Series SGN

CHEMISTRY

Paper & Solution

SET-1

Code : 56/1

Time : 3 Hrs. **Max. Marks : 70**

General Instructions :

(i) All questions are compulsory.

(ii) Questions number **1 to 5** are very short answer questions and carry **1** mark each.

(iii) Questions **6** to **10** are short answer questions and carry **2** marks each.

(iv) Question number **11 to 22** are also short-answer questions and carry **3** marks each.

(v) Question number **23** is a value based questions and carry **4** marks.

(vi) Question number **24 to 26** are long-answer questions and carry **5** marks each.

(vii) Use Log Tables, if necessary. Use of calculators is **not** allowed.

1. Analysis shows that FeO has a non-stoichiometric composition with formula $Fe_{0.95}O$. Give reason. **[1]**

Sol. Since in FeO, Fe present in both +2 & +3 O.S.. Hence FeO has non-Stoichometric composition

2. CO (g) and H_2 (g) react to give different products in the presence of different catalysts. Which ability of the catalyst is shown by these reactions ? **[1]**

Sol. It specify selectivity of a catalyst in this reaction which means a catalyst for one reaction can be inhibitors for another

3. Write the coordination number and oxidation state of Platinum in the complex $[Pt(en)_2Cl_2]$. **[1]**

Sol. Complex given –

$[Pt\ (en)_2Cl_2]$

Coordination no. = denticity × number of ligand

Coordination number = $2 \times 2 + 2 \times 1 = 6$

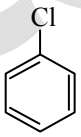
Charge on ligand + O.S. of metal ion = charge on complex

$-2 + x = 0$

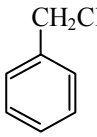
$\Rightarrow \quad x = +2$

4. Out of chlorobenzene and benzyl chloride, which one gets easily hydrolysed by aqueous NaOH and why ? **[1]**

Sol.



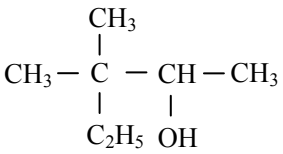
Chloro Benzene

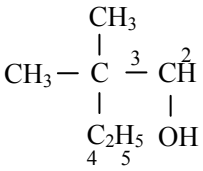


Benzyl chloride

The benzyl chloride is more readily hydrolysed in aq. NaOH as in chloro Benzene the lone pair of chlorine are in conjugation with π-Bond of Benzene due to which partial double bond character develop and it reduce its reactivity.

5. Write the IUPAC name of the following : **[1]**



Sol.  3, 3-dimethyl pentan-2-ol

6. Calculate the freezing point of a solution containing 60 g of glucose (Molar mass = 180 g mol^{-1}) in 250 g of water. (K_f of water = 1.86 K kg mol^{-1}) **[2]**

Sol. $W_1 = 250$ g, $w_2 = 60$ g, $mw_2 = 180$ g/mol, $K_f = 1.86$ k kg mol^{-1}

$\Delta t_f = k_f m$

$$\text{or } \Delta t_f = k_f \times \frac{w_2 \times 1000}{m.w_2 \times w_1(g)}$$

$$= 1.86 \times \frac{60 \times 1000}{180 \times 250}$$

$$= \frac{1.80 \times 600}{18 \times 25}$$

$$= \frac{1116}{450}$$

$$= 2.48 \text{ K}$$

$\Delta t_f = t_{(solvent)} - t_{(Solution)}$

Or $t_{(solution)} = t_{(solvent)} - \Delta t_f$

$= 273.15 - 2.48$

$= 270.67$ K

7. For the reaction

$2N_2O_5 (g) \rightarrow 4NO_2 (g) + O_2 (g)$

the rate of formation of NO_2 (g) is 2.8×10^{-3} M s^{-1}. Calculate the rate of disappearance of N_2O_5 g. **[2]**

Sol. A reaction is given

$2\ N_2O_5(g) \longrightarrow 4\ NO_2(g) + O_2(g)$

$\frac{\Delta NO_2}{\Delta t} = 2.8 \times 10^{-3}$ M /sec

So rate of reaction – (representation)

$$-\frac{1}{2}\frac{\Delta N_2O_5}{\Delta t} = \frac{1}{4}\frac{\Delta NO_2}{\Delta t} = \frac{\Delta O_2}{\Delta t}$$

or $$\frac{\Delta N_2O_5}{\Delta t} = \frac{1}{2}\frac{\Delta NO_2}{\Delta t}$$

$$\frac{\Delta N_2O_5}{\Delta t} = \frac{1}{2}\times 2.8\times 10^{-3} = 1.4 \times 10^{-3}\ \text{M/sec}$$

8. Among the hydrides of Group-15 elements, which have the

(a) lowest boiling point ?

(b) maximum basic character ?

(c) highest bond angle ?

(d) maximum reducing character ? **[2]**

Sol. Among group is element hydrides

(a) PH_3 has a lowest boiling point

(b) NH_3 has a maximum basic character

(c) NH_3 has a highest bond angle

(d) BiH_3 has maximum reducing character

9. How do you convert the following ?

(a) Ethanal to Propanone

(b) Toluene to Benzoic acid **[2]**

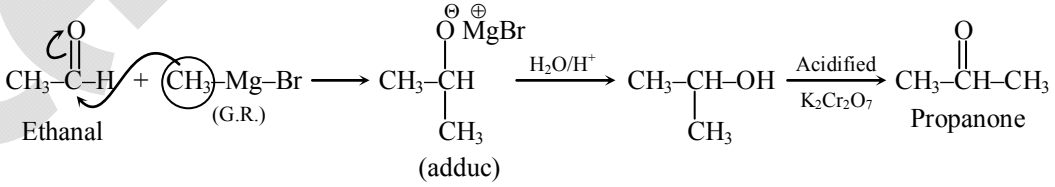
OR

Account for the following :

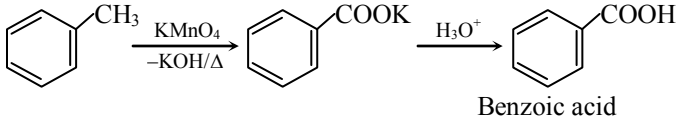
(a) Aromatic carboxylic acids don not undergo Friedel-Crafts reaction.

(b) pK_a value of 4-nitrobenzoic acid is lower than that of benzoic acid.

Sol. (a) Ethanal to Propanone



(b) Toluene to Benzoic acid



OR

(a) In case of aromatic carboxylic acid –COOH attach to the Benzene ring having electron with drawing effect and deactivated the benzene ring, hence do not exhibit friedel craft reaction.

(b) pK_a value of 4-nitrobenzoic acid is lower then benzoic acid is due to e^- with drawing nature of $-NO_2$ attach at para position of Benzene due to which tendency to loose H^+ ion increases and acidic character increases.

10. Complete and balance the following chemical equations :

(a) $Fe^{2+} + MnO_4^- + H^+ \rightarrow$

(b) $MnO_4^- + H_2O + I^- \rightarrow$ **[2]**

Sol. (a) $5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow Mn^{+2} + 8H_2O + 5I_2$

(b) $2MnO_4^- + H_2O + I^- \rightarrow 2MnO_2 + 20H^- + IO_3^-$

11. Give reasons for the following :

(a) Measurement of osmotic pressure method is preferred for the determination of molar masses of macromolecules such as proteins and polymers.

(b) Aquatic animals are more comfortable in cold water than in warm water.

(c) Elevation of boiling point of 1 M KCl solution is nearly double than that of 1 M sugar solution. **[3]**

Sol. (a) Protein are high molecular mass material the magnitude of colligative property depends inversely on the molecular mass and osmotic pressure is the only colligative property have measurable magnitude.

(b) Oxygen is in dissolved states in water and as temperature rises solubility of oxygen decreases which means solubility of oxygen in warm water is less.

(c) Since the elevation of boiling point is $\Delta t_b = iK_bm$ in both 1M KCl & 1 M sugar. The solvent is some but KCl is ionic due to which its dissociates completely. Hence the value van't hoff factor is twice in 1m KCl then 1M sugar due to which elevation in boiling point is more.

12. An element 'X' (At. mass = 40 g mol^{-1}) having f.c.c. structure, has unit cell edge length of 400 pm. Calculate the density of 'X' and the number of unit cells in 4 g of 'X'. ($N_A = 6.022 \times 10^{23}$ mol^{-1}) **[3]**

Sol. Atomic mass = 40 g/mol

$A = 400\ pm = 400 \times 10^{-10}$ cm or 4×10^{-8} cm

$$\Rightarrow \text{So } d = \frac{z \times M}{a^3 \times N_A} = \frac{4 \times 40}{(4 \times 10^{-8})^3 \times 6.023 \times 10^{23}}$$

$$d = \frac{160}{64 \times 6.023 \times 10^{-1}} = \frac{160}{6.4 \times 6.023} \cong 4.18 gm/cc$$

$\Rightarrow$ 40 g contain $\longrightarrow$ Na atoms

$$4g \text{ g contain} \longrightarrow \frac{N_A \times 4}{40} \text{ atoms} = \frac{N_A Atom}{10}$$

$$90 = \frac{6.023 \times 10^{23}}{10} \text{atoms or } \frac{6.023 \times 10^{22}}{4} = 1.50 \times 10^{22} \text{ unit cell}$$

13. A first order reaction is 50 % completed in 40 minutes at 300 K and in 20 minutes at 320 K. Calculate the activation energy of the reaction. (Given : log 2 = 0.3010, log 4 = 0.6021, R = 8.314 JK^{-1} mol^{-1}) **[3]**

Sol. $T_1 = 300$ K $\quad t_{1/2} = 40$ min

$T_2 = 320$ K $\quad t_{1/2} = 20$ min

We know $\quad t_{1/2} = \dfrac{.693}{K}$

$$\frac{\log K_2}{K_1} = \frac{Ea}{2.303\ R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$K \propto \frac{1}{t_{1/2}}$$

or $$\frac{\log (t_{1/2})_1}{(t_{1/2})_2} = \frac{Ea}{2.303\ R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\Rightarrow \quad \log\left(\frac{40}{20}\right) = \frac{Ea}{2.303 \times 8.314}\left(\frac{20}{320 \times 300}\right)$$

$$0.3010 = \frac{20\,Ea}{2.303 \times 8.314 \times 320 \times 300}$$

$$Ea = \frac{0.3010 \times 2.303 \times 8.314 \times 320 \times 300}{20 \times 1000} = 27.67 \text{ KJ/mol.}$$

14. What happens when

(a) a freshly prepared precipitate of $Fe(OH)_3$ is shaken with a small amount of $FeCl_3$ solution.

(b) persistent dialysis of a colloidal solution is carried out ?

(c) an emulsion is centrifuged ? **[3]**

Sol. (a) When precipitate particles of $Fe(OH)_3$ added in small amount of $FeCl_3$ Reptization occur. The common ion Fe^{+3} adsorbed on precipitate particles and converts to smaller colloidal particles.

(b) To increase the stability of colloids a small amount of electrolyte is added, so during the electrolyte almost remove and so the colloidal sol will coagulate.

(c) It the emulsion is centrifuged then it demulsified the immiscible mixture of two liquid and both get separate out.

15. Write the chemical reactions involved in the process of extraction of Gold. Explain the role of dilute NaCN and Zn in this process. **[3]**

Sol. Chemical reaction during extraction of gold –

$$4Au_{(s)} + 8CN^-_{(aq)} + 2H_2O_{(aq)} + O_{2(g)} \longrightarrow 4[Au(CN)_2]^-_{(aq)} + 4OH^-_{(aq)}$$

$$2[Au(CN)_2]^-_{(aq)} + Zn_{(s)} \longrightarrow [Zn(CN)_4]^{2-}_{(aq)} + 2Au_{(s)}$$

"the dilute NaCN and KCN is used to leached the metal in the presence of air while Zn is act as a reducing agent".

16. Give reasons :

(a) E^o value for Mn^{3+}/Mn^{2+} couple is much more positive than that for Fe^{3+}/Fe^{2+}.

(b) Iron has higher enthalpy of atomization than that of copper.

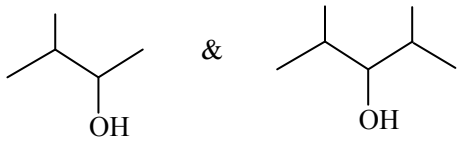
(c) Sc^{3+} is colourless in aqueous solution whereas Ti^{3+} is coloured. **[3]**

Sol. (a) E^o value for Mn^{+3}/Mn^{+2} is more positive it is due to fact that Mn^{+2} have higher stability then Mn^{+3} due to half filled d^5 configuration.

(b) Iron has higher no of unpaired electron then copper due to which extent of covalent bonding is more hence enthalpy of atomization is more.

(c) Sc^{+3} is colurless is due to absence of unpaired electron as it attain $3d^0$ configuration while Ti^{+3} has $3d^1$ configuration.

17. (a) Identify the chiral molecule in the following pair :

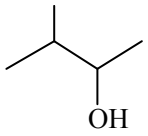


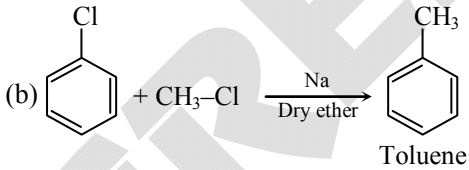
(i) (ii)

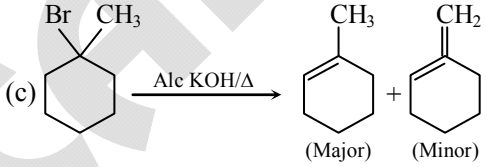
(b) Write the structure of the product when chlorobenzene is treated with methyl chloride in the presence of sodium metal and dry ether.

(c) Write the structure of the alkene formed by dehydrohalogenation of 1-bromo-1-methylcyclohexane with alcoholic KOH **[3]**

Sol. (a) The chiral molecule







18. (A), (B) and (C) are three non-cyclic functional isomers of carbonyl compound with molecular formula C_4H_8O. Isomers (A) and (C) give positive Tollens' test whereas isomer (B) does not give Tollens' Test but gives positive Iodoform test. Isomers (A) and (B) on reduction with Zn(Hg)/cons.HCl give the same product (D).

(a) Write the structures of (A), (B), (C) and (D)

(b) Out of (A), (B) and (C) isomers, which one is least reactive towards addition of HCN ? **[3]**

Sol. (a) (A) $CH_3–CH_2–CH_2–CHO$

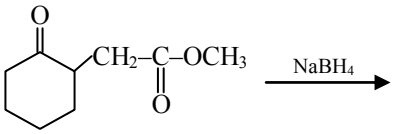
(B) $CH_3–\overset{\overset{O}{\|}}{C}–CH_2–CH_3$

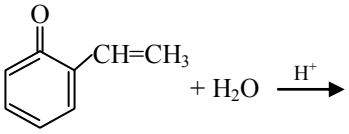
(C) $CH_3–\underset{\underset{CH_3}{|}}{CH}–\overset{\overset{O}{\|}}{C}–H$

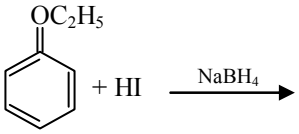
(D) $CH_3–CH_2–CH_2–CH_3$

(b) Since (B) is ketons so it will be less reactive towards nucleophilic addition reaction with HCN due to +I effect & sterric hinderence.

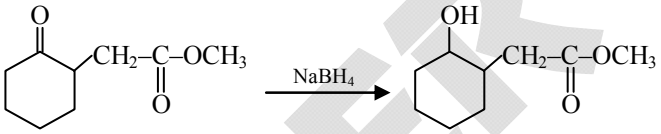
19. Write the structures of the main products in the following reactions :

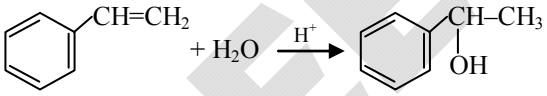
(i) 

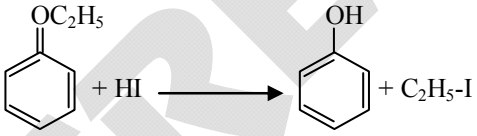
(ii) 

(iii) 

[3]

Sol. (i) 

(ii) 

(iii) 

20. (a) Why is bithional added to shop ?

(b) What is tincture of iodine ? write its one use.

(c) Among the following, which one acts as a food preservative ?

Aspartume, Asprin, Sodium Benzoate, Paracetamol. **[3]**

Sol. (a) Bithional added in soap to impart antiseptic property and to reduce odour produced by Bacterial decomposition.

(b) Tincture of iodine or iodine tincture is 2-7 % elemental iodine along with potassium iodide or sodium iodide in mixture of ethanol and water.
Uses : "use to prevent infection on minor cuts, scraps and burns"

(c) "Sodium Benzoate work as food preservative"

21. Define the following with an example of each :

(a) Polysaccharides

(b) Denatured protein

(c) Essential amino acids

OR

(a) Write the product when D-glucose reacts with conc. HNO_3?

(b) Amino acids show amphoteric behaviour. Why ?

(c) Write one difference between α-helix and β-pleated structures of proteins. **[3]**

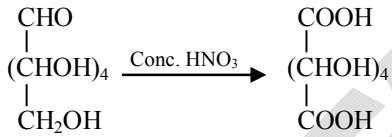
Sol. (a) Polysaccharides :
The compound that yield large number of monosaccarides unit on hydrolysis
Eg. Starch, Cellulose etc.

(b) Denatured Protein :
"Due to change in temperature on pH secondary & tertiary structure are destoryed but primary structure remain intact''

(c) Essential amino acids :
The amino acids which can not Bℓ synthesised within the body and obtained through diet.

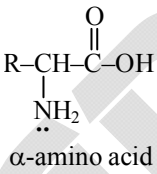
OR

(a). Product of reaction of D-glucose with concentrate HNO_3



D-glucose D-saccharic acid

(b) "The amino acids contain both acidic –COOH group and basic $–NH_2$ (amino) group in their structure due to which they can exist both as acid & base & exibit amphoteric nature.



α-amino acid

(c) In α-helix a polyreptide chain form by all possible hydrogen bonds by twisting into a right handed helical structure with –NH group of each amino acid.

"In β-pleated all reptide chains are stretched out to nearly extensions and then laid side by side which are held together by intermolecular hydrogen bond.

22. (a) Write the formula of the following coordination compounds: Iron(III)Hexacyanoferrate(II)

(b) What type of isomerism is exhibited by the complex $[Co(NH_3)_5Cl]SO_4$?

(c) Write the hybridisation and number of unpaired electrons in the complex $[CoF_6]^{3-}$

(Atomic No. of Co = 27) **[3]**

Sol. (a) $Fe_4[Fe(CN)_6]_3$

(b) $[Co(NH_3)_5Cl]SO_4$ (ionization isomers)

(c) $[CoF_6]^{-3}$

(i) Hybridization : sp^3d^2

(ii) Unpaired electron : 4-unpaired electron

23. Shyam went to a grocery shop to purchase some food items. The shopkeeper packed all the item in polythene bags and gave them to Shyam. But Shyam refused to accept the polythese bags and asked the shopkeeper to pack the items in paper bags. He informed the shopkeeper about the heavy penalty imposed by the government for using polythene bags. The shopkeeper promised that he would use paper bags in future in place of polythene bags.

Answer the following :

(a) Write the values (at least two) shown by Shyam

(b) Write one structural difference between low-density polythene and high-density polythene

(c) Why did Shyam refuse to accept the items in polythene bags ?

(d) What is a biodegradable polymer ? Give an example. **[4]**

Sol. (a) The value display by Shyam is awareness and concern about the consequences of using polythene bags.

(b) Low density polyethese form by free radical polymerization and posses highly branch structure while high density polythene posses a linear structure due to which it has high density due to closed packing

(c) As he knew about the consequences that they get into soil and slowly release toxic chemical as they are non-biodegradable polymers.

(d) Polymers broken down rapidly by enzyme catalysed reaction are called biodegradable polymers

Eg. Poly-β-hydroxybutyrate-co-β-hydroxyvalerate (PHBV) etc.

24. (a) Give reasons :

(i) H_3PO_3 undergoes disproportionation reaction but H_3PO_4 does not.

(ii) When Cl_2 reacts with excess of F_2, ClF_3 is formed and not FCl_3.

(iii) Dioxygen is a gas while sulphur is a solid at room temperature.

(b) Draw the structures of the following

(i) XeF_4

(ii) $HClO_3$

OR

(a) When concentrated sulphuric acid was added to an unknown salt present in a test tube a brown gas (A) was evolved. This gas intensified when copper turnings were added to this test tube. On cooling, the gas (A) changed into a colourless solid (B)

(i) Identify (A) and (B)

(ii) Write the structures of (A) and (B)

(iii) When does gas (A) change to solid on cooling ? **[5]**

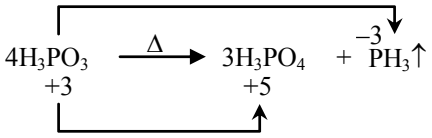
(b) Arrange the following in the decreasing order of their reducing character

HF, HCl, HBr, HI

(c) Complete the following reaction :

$XeF_4 + SbF_5 \longrightarrow$

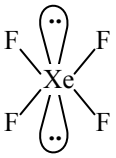
Sol. (i) Since in H_3PO_3 O.S. of central atom is +3 and on dissociation it undergo both oxidation +5 & reduction –3 in their respective compound

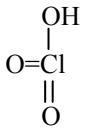


(ii) Due to high electronegativity & small size and absence of higher vaccant orbital flourine exibit only –1 O.S. so due to which FCl_3 is not possible.

(iii) Electron in oxygen atom, owing to small size of atom and tightly held hence less induced dipole-induced dipole attraction while electron of sulphur atom, owing to large size of the atom reach farther and cause. Strong induced dipole-induced dipole attraction.

Structure of compound –

(A) 

(B) 

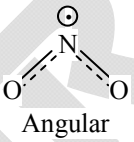
$(HClO_3)$

OR

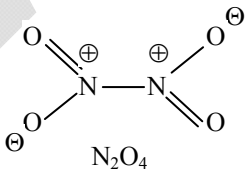
(a) (i) A $\rightarrow$ NO_2 (nitrogen dioxide)

B $\rightarrow$ N_2O_4 (dimitrogen tetra oxide)

(ii) Structures of A and B –



Angular



N_2O_4
(Planar)

(iii) "NO_2 contain odd number of valence electron hence behave as odd molecule and dimerized to convert into stable N_2O_4 molecule

(b) Decreasing order of reducing character -

HI > HBr > HCl > HF

(c) Complete following reaction

$XeF_4 + SbF_5 \longrightarrow [XeF_3]^+[SbF_6]^-$

25. (a) Write the cell reaction and calculate the e.m.f. of the following cell at 298K:

$Sn(s) \mid Sn^{2+}(0.004\ M) \parallel H^+(0.020\ M) \mid H_2(g)\ (1\ bar) \mid Pt(s)$

(Given : $E^0_{Sn^{2+}/Sn} = 0.14$)

(b) Give reasons :

(i) On the basis of E^0 values, O_2 gas should be liberated at anode but it is Cl_2 gas which is liberated in the electrolysis of aqueous NaCl.

(ii) Conductivity of CH_3COOH decreases on dilution.

OR

(a) For the reaction,

$2\ AgCl(s) + H_2(g)\ (1\ atm) \longrightarrow 2Ag(s) + 2H^+(0.1\ M) + 2Cl^-(0.1\ M)$

$\Delta G^\circ = -43600$ J at 25°C

Calculate the e.m.f. of the cell

[$\log 10^{-n} = -n$]

(b) Define fuel cell and write its two advantages. **[5]**

Sol. (a) Anode : $Sn(s) \longrightarrow Sn^{+2}(aq) + 2e^-$

Cathode : $2H^+_{(aq)} + 2e^- \longrightarrow H_2(g)$

Overall reaction :

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

$$E^o_{cell} = E^o_{Sn/sn^{+2}} - E^o_{H^+/H_2}$$

$$= -(-.14)$$

$$= 0.14\ V$$

$$E_{cell} = E^o_{cell} - \frac{0.0591}{2}\log_{10}\frac{[Sn^{+2}]}{[H^+]^2}$$

$$= 0.14 - \frac{0.0591}{2}\log_{10}\frac{[0.004]}{[0.020]^2}$$

$$= 0.14 - 0.0295$$

$$= +0.1105\ V$$

(b) (i) E^o_{Value} of O_2 is higher then Cl_2 but O_2 will lie liberate from H_2O only when the higher voltage is applied so because of this Cl_2 liberate instead of O_2.

Eg. $NaCl \rightarrow Na^+ + Cl^-$

$H_2O \rightleftharpoons H^+ + OH^-$

(ii) Conductivity changes as the concentration of the electrolyte changes. The number of ions per unit volume carrying the current decreases on dilution so conductivity will always decreases with decrease in concentration hence CH_3COOH conductivity decreases on dilution.

OR

A reaction is given –

(a) $2\ AgCl(s) + H_2(g)\ (a\ atm) \longrightarrow 2Ag(s) + 2H^+\ (0.1M) + 2Cl^-\ (0.1M)$

$\Delta G^o = -\ n\ F\ E^o_{cell}$

So $E^o_{cell} = \frac{-\Delta G^o}{nF} = \frac{-(-43600)}{2 \times 96500} = 0.23\ V$

$E_{cell} = E^o_{cell} - \frac{0.0591}{n} \log_{10}[H^+]^2[Cl^-]^2$

$\Rightarrow\ 0.23 - \frac{0.0591}{2} \log 10[10^{-1}]^2[10^{-1}]^2$

$\Rightarrow\ 0.23 + 0.12 = 0.35$ volt

(b) They are galvanic cell that are designed to convert the energy of combustion of fuel like hydrogen, methane, methanol directly into electrical energy.

Eg. Hydrogen-oxygen fuel cell

Two advantages

(1) Do not cause any pollution like thermal plant

(2) Due to continuous supply of fuels, these cells never become dead.

26. (a) Write the reactions involved in the following,

(i) Hofmann bromamide degradation reaction

(ii) Diazotisation

(iii) Gabriel phthalimide synthesis

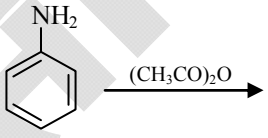
(b) Give reasons :

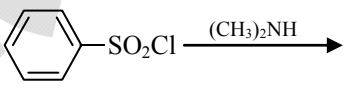
(i) $(CH_3)_2NH$ is more basic than $(CH_3)_3N$ in an aqueous solution

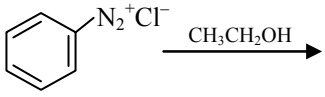
(ii) Aromatic diazonium salts are more stable than aliphatic diazonium salts.

OR

(a) Write the structures of the main products of the following reactions :

(i) 

(ii) 

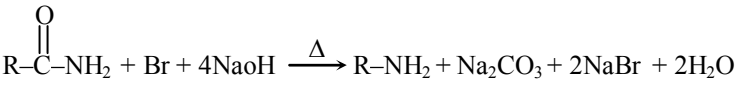
(iii) 

(b) Give a simple chemical test to distinguish between Aniline and N,N-dimethylaniline.

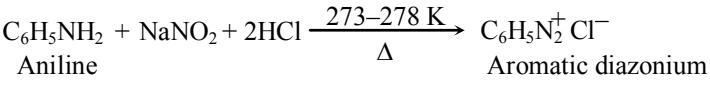
(c) Arrange the following in the increasing order of their pK_b values. :

$C_6H_5NH_2$, $C_2H_5NH_2$, $C_6H_5NHCH_3$ **[5]**

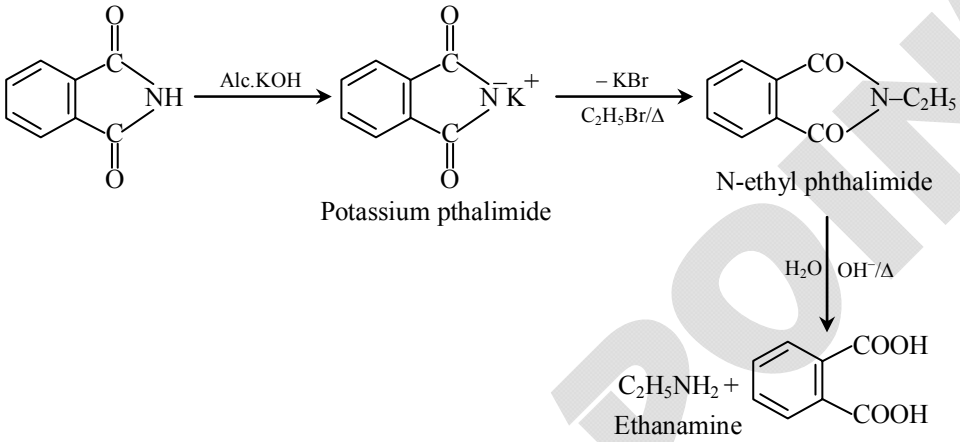
Sol. (a) (i) Hofmann Bromamide degradation reaction –



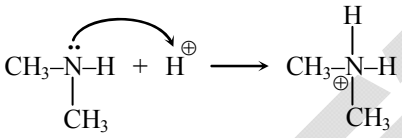
(ii) Diazotisation –

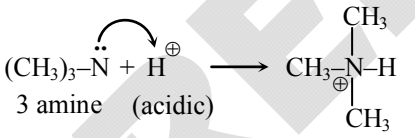


(iii) Gabriel Pthalimide reaction - Salt



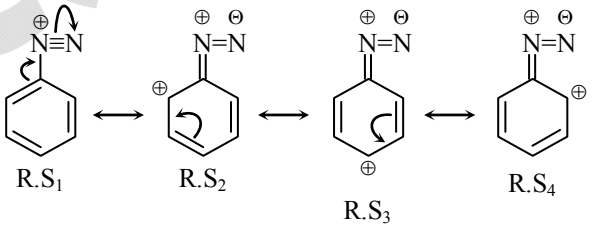
(b) (i) Hofmann bromamide degradation reaction –





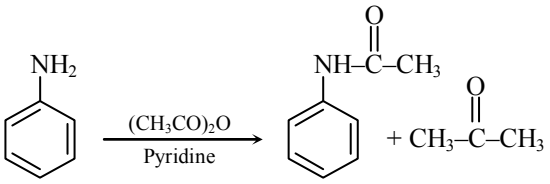
Since 2 amine salt form are more stable then 3 amine salt due to inductive effect (+I effect) and higher degree of hydration, so higher the state of salt more will be the reactivity of corresponding compound.

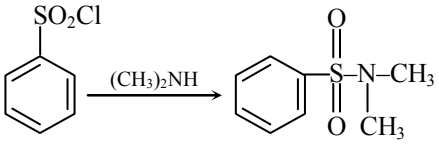
(ii) The aromatic diazonium salt more stable then aliphatic diazonium salt is due to resonance.



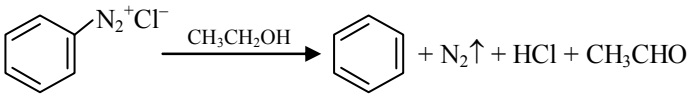
OR

(a) Write the product

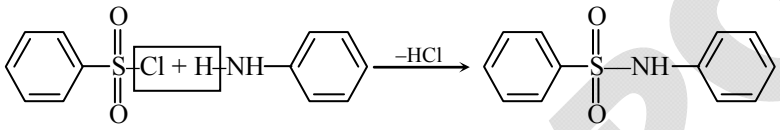
(i) 

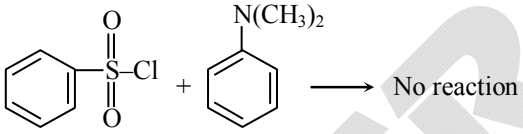
(ii) 

N, N-dimethyl Benzene sulphonamide

(iii) 

(b) Test to distinguish aniline & N,N-dimethyl aniline





(c) Increasing order of pK_b :

$C_2H_5–NH_2 < C_6H_5–NH–CH_3 < C_6H_5–NH_2$