Section A

1. **(a)** 3, 4, 4 - trimethylpent - 2 - ene

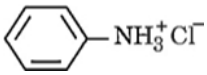
   Explanation:

   The longest chain contains a double bond and five carbon i.e pent-2-ene and 2 methyl is attached to the 4th carbon and one is attached to 3rd carbon. Therefore IUPAC name is 3, 4, 4 - trimethylpent - 2 - ene.

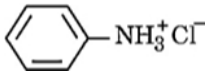
2. **(b)** Starch

   Explanation:

   Starch is a polymer of D-glucose units, thus on hydrolysis it only gives glucose.

3. **(b)** 

   Explanation:

4. **(a)** Aldehydes with no α- hydroge

   Explanation:

   Aldehydes with no α-hydrogen undergo Canizzaro reaction.

5. **(b)** four times

   Explanation:

   four times

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

   Explanation:

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

7. **(a)** $\mu = 0$

   Explanation:

   CCl_4 is a symmetrical molecule. Hence, the dipole moment is zero.

8. **(c)** harder

   Explanation:

   A number of interstitial compounds are formed by the transition metals. Transition metals react with elements such as hydrogen, carbon, nitrogen, boron etc. to form interstitial compounds. As vacant spaces of the transition metals are filled up by small atoms, these compounds are hard and rigid.

9. **(c)** $\frac{d[NH_3]}{dt} = -\frac{2}{3}\frac{d[H_2]}{dt}$

   Explanation:

   For the given reaction,

   $rate = -\frac{1}{2}\frac{d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = \frac{1}{2}\frac{d[NH_3]}{dt}$

10.

(d) Tollen's reagent

Explanation:

Tollen's Test is used to distinguish between aldehyde and ketone. It uses the fact that aldehydes are easily oxidised to their corresponding acids while ketones are not.

Tollen's reagent is aqueous ammonical silver nitrate solution which reacts with aldehydes as shown.

$RCHO + 2Ag^+ + 2OH^- \rightarrow RCOO^- + Ag + H_2O$.

$RCOR + 2Ag^+ + 2OH \rightarrow$ No reaction

If this test is carried in a glass tube, the Ag formed forms a mirror on the sides of the test tube so the test is also known as the silver mirror test.

Aldehydes show Tollen's test while acetone which is a ketone does not give Tollen's test.

11. **(a)** ethers

Explanation:

The Williamson ether synthesis is an organic reaction, forming an ether from an organohalide and deprotonated alcohol (alkoxide). This reaction was developed by Alexander Williamson in 1850. Typically it involves the reaction of an alkoxide ion with a primary alkyl halide via an S_N2 reaction.

12. **(b)** LiA/H_4

Explanation:

LiA/H_4

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

Explanation:

Isobutanal does not give an iodoform test because it does not have the $-COCH_3$ group.

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

Explanation:

Halogens are ortho-para directing due to (+M) or (+R) effect. Moreover, they are deactivating due to high electronegativity.

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. $\triangle T_f$ = molality $\times$ K_f

Since $\triangle T_f$ is same for both solutions,

i.e. $\triangle T_{f_1} - \Delta T_{f_2}$ (given)

$molality_{(urea)} \times K_f = molality_{(x)} \times K_f$

$\frac{\frac{7}{60}\times1000}{100} = \frac{\frac{42}{M_{w(x)}}\times1000}{100}$

$M_w = \frac{42\times60}{7}$ = 360 gm

Hence, molar mass of Z = 360gm.

OR

At a given pressure the solubility of oxygen in water increases with a decrease in temperature. Therefore, the concentration of oxygen in the sea is more in cold water and thus the presence of more oxygen at a lower temperature makes the aquatic species more comfortable in cold water.

18. **Spectrochemical series:** The arrangements of ligands in order of their increasing field strength, i.e. increasing crystal field splitting energy (CFSE) value is called spectrochemical series.
Crystal field splitting energy is the basis of formation of the spectrochemical series.
19. Transition metals can act as catalysts because these can change their oxidation state. The reaction between iodide and persulphate ions catalyzes by Fe is as follows:

$2I^- + S_2O_8^{2-} \xrightarrow{Fe(III)} I_2 + 2SO_4^{2-}$

Role of Fe(III) ions:

$2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$

$2Fe^{2+} + S_2O_8^{2-} \longrightarrow 2Fe^{3+} + 2SO_4^{2-}$

20. Answer the following:

(i) a. Rate = $k[X]^p$

27 Rate = $k[3X]^p$

$\therefore 27 = 3^p$

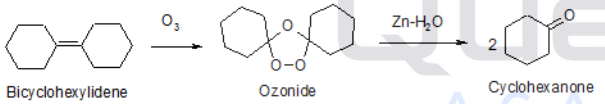
$(3)^3 = 3^p$

p = 3 Third order

b. When one of the reactants is in excess.

Example: Hydrolysis of ester/ sucrose

(ii) Elementary reactions have the same value of order and molecularity because the elementary reaction proceeds in a single step.

21. 

Section C

22. Zn is oxidized and Ag_2O is reduced (as Ag^+ ions change to Ag)

$E^0_{cell} = E^0[Ag_2O/Ag](red) + E^0[Zn/Zn^{2+}](ox)$

= 0.344 + 0.76

= 1.104 V

$\Delta_r G^0 = -nFE^0cell = -2 \times 96500 \times 1.104J$

$= -2.13 \times 10^5 J$

23. It is given that a reaction is first order in A and second order in B.

a. The differential rate equation will be

$-\frac{d[R]}{dt} = k[A][B]^2$

b. If the concentration of B is increased three times, then

$-\frac{d[R]}{dt} = k[A][3B]^2 = 9.k[A][B]^2$

Therefore, the rate of reaction will increase 9 times.

c. When the concentrations of both A and B are doubled,

$-\frac{d[R]}{dt} = k[A][B]^2 = k[2A][2B]^2 = 8.k[A][B]^2$

Therefore, the rate of reaction will increase 8 times.

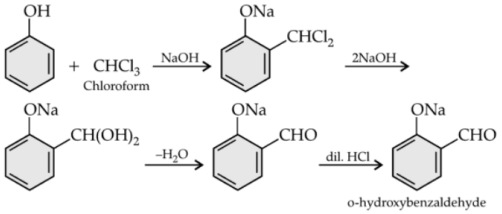
24. The compound 'B' is obtained by oxidation of $C_4H_{10}O$ and gives positive iodoform test and also reacts with CH_3MgBr,it must be methyl Ketone , it must be methyl ketone having four carbon atoms i.e, $CH_3COCH_2CH_3$ This can be obtained by oxidation of 2 –

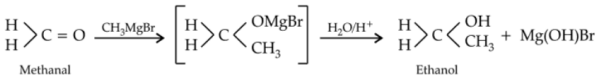
butanol i.e , $CH_3\underset{\underset{HO}{|}}{CH}\ CH_2CH_3$ Therefore , the reactions are.

$$H_3C-CH_2-\underset{\underset{OH}{|}}{CH}-CH_3 \xrightarrow[oxidation]{(o)} CH_3CH_2\,CH_3CH_2-\underset{\underset{O}{||}}{C}-CH_3 \xrightarrow[H_2O/H^+]{CH_3MgBr} CH_3CH_2-\underset{\underset{OH}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$$

OR

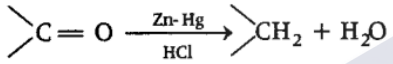
i. By Reimer-Tiemann reaction:

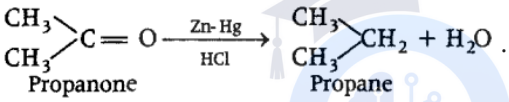


ii. Methanal to ethanol 

iii. Phenol to phenyl ethanoate.$C_6H_5OH + \underset{Acetic\ anhydride}{(CH_3CO)_2O} \rightarrow \underset{Phenylethanoate}{CH_3COOC_6H_5} + CH_3COOH$

25. i. **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.



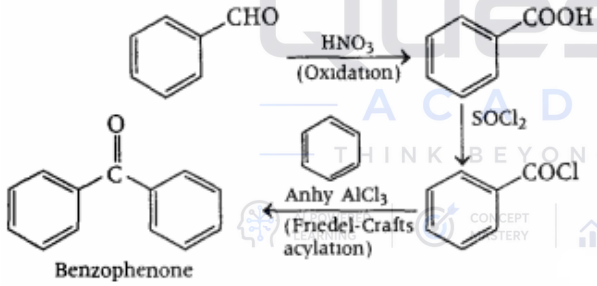
e.g. 

ii. a. **Ethanal to 3-hydroxybutanal**

$$\underset{Ethanal}{2CH_3-CHO} \underset{\text{(Aldol condensation)}}{\overset{\text{Dil. NaOH}}{\rightleftharpoons}} \overset{4}{C}H_3-\underset{\underset{OH}{|}}{\overset{3}{C}}H-\overset{2}{C}H_2-\overset{1}{C}HO$$

$3-hydroxybutanal$

b. **Benzaldehyde to benzophenone**



26. For hydrogen electrode:

$H^+ + e^- \rightarrow \frac{1}{2}H_2$

Applying Nernst equation:

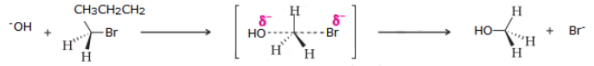
$E = E^0 - \frac{0.0591}{n}\log\frac{1}{[H^+]}$

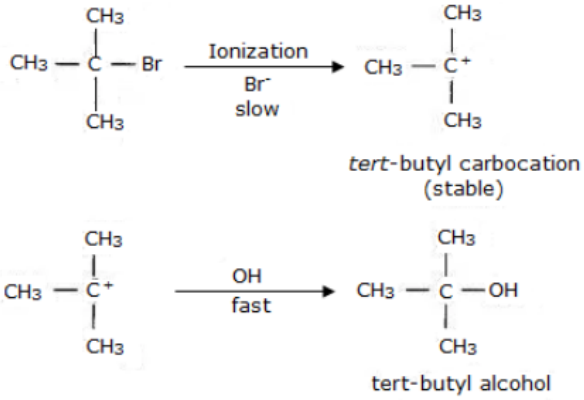
$= 0 - \frac{0.0591}{1}\log\frac{1}{10^{-10}}$ [pH = 10 means $[H^+]$

$= 10^{-10}M$

$= -0.0591 \times 10 = -0.591V$

27. Tert-butylbromide undergoes substitution by S_N1 unimolecular substitution mechanism because it is able to form a stable carbocation in the first step after cleavage of the halide group. The carbocation then reacts with the nucleophile OH^-. On the other hand, primary halide n-butylbromide cannot form a stable carbocation so it undergoes S_N2 bimolecular substitution mechanism, which is a one-step substitution that involves the attack of OH^- and simultaneous leaving of X^- to form n-butyl alcohol.





28. From the given reaction

1 mol of $Cr_2O_7^{2-}$ ions requires

$6F = 6 \times 96500\ C$

= 579000 C of electricity for reduction of Cr^{3+}.

Section D

29. a. Cu has incomplete d-orbital in +2 oxidation state whereas Zn has fully filled d-orbital in ground state as well as in +2 oxidation state.

b. Because both (n-1)d and ns subshell electrons take part in the bond formation due to their comparable energies/ due to the presence of unpaired electrons in d-orbitals.

c. i. Because of irregular values of $(\triangle_i H_1 + \triangle_i H_2)$ and sublimation enthalpies.

ii. In transition metals, oxidation states differ by +1 whereas in non-transition metals differ by +2.

OR

i. Because Cr^{2+} will be converted to Cr^{3+} which has more stable half filled t_{2g} configuration while Mn^{3+} changes to Mn^{2+} which has more stable half-filled d^5 configuration.

ii. $2MnO_4^- + H_2O + I^- \longrightarrow 2\ MnO_2 + 2\ OH^- + IO_3^-$

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 × 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) Vitamin C cannot be stored in our body because it is water soluble. As a result, it is readily excreted in the urine.

(ii) In α-helix structure of the protein, a polypeptide chain is stabilized by the formation of intramolecular H-bonding by twisting into right-handed screw with -NH- group of amino acids in one turn with the >C = O groups of amino acids belonging to adjacent turn.

(iii) Glycogen is stored in liver of animals. In the liver, glycogen can make up 5-6% of the organ's fresh weight, and the liver of an adult, weighing 1.5 kg, can store roughly 100-120 grams of glycogen.

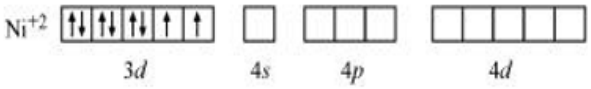
(iv) α-Amino acid, $R - \underset{NH_2}{\overset{\cdot}{C}}H - COOH$ forms a polypeptide chain in the proteins.

(v) Vitamin A

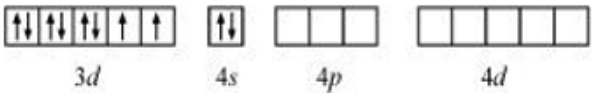
(vi) B_6 / Pyridoxine

(vii) Uracil.

32. Though both $[NICl_4]^{2-}$ and $[Ni(CO)_4]$ are tetrahedral, their magnetic characters are different. This is due to a difference in the nature of ligands. CN^- is a weak field ligand and it does not cause the pairing of unpaired 3d electrons. Hence, $[NICl_4]^{2-}$ is paramagnetic.



In $[Ni(CO)_4]$,Ni is in the zero oxidation state i.e., it has a configuration of $3d^8 4s^2$.

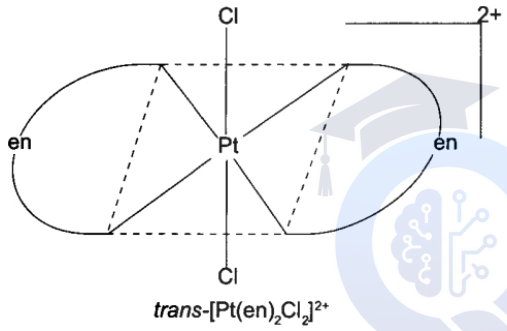


But CO is a strong field ligand. Therefore, it causes the pairing of unpaired 3d electrons. Also, it causes the 4s electrons to shift to the 3d orbital, thereby giving rise to sp^3hybridization. Since no unpaired electrons are present in this case, $[Ni(CO)_4]$ is diamagnetic.

OR

a. i. Hexaaminenickel (II) chloride
ii. Potassium hexacyanidoferrate (III)
iii. Tris(ethane-1,2-diamine)cobalt (III) ion

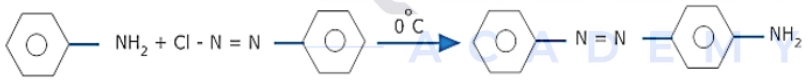
b.



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

IUPAC Name of the entity:
Dichloridobis (ethane-1,2-diamine platinum

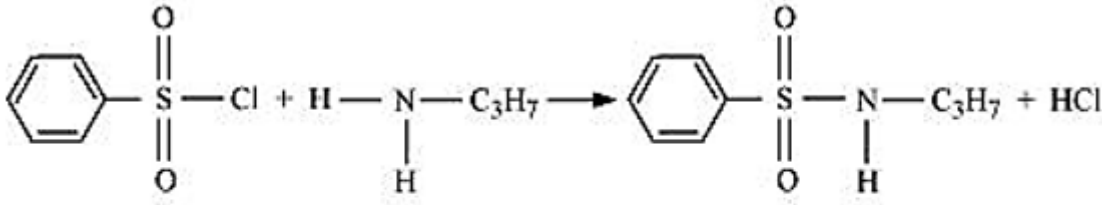
33. i. Ethylamine and aniline can be distinguished by the azo-dye test. On treating aniline with a benzene diazonium salt, orange or red coloured azo-dye is formed which is not formed with ethylamine.



Aniline azodye

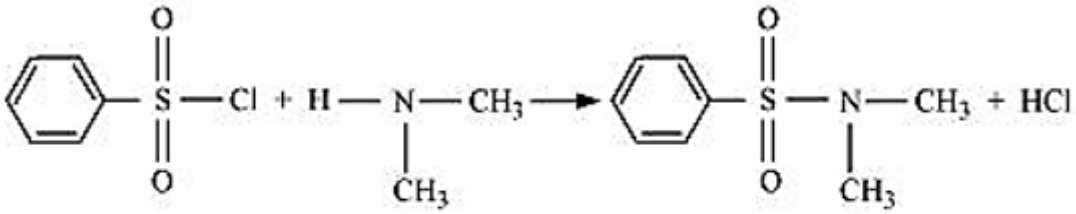
ii. Primary, secondary and tertiary amines can be identified and distinguished by Hinsberg's test. In this test, the amines are allowed to react with Hinsberg's reagent (benzene sulphonyl chloride $C_6H_5SO_2Cl$).

a. Primary amines react with benzene sulphonyl chloride to form N-alkyl benzene sulphonamide which is soluble in alkali.



Benzenesulphonyl chloride Propanamine *N*-Propylbenzenesulphonamide

b. Secondary amines react with Hinsberg's reagent to form N, N-dialkyl benzene sulphonamide which is insoluble in alkali.



Benzenesulphonyl chloride | Dimethylamine | *N*, *N*-Dimethylbenzenesulphonamide (insoluble in alkali)

c. Tertiary amines do not react with Hinsberg's reagent.

OR

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