Section A

1. **(c)** CH_2=CH-CH_2-Cl

Explanation:

The most reactive towards nucleophilic substitution reaction is CH_2=CH-CH_2-Cl

2. **(b)** Vitamin C

Explanation:

Scurvy is caused by not having enough vitamin C in your diet over a long period of time. Vitamin C is mainly found in fruit and vegetables.

3. **(c)** All of these

Explanation:

Oxidation of alcohols to aldehydes is partial oxidation; aldehydes are further oxidized to carboxylic acids. Conditions required for making aldehydes are heat and distillation.

In aldehyde formation, the temperature of the reaction should be kept above the boiling point of the aldehyde and below the boiling point of the alcohol.

These include:

- Chromium-based reagents, such as Collins reagent ($CrO_3 \cdot Py_2$)
- PDC or PCC.
- Heat in the presence of Cu at 573K.

4. **(c)** $CH_3 - CH_2 - \underset{\underset{OH}{|}}{C}H - CH_3$

Explanation:

$CH_3 - CH_2 - \underset{\underset{OH}{|}}{C}H - CH_3$

5. **(a)** $4.62 \times 10^{-2}\ min^{-1}$

Explanation:

for first order reaction

$t_{1/2} = \frac{0.693}{k}$

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

Explanation:

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

7. **(c)** shorter and stronger

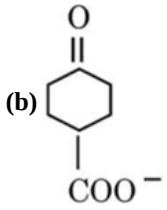
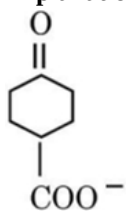
Explanation:

In chlorobenzene, the hybridization of carbon attached to Cl is sp^2, and in methyl chloride hybridization of C attached to Cl is sp^3. In sp^2 hybridization, s-character is 33% and in sp^3 s-character is 25%. The sp^2 hybridized carbon with a greater s-character is more electronegative and can hold the electron pair of C—X bond more tightly than sp^3-hybridized carbon in haloalkane with less s-character resulting in a short bond length of C-Cl bond. Since it is difficult to break a shorter bond than a longer

bond, means it is stronger. Also in chlorobenzene, the electron pairs on Cl atom are in conjugation with π-electrons of the ring, so C—Cl bond acquires a partial double bond character due to resonance which makes the bond stronger.

8. **(a)** Zn
Explanation:
Zn

9. **(b)** Increases
Explanation:
With an increase in temperature the effective molecular collisions increases, hence the rate of reaction also increases.

10. **(b)** 
Explanation:


11. **(d)** Alkene
Explanation:
Alkene

12. **(a)** Br_2/NaOH
Explanation:
$$CH_3 - \underset{\underset{C_6H_5}{|}}{C}H - CONH_2 \xrightarrow[\text{(Hofmann'sbromamide reaction)}]{Br_2/NaOH} CH_3 - \underset{\underset{C_6H_5}{|}}{C}H - NH_2 + Na_2CO_3 + 2H_2O$$
2 - Phenylpropanamide — 1 - Phenyletanamine

13. **(c)** Assertion (A) is true, but Reason (R) is false.
Explanation:
In a tetrapeptide, there are four amino acids connected by three peptide bonds

14. **(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.

15. **(d)** A is false but R is true.
Explanation:
Haloalkanes react with AgCN to form alkyl isocyanides as the main product while KCN forms alkyl cyanides as the chief product.

16. **(d)** Both A and R are false.

Explanation:

Last traces of moisture in ethanol cannot be removed by keeping it over sodium wire. Sodium reacts both with H_2O and ethanol.

Section B

17. Given,5% sugar solution means, w_B = 5g

w_A = 95g,M_B = 342g mol^{-1}

Similarly, for 5% glucose solution, w_B(glucose) = 5g

w_A = 95 g and M_B(glucose) = 180 g mol^{-1}

ΔT_f(canesugar) = 273.15K - 271K = 2.15K

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

$2.15 = \frac{K_f \times 5 \times 1000}{342 \times 95}$

$k_f = \frac{2.15 \times 342 \times 95}{5 \times 1000} = 13.9707$

similarly, for glucose

$\Delta T_f(glucose) = \frac{13.9707 \times 5 \times 1000}{180 \times 95}$

$\Delta T_f = 4.085K$

Freezing point of the solution

= 273.15K - 4.085K = 269.065 K

OR

When the new forces of attraction between components are greater than those in the pure components. That is when two components A and B are mixed, the interactions between A....B is greater than A...A and B...B interaction then the binary non-ideal solution would show negative deviation from Raoult's law.

18. i. Hydration isomerism

ii. Electronic configuration is t_{2g}^4

iii. Hybridization is sp^3d^2 and shape is octahedral.

19. a. The general electronic configuration of lanthanoids is $4f^{1\text{-}14}\ 5d^{0\text{-}1}\ 6s^2$

b. +3 and +4

c. 5f 6d 7s orbitals are of comparable energies

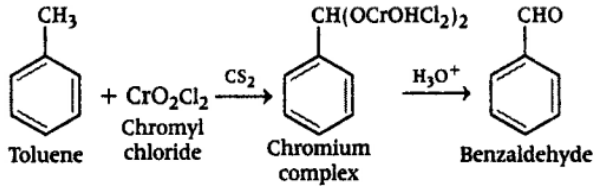
20. Answer the following:

(i) The rate law is R = k $[NO]^2$ $[H_2]$

(ii) a. Zero order, mol L^{-1} s^{-1} or mol L^{-1} t^{-1}

b. -K

21. **Etard Reaction:** Toluene reacts with chromyl chloride in presence of CS_2 followed by hydrolysis produces benzaldehyde.



Section C

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

E^0_{cell} = -0.40 - (-0.76) = 0.36 V

$E_{cell} = 0.36 - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[Cd^{2+}]}$

= 0.36 - $\frac{0.059}{2}\log\frac{(0.1)}{(-01)}$

= 0.36 - 0.0295 log10

E_{cell} = 0.3305 V

23. i. For 15% decomposition of H_20_2

$[R]_0$ = 100 M, [R] = 100 - 15 = 85 M

k = 1.06×10^{-3} min^{-1}

For first order reaction

$t = \frac{2.303}{k} \log \frac{[R_0]}{[R]}$

$t = \frac{2.303}{1.06 \times 10^{-3}} \times \log\left[\frac{100}{85}\right]$

$t = \frac{2.303}{1.06 \times 10^{-3}} \times [\log 100 - \log 85]$

$t = \frac{2.303}{1.06 \times 10^{-3}} \times \log(2 - 1.9292)$

$t = \frac{2.303}{1.06 \times 10^{-3}} \times (0.0706)$

t = 153.38 min.

ii. Similarly, for 85% decomposition of reaction

$t = \left(\frac{2.303}{1.06 \times 10^{-3}}\right) \log\left(\frac{100}{15}\right)$

t = 1790.325 min.

24. i. $\underset{\text{Butanol}}{CH_3CH_2CH_2CH_2OH} \xrightarrow[Oxidation]{[O]} \underset{\text{Butanoic acid}}{CH_3CH_2CH_2COOH}$

ii. $CH_3 - \underset{OH}{\underset{|}{CH}} - CH_2CH_3 \xrightarrow[Oxidation]{[O]} CH_3 - \underset{O}{\underset{||}{C}} - CH_2CH_3$

Butan$-2-one$

iii. $CH_3 - \underset{CH_3}{\overset{H}{\overset{|}{\underset{|}{C}}}} - CH_2 - OH \xrightarrow[Oxidation]{[O]} CH_3 - \underset{CH_3}{\overset{H}{\overset{|}{\underset{|}{C}}}} - COOH$

$2-Methylpropanoic\ acid$

OR

The process of fermentation involves breaking down of large molecules into simpler ones in presence of enzymes.

In India, ethanol is mainly prepared by fermentation of molecules a dark brown coloured group left after crystallization of sugar.

$\underset{Maltose}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[(from\ yeast)]{Maltase} 2\underset{Glucose}{C_6H_{12}O_6}$

$\underset{Glucose}{C_6H_{12}O_6} \xrightarrow{Zymase} 2\underset{Ethyl\ alcohol}{C_2H_5OH} + 2CO_2$

25. i. Acetaldehyde

ii. Aqueous copper sulphate solution and alkaline solution of sodium-potassium tartarate (Rochelle's salt).

iii. $CH_3CH = NNHCONH_2$

26. At cathode, the following reduction reactions can take place:

$Na^+_{(aq)} + e^- \rightarrow Na_{(s)}; E^0_{Na^+/Na} = -2.71V$

$H^+_{(aq)} + e^- \rightarrow \frac{1}{2}H_2(g);\ E^0_{H^+/H_2} = OV$

A reduction reaction with higher reduction potential is preferred. Therefore, the reaction at the cathode during electrolysis is

$H^+_{(aq)} + e^- \rightarrow \frac{1}{2}H_{2(g)}$

This is why electrolysis of aqueous solution of NaCl gives H_2 at the cathode.

At anode, the following oxidation reactions can take place:

$Cl^-_{(aq)} \rightarrow \frac{1}{2}Cl_{2(g)} + e^- E^0_{Cl_2/2Cl^-} = +1.36V$

$2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^- E^0_{H^+ + O_2/H_2O}$ = 1.23V

At anode, the reaction with lower value of E_0 is preferred. But, due to overvoltage, oxidation of chloride ion occurs and chlorine gas is obtained. Hence, the reaction at the anode during electrolysis is

$Cl^-_{(aq)} \rightarrow \frac{1}{2}Cl_{2(g)} + e^-\ E^0_{Cl_2/2Cl^-} = +1.36V$

This is why electrolysis of aqueous solution of NaCl gives Cl_2 at the anode.

The overall cell reaction is given below.

$H^+ + Cl^- \rightarrow \frac{1}{2}H_2 + \frac{1}{2}Cl_2$

27. In S_N2 reaction, steric factors determine the reactivity. more reactive alkyl halides have less steric hindrance. Hence, the decreasing order of the reactivity of alkyl halides is $1^o > 2^o > 3^o$. The order of reactivity as follows:

i. 1-bromopentane > 2-bromopentane > 2-bromo-2-methylbutane

ii. 1-bromo-3-methylbutane > 3-bromo-2-methylbutane > 2-bromo-2-methylbutane

iii. 1-bromobutane > 1-bromo-3-methylbutane > 1-bromo-2-methylbutane> 1-bromo-2, 2 dimethylpropane

28. a. We have

$E^{\Theta}_{(Cu^{2+}/Cu)} = 0.34V$ and $E^{\Theta}_{(Ag^{+}/Ag)} = 0.80V$

Standard emf of Cu is less than Ag, therefore it is strong reducing agent and is oxidised. Therefore Cu acts as Anode and Ag acts as Cathode.

Half cell reactions are:

At Cathode (Reduction):

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

At Anode (Oxidation):

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

b. The reactions are :

At Anode:

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

At Cathode:

$2H^{+}(aq) + 2e^{-} \rightarrow H_2(g)$

Full cell reaction:

$Sn(s) + 2H^{+}(aq) \rightarrow Sn^{2+}(aq) + H_2(g)$

Standard emf of the cell is:

$E^0_{cell} = E^0_{H^+/H_2} - E^0_{Sn^{2+}/Sn}$

= 0 - (-0.14)V

= + 0.14V

For this reaction n=2 moles of electrons. Using Nernst equation,

$E_{cell} = 0.14 - \frac{0.0591}{2}\log\frac{[Sn^2+]}{[H^+]^2}$

$= 0.14 - \frac{0.0591}{2}\log\frac{0.04}{(0.02)^2}$

$= 0.14 - \frac{0.0591}{2}\log\frac{4}{100} \times \frac{100}{2} \times \frac{100}{2}$

= 0.14 V - 0.0591 V

= 0.0809 V

Section D

29. i. The transition metals are quite similar in size and, therefore, the atoms of one metal can substitute the atoms of other metal in its crystal lattice. Thus, on cooling a mixture solution of two or more transition metals, solid alloys are formed.

ii. The high enthalpies of atomization are due to a large number of unpaired electrons in their atoms. Therefore, they have stronger interatomic interactions and hence, stronger bonding between atoms.

iii. Transition elements and many of their compounds are paramagnetic, i.e., they are weakly attracted by a magnetic field. This is due to the presence of unpaired electrons in atoms, ions or molecules. The paramagnetic character increases as the number of unpaired electrons increases.

OR

a. The ability of transition metal ion to pass easily from one oxidation state to another and thus providing a new path to reaction with lower activation energy.

b. The surface of transition metal acts as very good adsorbent and thus provides increased concentration of reactants on their surface causing the reaction to occur.

30. i. KCl in a kg of water would be expected to increase the boiling point by 2 $\times$ 0.52 K = 1.04 K. This could led us to conclude that mass of 2 moles of particles is 74.5 g hence mass of 1 mole of KCl would be 37.25 g. Hence, in case of KCl where dissociation occurs experimentally determined molar mass is always lower than true value.

ii. Negative Deviation.

iii. A liquid mixture consisting of 20 % acetone and 80%. chloroform by mass.

OR

Negative Deviation.

Section E

31. Attempt any five of the following:

(i) a. Amino acids which cannot be synthesised in the body and must be obtained through diet.

b. When nucleoside is linked to phosphoric acid at 5'-position of sugar moiety. / Base + sugar + phosphoric acid.

(ii) Uracil, cytosine, guanine and adenine are present in RNA. Among these, uracil is not present in DNA.

(iii) Nucleic acids are polymers of Nucleotides.

Because the H-bonds are formed between specific pairs of bases/pairing between A & T and between C & G.

(iv) Hydrolysis of DNA gives 2-deoxyribose, nitrogen containing heterocyclic base(Adenine, Guanine, Cytosine and Thymine), phosphoric acid.

(v) The reducing sugars have free aldehydic or ketonic groups.

(vi) **Starch:** It is a branched chain polymer of α-glucose and consists of two components: Amylose(water soluble) and Amylopectin (water insoluble).

Cellulose: It is a straight chain polysaccharide composed only of β-D-glucose units which are joined by glycosidic linkage between C_1 of one glucose unit and C_4 of the next glucose unit.

(vii) a. The pentaacetate of glucose does not react with hydroxylamine / HCN / Schiff's reagent indicating the absence of free -CHO group.

b. Adenine, Guanine, Uracil and Cytosine Uracil

32. a. i. $[Fe(H_2O)_6]^{3+}$

$[Fe(H_2O_6]^{3+}$

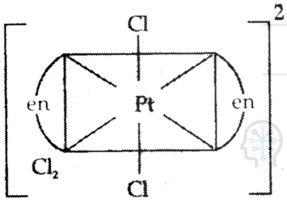
Since H_2O is a weak field ligand, it cannot cause pairing of electrons. Therefore, the number of unpaired electrons is 5.

$\mu = \sqrt{n(n+2)} = \sqrt{5(5+2)} = \sqrt{35}$ = 5.92 BM

Thus, it is strongly paramagnetic (due to presence of unpaired electrons).

In $[Fe(H_2O)_6]^{3+}$ outer d-orbitals are used in hybridization to from high spin complex.

ii. Geometrical isomers of $[Pt(en)_2Cl_2]^{2+}$



trans-$[PtCl_2(en)_2]^{2+}$ is optically inactive

b. i. $t_{2g}{}^4 e_g{}^2$ Paramagnetic

ii. Dichloridobis (ethane-1,2-diamine)cobalt (III) nitrate

OR

i. Crystal field splitting energy is the energy difference between two sets of d-orbital levels that split when ligands approach a transition metal ion.

If $\Delta_0 > P$, it becomes more energetically favourable for the d^4 election to occupy a t_{2g} orbital with configuration $t_{2g}^4 e_g^0$.

ii. $[Ni(CN)_4]^{2}$ is colounless whereas

$[Ni(H_2O)_6]^{2+}$ is green, because

In both complexes, Ni is in +2 oxidation state with electronic configuration of $3\ d^8$.

In the presence of weak field water ligands, two unpaired electrons do not pair up.

Hence, the complex $[Ni(H_2O)_6]^{2+}$ has two unpaired electrons which result in green colour compound.

Due to d-d transition, red light is absorbed and complimentary light emitted is green.

In presence of strong field cyanide ligand, the unpaired electrons in 3d orbital pair up.

Due to an absence of unpaired electrons and no d-d transitions are possible and the complex $[Ni(CN)_4]^{2-}$ ends up as colourless compound.

33. i. Aniline is typical of aromatic primary amines - where the -NH_2 group is attached directly to a benzene ring. These are very much weaker bases than ammonia.

Aniline is more basic than ethylamine because of resonance. When aniline loses a proton the resulting ion is more stable than that of ethylamine and hence, aniline is more basic than ethylamine. Hence, aniline looses proton more readily than ethylamine.

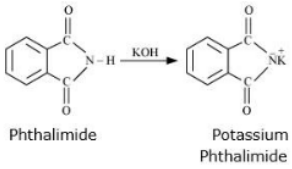
ii. Aniline being a Lewis base reacts with Lewis acid ($AlCl_3$) to form a salt.

$$C_6H_5NH_2 + AlCl_3 \longrightarrow C_6H_5\overset{+}{N}H_2AlCl_3^-$$

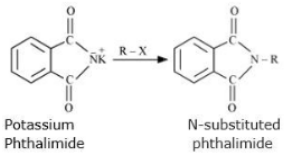
As a result, N acquires a positive charge so, it acts as a strong deactivating group for electrophilic substitution reaction. Thus, aniline does not undergo Friedel-Crafts reaction.

iii. Gabriel phthalimide synthesis is a very convenient method for the preparation of pure aliphatic amines

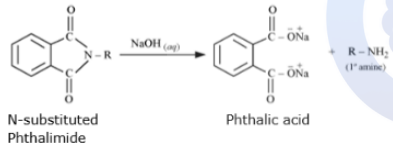
Step 1: Phthalimide is treated with KOH to form potassium phthalimide



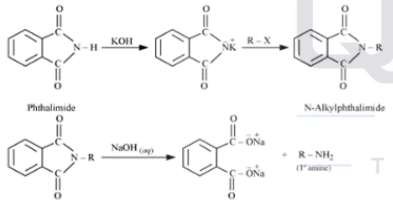
Step 2: Potassium phthalimide is treated with a suitable alkyl halide to form N-substituted phthalimides.



Step 3: N-substituted phthalimides undergoes hydrolysis in the presence of dil. HCl or with alkali(NaOH) to give primary amines.



Overall reaction:



Gabriel phthalimide synthesis results in the formation of primary(1° amine) only. Secondary or tertiary amines are not formed through this synthesis. Hence, Gabriel phthalimide synthesis preferred for the formation of primary amines only.

OR