$CH_3CH_2OH \xrightarrow{PCl_5} CH_3CH_2Cl \xrightarrow{KCN} CH_3CH_2CN$

28. given that Quantity of electricity passed $= 5A \times 20 \times 60s$

= 6000 C time = 20 min

$Ni^{2+} + 2e^- \rightarrow Ni$

Thus, 2 F, i.e. $2 \times 96500\,C$ deposit Ni = 1 mole i.e. 58.7 g

(at mass of Ni = 58.7)

Thus 2 F i.e. $2 \times 96500\,C$ deposit Ni = 1 mole

6000 C will deposit Ni

$= \frac{58.7}{2\times96500} \times 6000g$ = 1.825 g

Section D

29. i. This is because of relatively poor shielding by 5f electrons in actinoids in comparison with shielding of 4f electrons in lanthanoids.

ii. Actinoids have irregularities in the electronic configuration because of almost equal energy of 5f, 6d and 7s orbitals. Therefore, there are some irregularities in the filling of 5f, 6d, and 7s orbitals. The electron may enter either of these orbitals.

iii. The structural variability in actinoids is obtained due to irregularities in metallic radii which are far greater than in lanthanoids.

OR

Magnetic properties of actinoid complexes are borne by 5f open shell orbitals. These orbitals have a marked inner shell character, as in lanthanides, but interact more with the chemical environment than the 4f of lanthanides, leading to unique magnetic properties.

30. i. Carbondioxide is a gas which provide fizz and tangy flavour. He can dissolve Carbondioxide gas in the drink.

ii. Henry's law which states that solubility of a gas in liquid is directly proportional to partial pressure of the gas.

iii. Bottles should be sealed under high pressure of CO_2 and capping should be done perfectly to avoid leakage of CO_2 as any loss of partial pressure will result into decrease in solubility.

OR

$p_{He} = K_{Hx} \times X_{He}$

= (144.97 × 10^3 bar) (1.2 × 10^{-6})

= 0.174 bar

Section E

31. Attempt any five of the following:

(i) a. n-hexane is formed

$$\overset{CHO}{\underset{CH_2OH}{(CHOH)_4}} \xrightarrow{HI\ ,\ \triangle} CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$$

b. Saccharic acid is formed

$$\overset{CHO}{\underset{CH_2OH}{(CHOH)_4}} \xrightarrow{Oxidation} \overset{COOH}{\underset{COOH}{(CHOH)_4}}$$

(ii) Water soluble - Vitamin B / C

Fat soluble - A, D, E, K (Any one)

(iii) a. $\overset{CHO}{\underset{CH_2OH}{(CHOH)_4}} \xrightarrow{NH_2OH} \overset{CH=N-OH}{\underset{CH_2OH}{(CHOH)_4}}$

b. $\overset{CHO}{\underset{CH_2OH}{(CHOH)_4}} \xrightarrow{Br_2\ water} \overset{COOH}{\underset{CH_2OH}{(CHOH)_4}}$

(iv) i. Adenine, Guanine

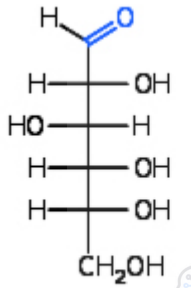
ii. 1. Vitamin D

2. Vitamin B_{12}

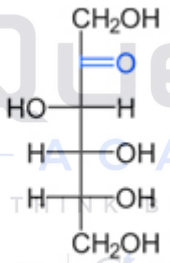
(v) Glucose has aldehydic group. Glucose is called as aldose

Fructose has ketonic group. Fructose is called as ketose.

Structures:



Glucose



Fructose

(vi) $\overset{CHO}{\underset{CH_2OH}{(CHOH)_4}} \xrightarrow{\text{Acetic anhydride}} \overset{CHO}{\underset{CH_2-O-C-CH_3}{(CH-O-C-CH_3)_4}}$

It confirms the presence of -OH groups/five -OH groups.

(vii) When a protein is subjected to a change in temperature or chemical change then it loses its biological activity.

2^o and 3^o structures are destroyed but 1^o structure remains intact.

32. i. The equilibrium is:

$$Ag^+ + 2NH_3 [Ag(NH_3)_2]^+$$

$\therefore$ Stability constant,

$$K_f = \frac{[Ag(NH_3)_2]^+}{[Ag^+][NH_3]^2}$$

$= 1.7 \times 10^7$ (Given)

or $\frac{[Ag(NH_3)_2]^+}{[Ag^+]}$

$= 1.7 \times 10^7 \times [NH_3]^2$

$= 1.7 \times 10^7 \times (0.1)^2$

$= 1.7 \times 10^5$

ii. The equilibrium is

$Ag^+ + 2S_2O_3^{2-} \overset{k_f}{\rightleftharpoons} [Ag(S_2O_3)_2]^{3-}$

$\therefore$ Stability constant,

$\therefore \quad \frac{[Ag(S_2O_3)_2]^{3-}}{[Ag^+]} = 1.0 \times 10^{13} \times [S_2O_3^{2-}]^2 = 1.0 \times 10^{13}(0.1)^2 = 1 \times 10^{11}$

$\therefore \frac{[Ag(S_2O_3)_2]^{3-}}{[Ag^+]} = 1.0 \times 10^{13} \times [S_2O_3^{2-}]^2 = 1.0 \times 10^{13}(0.1)^2 = 1 \times 10^{11}$

OR

a. The formula of Tetraammineaquachloridocobalt(III) chloride is $[Co(NH_3)_4\ (H_2O)Cl)\ Cl_2$.

b. The formula of Potassium tetrahydroxidozincate(II) is $K_2\ [Zn(OH)_4]$.

c. The formula of potassium trioxalatoaluminate(III) is $K_3\ [Al(C_2O_4)_3]$.

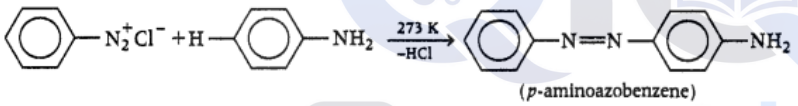
d. The formula of Dichloridobis(ethane-1, 2-diamine)cobalt(III) is $[CoCl_2\ (en)^2]^+$.

e. The formula of Tetracarbonylnickel(0) is $[Ni(CO)_4]$.

33. i. Hofmann bromamide degradation reaction It is a method for the preparation of primary amines by treating an amide with bromine in an aqueous or ethanolic solution of sodium hydroxide. The amines so formed contain one carbon less than that present in the parent amide.

ii. Gattermann reaction When benzene diazonium chloride is treated with Cu/HCl Cu/HBr, chlorobenzene or bromobenzene is obtained. This reaction is known as Gattermann reaction

iii. Coupllng 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 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 coupling reaction.

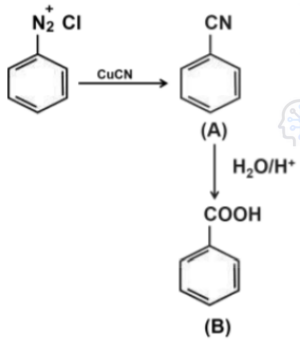


(*p*-aminoazobenzene)

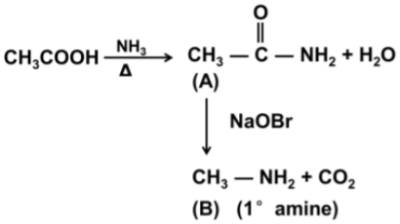
OR

i. The structure of A and B on following reaction is:

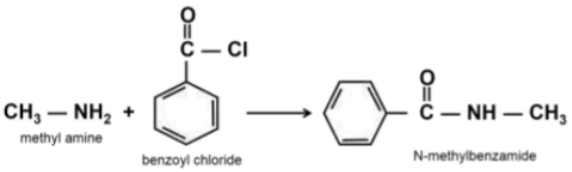
a.



b.



ii. The chemical reaction of methyl amine with benzoyl chloride and IUPAC name of the product form is as follows:



iii. Increasing order of pK_b values

$(C_2H_5)_2\ddot{N}H < C_2H_5NH_2 < \ddot{N}H_3 < C_6H_5\ddot{N}H_2$