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All India 2023 Solved Paper

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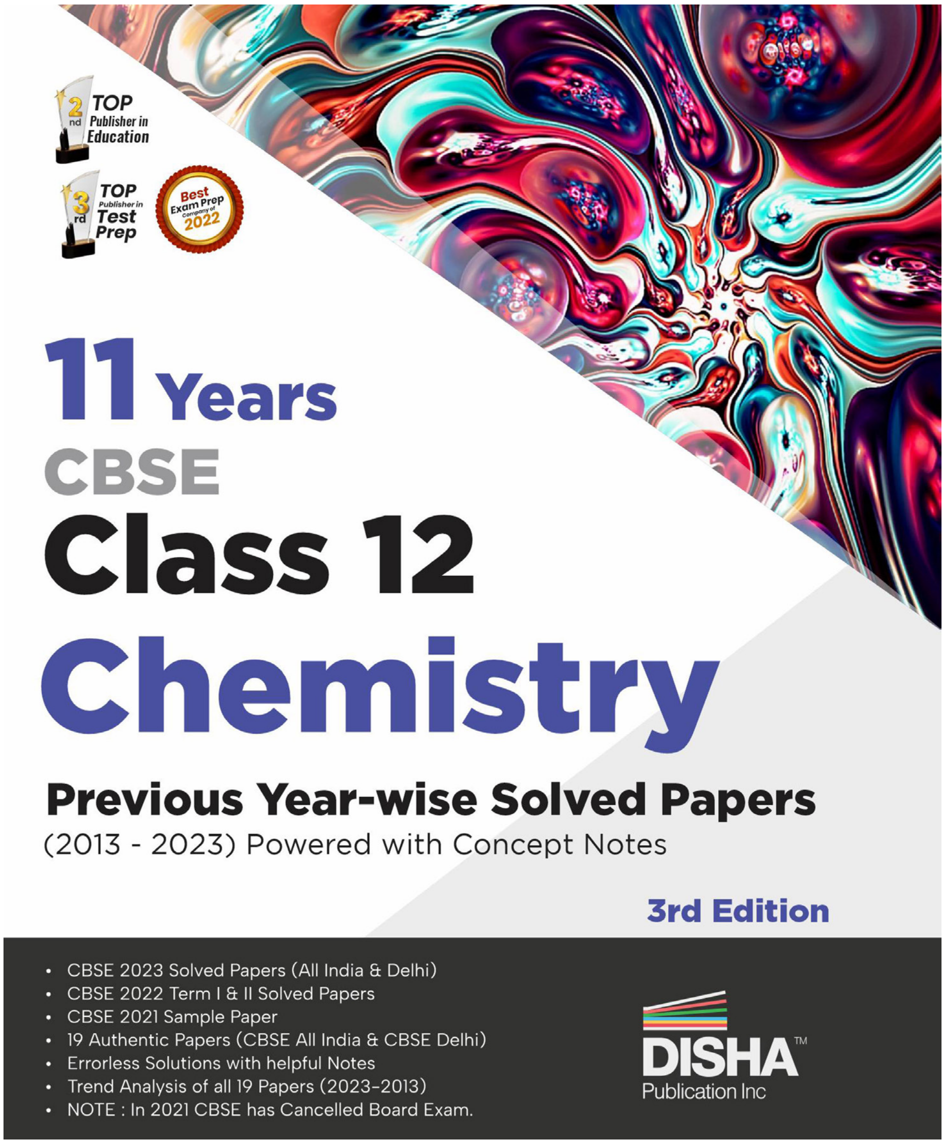

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All India 2023

CBSE Board Solved Paper

Time Allowed : 3 Hours | ***Maximum Marks : 70***

General Instructions:

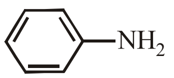
(i) This Question Paper contains **35** questions. All questions are compulsory.
(ii) Question Paper is divided into **FIVE** sections. Section **A, B, C, D** and **E**.
(iii) In section A – question number **1** to **18** are Multiple Choice (MCQ) type questions carrying **1** mark each.
(iv) In section B – question number **19** to **25** are Very Short Answer (VSA) type questions carrying **2** marks each.
(v) In section C – question number **26** to **30** are short Answer (SA) type questions carrying **3** marks each.
(vi) In section D – question number **31** & **32** are case based questions carrying **4** marks each.
(vii) In section E – question number **33** to **35** are Long Answer (LA) questions carrying **5** marks each.
(viii) There is no overall choice. However, an internal choice has been provided in 2 questions in Section **B**, 2 questions in Section **C**, 2 questions in Section **D** and 2 questions in Section **E**.
(ix) Use of calculator is NOT allowed.

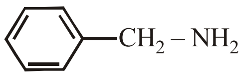
SECTION - A

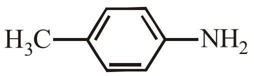
1. Auto oxidation of chloroform in air and sunlight produces a poisonous gas known as
(a) Tear gas (b) Mustard gas
(c) Phosgene gas (d) Chlorine gas

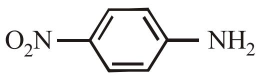
2. Which of the following ligands is an ambidentate ligand?
(a) CO (b) NO_2
(c) NH_3 (d) H_2O

3. Among the following which has the highest value of p^Kb?

(a) 

(b) 

(c) 

(d) 

4. The slope in the plot of log $\frac{[R]_o}{[R]}$ vs. time for a first order reaction is

(a) $\frac{+k}{2.303}$ (b) $+k$

(c) $\frac{-k}{2.303}$ (d) $-k$

5. When D-glucose reacts with HI, it forms
(a) Gluconic acid
(b) n-hexane
(c) Saccharic acid
(d) Iodohexane

6. Inversion of configuration occurs in
(a) S_N2 reaction
(b) S_N1 reaction
(c) Neither S_N2 nor S_N1 reaction
(d) S_N1 as well as S_N2 reaction

7. Solubility of gas in liquid decreases with increase in
(a) Pressure
(b) Temperature
(c) Volume
(d) Number of solute molecules

8. Which of the following relations is incorrect?

(a) $R = \frac{1}{k}\left(\frac{l}{a}\right)$ (b) $G = k\left(\frac{a}{l}\right)$

(c) $G = k\left(\frac{l}{a}\right)$ (d) $\wedge_m = \frac{k}{c}$

9. The reagent that can be used to distinguish acetophenone and benzophenone is
(a) 2, 4-dinitrophenyl hydrazine
(b) aqueous $NaHSO_3$
(c) Fehling solution
(d) I_2 and NaOH

10. Which of the following reactions are feasible?

(a) $CH_3CH_2Br + Na^+ O^- C(CH_3)_3 \rightarrow CH_3CH_2–O – C\,(CH_3)_3$

(b) $(CH_3)_3C– Cl + Na^+ O^- CH_2CH_3 \rightarrow CH_3CH_2– O – C\,(CH_3)_3$

(c) Both (a) and (b)

(d) Neither (a) nor (b)

11. Which of the following compounds will undergo self-condensation in the presence of dilute NaOH solution?

(a) C_6H_5CHO (b) CH_3CH_2CHO

(c) $(CH_3)_3C – CHO$ (d) $H – CHO$

12. For the reaction $3A \rightarrow 2B$, rate of reaction $-\frac{d[A]}{dt}$ is equal to

(a) $\frac{+3}{2}\frac{d[B]}{dt}$ (b) $\frac{+2}{3}\frac{d[B]}{dt}$

(c) $\frac{+1}{3}\frac{d[B]}{dt}$ (d) $\frac{+1}{2}\frac{d[B]}{dt}$

13. Which of the following transition metals shows 4.1 and 4.2 oxidation states?

(a) Mn (b) Zn

(c) Sc (d) Cu

14. The formula of the complex Iron (III) hexacyanidoferrate (II) is

(a) $Fe_2[Fe(CN)_6]_3$ (b) $Fe_1[Fe(CN)_6]_3$

(c) $Fe[Fe(CN)_6]$ (d) $Fe_3[Fe(CN)_6]_2$

For Questions 15-18: Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

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

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

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

(d) (A) is false, but (R) is true.

15. **Assertion (A) :** The enthalpy of mixing $\Delta_{mix} H$ is equal to zero for an ideal solution.

Reason (R) : For an ideal solution the interaction between solute and solvent molecules is stronger than the interactions between solute-solute or solvent-solvent molecules.

16. **Assertion (A) :** Molar conductivity decreases with increase in concentration.

Reason (R) : When concentration approaches zero, the molar conductivity is known as limiting molar conductivity.

17. **Assertion (A) :** Transition metals show their highest oxidation state with oxygen.

Reason (R) : The ability of oxygen to form multiple bonds to metals.

18. **Assertion (A) :** Chlorobenzene is resistant to nucleophilic substitution reaction at room temperature.

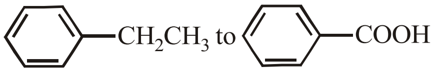
Reason (R) : C-Cl bond gets weaker due to resonance.

SECTION - B

19. What are nucleic acids? Why two strands in DNA are not identical but are complementary? **1 × 2**

20. Do the following conversions in not more than two steps: **2 × 1**

(a) CH_3COOH to CH_3COCH_3

(b) 

21. Write the chemical equation involved in the following reactions: **2 × 1**

(a) Reimer-Tiemann reaction

(b) Acetylation of Salicylic acid

22. (a) The conversion of molecule A to B followed second order kinetics. If concentration of A increased to three times, how will it affect the rate of formation of B? **2 × 1**

(b) Define Pseudo first order reaction with an example.

23. The vapour pressure of pure liquid X and pure liquid Y at 25 °C are 120 mm Hg and 160 mm Hg respectively. If equal moles of X and Y are mixed to form an ideal solution, calculate the vapour pressure of the solution. **2**

24. (a) Give reasons: **2 × 1**

(i) Mercury cell delivers a constant potential during its life time

(ii) In the experimental determination of electrolytic conductance Direct Current (DC) is not used.

OR

(b) Define fuel cell with an example. What advantages do the fuel cells have over primary and secondary batteries? **2**

25. (a) Write the IUPAC names of the following: **2 × 1**

(i) $[Co(NH_3)_5(ONO)]^{2+}$

(ii) $K_2[NiCl_4]$

OR

(b) (i) What is a chelate complex? Give one example.

(ii) What are heteropletic complex? Give one example. **2 × 1**

SECTION - C

26. Answer any 3 of the following: **3 × 1**

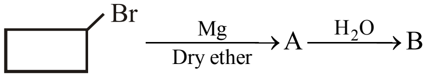
(a) Which isomer of C_5H_{10} gives a single monochloro compound C_5H_9Cl in bright sunlight?

(b) Arrange the following compounds in increasing order of reactivity towards S_N2 reaction:

2-Bromopentane, 1-Bromopentane, 2-Bromo-2-methylbutane

(c) Why p-dichlorobenzene has higher melting point than those of ortho-and meta-isomers?

(d) Identify A and B in the following:



27. (a) (i) Write the mechanism of the following reaction: **2 × 1**

$$2CH_3CH_2OH \xrightarrow[413K]{H^+} CH_3-CH_2-O-CH_2-CH_3+H_2O$$

(ii) Why ortho-nitrophenol is steam volatile while para nitrophenol is not?

OR

(b) What happens when **3 × 1**

(i) Anisole is treated with CH_3Cl anhydrous $AlCl_3$?

(ii) Phenol is oxidised with $Na_2Cr_2O_7/H^+$?

(iii) $(CH_3)_3C-OH$ is heated with CuI 573 K ?

Write chemical equation in support of your answer.

28. (a) Draw of geometrical isomers of $[Co(en)_2Cl_2]^{2+}$. Which geometrical isomer of $[Co(en)_2Cl_2]^{2+}$ is not optically active and why?

(b) Write the hybridisation and magnetic behaviour of $[CoF_6]^3$. **2 + 1**

[Given : Atomic number of Co = 27]

29. A first order reaction is 50% complete in 30 minutes at 300 K and in 10 minutes at 320 K. Calculate activation energy (E_a) for the reaction. [$R = 8.314\ J\ K^{-1}\ mol^{-1}$] **3**

[Given : log 2 = 0.3010. log 3 = 0.4771. log 4 = 0.6021]

30. When 19.5 g of $F - CH_2 - COOH$ (Molar mass = 78g mol^{-1}). is dissolved in 500 g of water, the depression in freezing point is observed to be FC. Calculate the degree of dissociation of $F-CH_2-COOH$. **3**

[Given : K_f for water = 1.86 K kg mol^{-1}]

SECTION - D

The following questions are case based questions Read the passage carefully and answer the questions that follow:

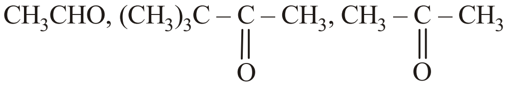
31. The carbon - oxygen double bond is polarised in aldehydes and ketones due to higher electronegativity of oxygen relative to carbon. Therefore they undergo nucleophilic addition reactions with a number of nucleophiles such as HCN, $NaHSO_3$, alcohols, ammonia derivatives and Grignard reagents. Aldehydes are easily oxidised by mild oxidising agents as compared to ketones. The carbonyl group of carboxylic acid does not give reactions of aldehydes and ketones. Carboxylic acids are considerably more acidic than alcohols and most of simple phenols.

Answer the following:

(a) Write the name of the product when an aldehyde reacts with excess alcohol in presence of dry HCl. **1**

(b) Why carboxylic acid is a stronger acid than phenol? **1**

(c) (i) Arrange the following compounds in increasing order of their reactivity towards CH_3MgBr:



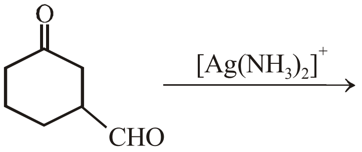
$$CH_3CHO,\ (CH_3)_3C-\underset{\underset{O}{\|}}{C}-CH_3,\ CH_3-\underset{\underset{O}{\|}}{C}-CH_3$$

(ii) Write a chemical test to distinguish between propanal and propanone. **2 × 1**

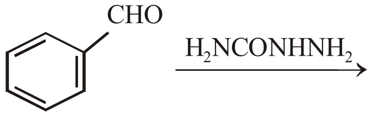
OR

(c) Write the main product in the following:

(i)



(ii)



2 + 1

32. Carbohydrates are optically active polyhydroxy aldehyde and ketones. They are also called saccharides. All these carbohydrates which reduce. Fehling's solution and Tollen's reagent are referred to as reducing sugar Glucose, the most important source of energy for mammals is obtained by the hydrolysis of starch. Vitamins are necessary food factors required in the diet. Proteins are the polymers of a acids and perform various structural and dynamic functions in the organisms. Deficiency of vitamins leads to many diseases.

Answer the following:

(a) The penta-acetate of glucose does not react with Hydroxylamine. What does it indicate? **1**

(b) Why cannot vitamin C be stored in our body? **1**

(c) Define the following as related to proteins.

(i) Peptide linkage

(ii) Denaturation **2 × 1**

OR

(c) Define the following as related to carbohydrates:

(i) Anomers **2 × 1**

(ii) Glycoside linkage

SECTION - E

33. (I) Give reasons: **3 + 2**

(i) Aniline on nitration gives good amount of m-nitroaniline, though – NH_2 group is o/p directing in electrophilic substitution reactions.

(ii) $(CH_3)_2$ NH is more basic than $(CH_3)_3N$ in an aqueous solution.

(iii) Ammonolysis of alkyl halides is not a good method to prepare pure primary amines.

(II) Write the reaction involved in the following:

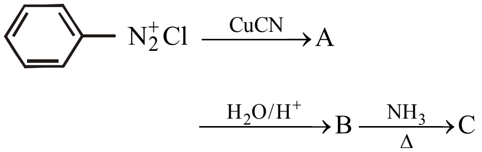
(i) Carbyl amine test

(ii) Gabriel phthalimide synthesis

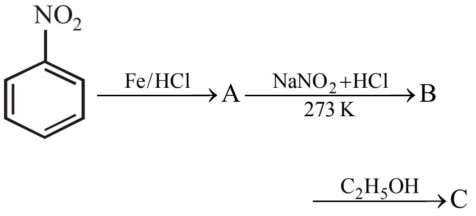
OR

(b) (I) Write the structure of A, B and C in the following reactions: **3 + 1 + 1**

(i)



(ii)



(II) Why aniline does not undergo Friedal-Crafts reaction?

(III) Arrange the following in increasing order of their boiling point:

$$C_2H_5OH, C_2H_5NH_2, (C_2H_5)_3 N$$

34. (a) Conductivity of 2×10^{-3} methanoic acid is 8×10^{-5} cm^{-1}. Calculate its molar conductivity and degree of dissociation of $\wedge^o_m$ for methanoic acid is 404 S cm^2 mol^{-1}. **3 + 2**

(b) Calculate the Δ_rG^o and log K_c for the given reaction at 298 K:

$$Ni_{(s)} + 2Ag^+{}_{(aq)} \rightleftharpoons Ni^{2+}{}_{(aq)} + 2Ag_{(s)}$$

Given: $E^o_{N_1{}^{2+}/N_1} = -0.25V, E^o_{Ag^+/Ag} = +0.80V$

$1 F = 96500\ C\ mol^{-1}$.

35. (I) Account for the following: **3 + 2**

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

(ii) Sc^{3+} is colourless whereas Ti^{3+} is coloured in an aqueous solution.

(iii) Actinoids show wide range of oxidation states.

(II) Write the chemical equations for the preparation of $KMnO_4$ from MnO_2.

OR

(b) (I) Account for the following: **2 + 2 + 1**

(i) Transition metals form alloys.

(ii) Ce^{4+} is a strong oxidising agent.

(II) Write one similarity and one difference between chemistry of Lanthanoids and Actinoids.

(III) Complete the following ionic equation:

$$Cr_2O_7^{2-} + 2OH^- \longrightarrow$$

Solutions

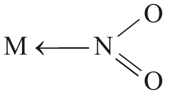
SECTION - A

1. **(c)** Phosgene gas;

$$2CHCl_3 + O_2 \xrightarrow{\text{sunlight}} \underset{\text{Carbonyl chloride or Phosgene}}{2COCl_2} + 2HCl$$

(1 Mark)

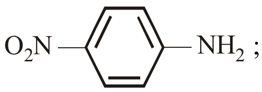
2. **(b)** NO_2;



and $M \longleftarrow O - N = O$

Two donor atoms of NO_2 are 'O' and 'N' are ligating with central metal atom (M) at a time. **(1 Mark)**

3. **(d)**



$K_b = \dfrac{[R\overset{+}{N}H_3][OH^-]}{[RNH_2]}$

Larger K_b value → smaller pK_b value → higher basicity.

$-NO_2$ group exerts $-I$ effect on the lone pair of $-NH_2$ group. This results into the difficulty of lone pair towards acid. Therefore, K_b value becomes smaller, pK_b value larger. **(1 Mark)**

4. **(a)** $\dfrac{+K}{2.303}$;

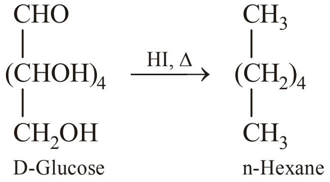
For 1st order reaction, $[R] = [R]_0 e^{-kt}$

or, $\dfrac{[R]_0}{[R]} = e^{kt}$

or, $2.303 \log \dfrac{[R]_0}{[R]} = kt$

or, $\log \dfrac{[R]_0}{[R]} = \dfrac{k}{2.303} t$ **(1 Mark)**

5. **(b)** n-hexane;



$$\underset{\text{D-Glucose}}{\begin{array}{c} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}} \xrightarrow{HI,\,\Delta} \underset{\text{n-Hexane}}{\begin{array}{c} CH_3 \\ | \\ (CH_2)_4 \\ | \\ CH_3 \end{array}}$$

(1 Mark)

6. **(a)** S_N2;

S_N2 reaction always produces the product with inversion of configuration in comparison to the reactant. **(1 Mark)**

7. **(b)** Temperature;

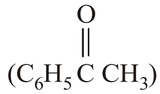
The solubility of gas in the decreases with increase in temperature as the kinetic energy of the gas increases. Which is increases the escaping tendency from liquid. **(1 Mark)**

8. **(c)** $G = K\left(\dfrac{l}{a}\right)$

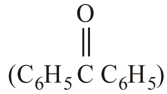
Conductance (G) is directly proportional to area (a) of the conductor, conductivity of the medium and inversely proportional to the length of the conductor. **(1 Mark)**

9. **(d)** I_2 and NaOH;

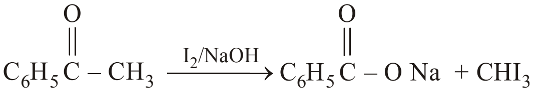
This is the reagent of iodoform reaction. At least one methyl group to attached to $\rangle C = O$ group is required to occur this reaction.



Acetophenone ($C_6H_5\overset{\overset{O}{\|}}{C}CH_3$) has $-CH_3$ group but



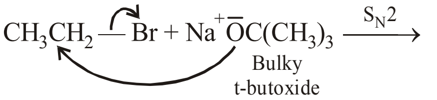
benzophenone ($C_6H_5\overset{\overset{O}{\|}}{C}C_6H_5$) has no $-CH_3$ group.



$$C_6H_5\overset{\overset{O}{\|}}{C}-CH_3 \xrightarrow{I_2/NaOH} C_6H_5\overset{\overset{O}{\|}}{C}-O\,Na + CHI_3$$

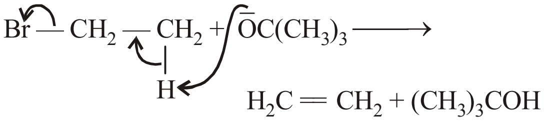
(1 Mark)

10. **(b)**



$$CH_3CH_2-Br + Na^+\,{}^-OC(CH_3)_3 \xrightarrow{S_N2} CH_3CH_2-O-C(CH_3)_3 + Br^- + Na^+$$

Although primary alkyl halide favours the S_N2 reaction but the bulky t-Butoxide nucleophile acts as strong base instead of nucleophile.



$$Br-CH_2-CH_2(H) + {}^-OC(CH_3)_3 \longrightarrow H_2C = CH_2 + (CH_3)_3COH$$

Whereas in (b) the substrate facilitates the carbocation stability and therefore, S_N1 mechanism as the attacking nucleophile is not bulky one. **(1 Mark)**

11. **(b)** CH_3CH_2CHO

It undergoes aldol condensation in presence of dil. NaOH and in order to occur this reaction at least one α – H has to be present.

$$2CH_3CH_2CHO \xrightarrow[\text{(ii) }\Delta]{\text{(i) dil. NaOH}} \underset{\text{But-2-enal}}{CH_3-CH=CH-CHO}$$

(1 Mark)

12. **(a)** $\dfrac{+3}{2}\dfrac{d[B]}{dt}$;

$3A \longrightarrow 2B$

Rate of the reaction $= -\dfrac{1}{3}\dfrac{d[A]}{dt} = \dfrac{1}{2}\dfrac{d[B]}{dt}$

$\therefore -\dfrac{d[A]}{dt} = \dfrac{3}{2}\dfrac{d[B]}{dt}$ **(1 Mark)**

13. **(d)** Cu;

Cu shows (+1) and (+2) oxidation states **(1 Mark)**

14. **(b)** $\overset{III}{Fe_4}[\overset{II}{Fe}(CN)_6]_3$;

Counter ion : $4Fe(III) \longrightarrow (+3) \times 4 = +12$

Complex ion :

$$\underset{\underset{\text{Unidentate ligand }(CN^{-})}{\uparrow}}{\overset{II}{[Fe(CN)_6]_3}} \longrightarrow [(+2)+\{(-6)\times 1\}]\times 3=-12$$

(1 Mark)

15. (c) For ideal solution, $\Delta_{mix}H = 0$
Solute – Solvent interaction = Solute – solute or Solvent – solvent interaction **(1 Mark)**

16. (b) Molar conductivity (Λ_m) decreases with increase in concentration can be explained by Debye – Huckel – Onsager equation.

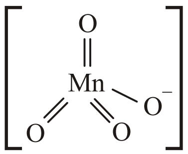
$$\Lambda_C = \underset{\underset{\text{Limiting molar conductivity}}{\uparrow}}{\Lambda_0} - A\sqrt{\underset{\uparrow\ \text{Concentration}}{C}}$$

As the concentration of the electrolyte increases the ion-cloud surrounding the a′ particular ion increases as the ion-cloud is created by oppositely charged ions. Therefore, the movement of desired ion towards the electrode gets hindered. As the dilution increases the counter ion-cloud is simultaneously decreases and conductivity increases. **(1 Mark)**

17. (a) Oxygen forms double bonds to metals in order to stabilize the highest oxidation states of metal. e.g.

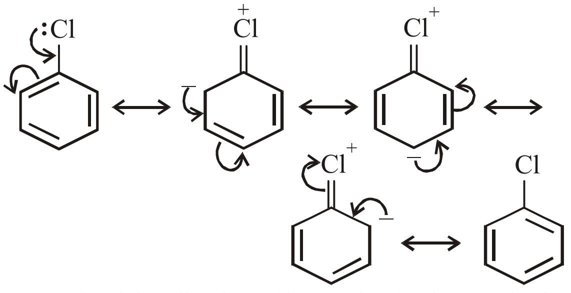
$[MnO_4^-] \longrightarrow$ Mn in (+7) oxidation state.

Structure ::



(1 Mark)

18. (c)



Due to the delocalization of lone pair of 'Cl' atom in the benzene ring the electron density enhances, which is not favourable for nucleophilic substitution reaction. Further, the C – Cl bond gets stronger due to resonance. **(1 Mark)**

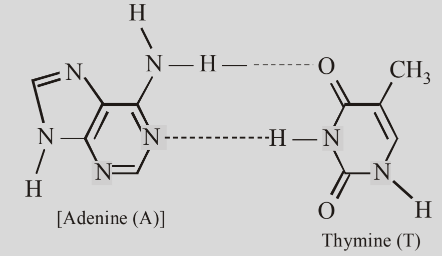
SECTION - B

19. Nucleic Acids, the long chain polymeric biomolecules, are one of the components of chromosome present in the nucleus of the cell. These are responsible for transmitting the genetic information. The monomer of the biopolymer is known as nucleotide. **(1 Mark)**

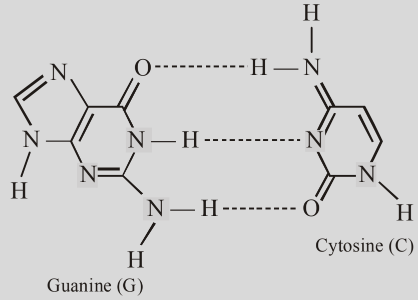
The two strands in DNA are complementary to each other because the H-bonds form between specific pairs of bases belong to different chains. **(1 Mark)**

Note

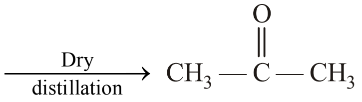
Adenine forms H-bonds with Thymine : 2H-bonds



Guanine pairs with cytosine : 3H-bonds

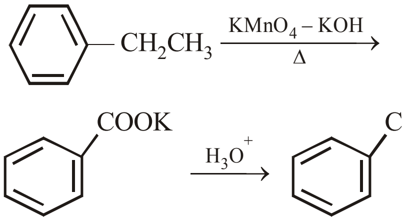


20. (a) $CH_3COOH \xrightarrow{Ca(OH)_2} (CH_3COO)_2Ca$



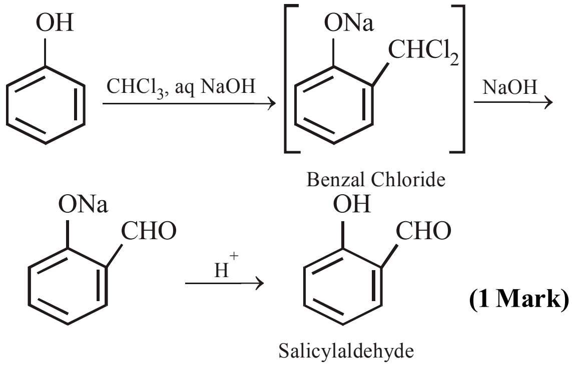
$$\xrightarrow[\text{distillation}]{\text{Dry}} CH_3-\overset{\overset{O}{\|}}{C}-CH_3$$ **(1 Mark)**

(b)



(1 Mark)

21. (a) Reimer-Tiemann Reaction:

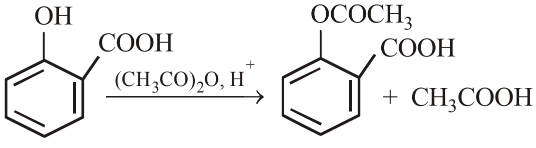


(1 Mark)

Note

This reaction is specifically used for ortho-formylation.

(b) Acetylation of Salicylic acid:



(Salicylic acid) (Acetylacetic acid) (Aspirin)

(1 Mark)

22. (a) $A \longrightarrow B$

Rate of the reaction : $r_1 = k[A]^2$ (∵ 2nd order kinetics)

Increasing concentration of A by 3 times:

$$r_2 = k(3[A])^2 = 9k[A]^2 = 9r_1$$

∴ Rate of the reaction enhances by 9 times.

The formation of 'B' enhances by 9 times. **(1 Mark)**

(b) The order of the reaction is sometimes, of higher order but appears as a first order reaction due to the presence of one of the components in excess. Such reactions are known as pseudofirst order reaction. e.g. Acid catalysed hydrolysis of ester, **(½ Mark)**

$$CH_3COOC_2H_5 + H_2O \xrightarrow{H^+} CH_3COOH + C_2H_5OH$$

Rate = $k[CH_3COOC_2H_5]\,[H_2O]$

H_2O is present in the reaction mixture in excess. Therefore, there is hardly any change happens in the concentration of water in the end of reaction.

∴ Rate = $k'[CH_3COOC_2H_5]$

Rate becomes dependent on the concentration of ester.

(½ Mark)

23. $p_x{}^0 = 120$ mm Hg, $p_y{}^0 = 166$ mm Hg at 25°C

Equal moles of X and Y.

∴ χ_x = mole fraction of X = $\frac{1}{2}$

χ_y = mole fraction of Y = $\frac{1}{2}$ **(½ Mark)**

$p_{Total} = p_x + p_y$ **(½ Mark)**

$= \chi_x p_x{}^0 + \chi_y p_y{}^0$

$= \left(\frac{1}{2} \times 120 + \frac{1}{2} \times 160\right)$ mm Hg **(½ Mark)**

$= 140$ mm Hg **(½ Mark)**

The vapour pressure of the solution = 140 mm Hg.

24. (a) (i) Mercury cell delivers a constant potential, ~1.35 V during its life time as the overall reaction does not involve any ion in solution whose concentration can change during its life time. **(1 Mark)**

(ii) Passing the direct current (DC) in the electrolyte changes the composition of the solution. **(1 Mark)**

OR

(b) Fuel Cell: The galvanic cells which are designed to convert the energy of combustion of fuels like hydrogen, methane, methanol etc. directly into electrical energy are called fuel cells. **(1 Mark)**

Advantages:

(a) It produces electricity with an efficiency of about 70% compared to thermal plants whose efficiency is about 40%.

(b) Fuel cells are pollution free.

(c) The H_2–O_2 fuel cell produces water vapour which can be, further, condensed and reused as a drinking water.

(1 Mark)

25. (a) (i) $[Co(NH_3)_5(ONO)]^{2+} \Rightarrow$

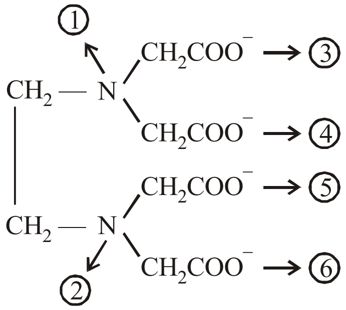
Pentaamminenitrito-O-Cobalt(III) **(1 Mark)**

(ii) $K_2(NiCl_4) \Rightarrow$ Potassium tetrachloridonickelate (II)

(1 Mark)

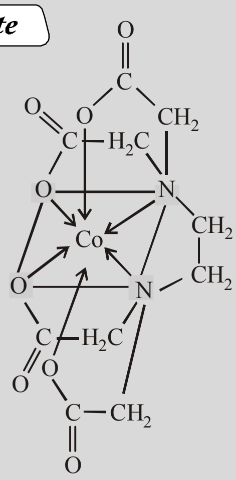
OR

(b) The complex which is formed by ligating more than one donor sites of a multidentate ligand simultaneously to the metal centre is known as chelating complex. e.g. **(1 Mark)**



⇒ Ethylenediamminetetraacetate ion ($EDTA^{4-}$) is a hexadentate ligand. It uses all 6 donor site to form a chelating complex. **(1 Mark)**

Note



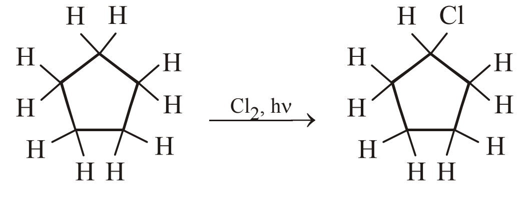
⇒ *[Co(EDTA)]; a chelating complex.*

25. (b) (ii) The complexes in which a metal is bound to more than one kind of donor groups, are known as heteroleptic complex. **(1 Mark)**

e.g. $[Co(NH_3)_4Cl_2]^+$ **(1 Mark)**

SECTION - C

26. (a) To produce single monochloro compound all the 'H' atoms have to be equivalent. That is possible only in the following structure.



C_5H_{10} = Cyclopentane

(1 Mark)

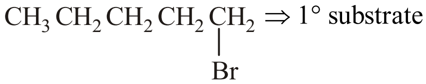
(b) 2-Bromopentane :

(I)

$CH_3CH_2CH_2CH(Br)CH_3 \Rightarrow 2°$ substrate

1-Bromopentane :

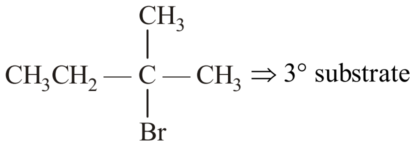
(II)



$CH_3CH_2CH_2CH_2CH_2Br \Rightarrow 1°$ substrate

2-Bromo-2-methylbutane :

(III)

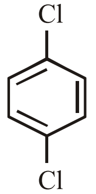


$CH_3CH_2—C(CH_3)(Br)—CH_3 \Rightarrow 3°$ substrate

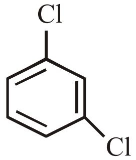
order of reactivity towards S_N2 reaction:

$3° < 2° < 1° \Rightarrow (III) < (I) < (II)$ **(1 Mark)**

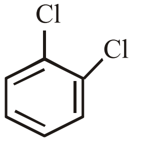
(c)



p-dichloro benzene



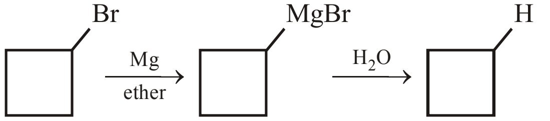
m-dichloro benzene



o-dichloro benzene

p-dichlorobenzene is symmetric in structure in comparison to o- or m-dichlorobenzene. Therefore, the packing of p-dichlorobenzene in crystal lattice is highly ordered and compact in comparison to other two isomers. **(1 Mark)**

(d)



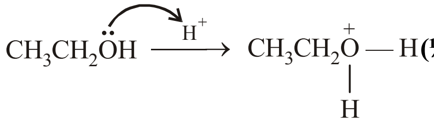
Cyclobutane

(1 Mark)

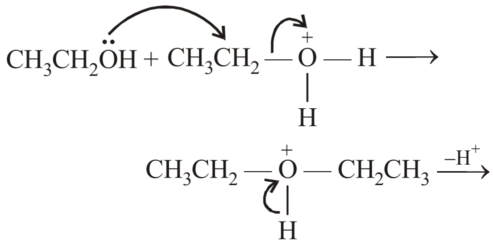
Note

The 'c' atom attached to – MgBr always have more electron density as Mg is the electropositive elements. So, the Grignard agent always acts as nucleophile.

27. (a) (i)



(½ Mark)



(1 Mark)

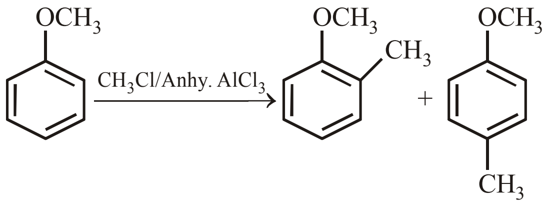
$CH_3CH_2—O—CH_2CH_3$

(½ Mark)

(ii) Ortho-nitrophenol is steam volatile while para-nitrophenol is not due to intermolecular Hydrogen bonding present in p-nitrophenol. **(1 Mark)**

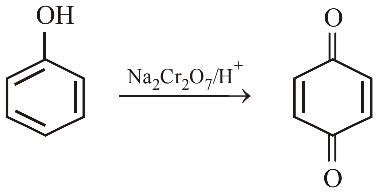
OR

(i)



(1 Mark)

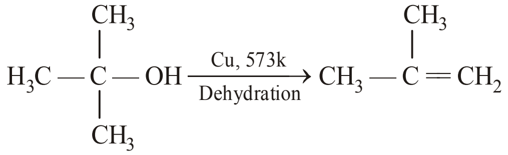
(ii)



Benzoquinone

(1 Mark)

(iii)

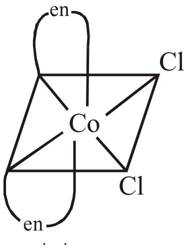


$H_3C—C(CH_3)_2—OH \xrightarrow[\text{Dehydration}]{\text{Cu, 573k}} CH_3—C(CH_3)=CH_2$

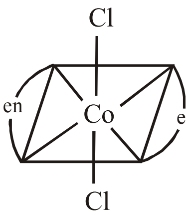
(1 Mark)

t-alcohol gives alkene by dehydration whereas p- and s-alcohols undergo dehydrogenation resulting into aldehyde and ketone, respectively.

28. (a)



cis-isomer



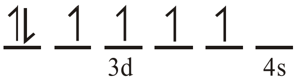
Trans-isomer

(1 Mark)

Trans - isomer is not optically active as it has plane of symmetry and axis of symmetry. **(1 Mark)**

(b) $[CoF_6]^{3-} \Rightarrow$ Co is in (+3) oxidation state.

Co^{3+} (24) $\Rightarrow 3d^6 4s^0 \Rightarrow$



Since F^- is a weak field ligand, the outer d-orbital participates in the hybridization to form 6 equivalent bonds. Hence, the hybridization of the central metal atomic orbitals is $\mathbf{sp^3d^2}$.

Co^{3+} has 4 unpaired electrons which imparts the spin magnetic moment of the complex. Therefore $[CoF_6]^{3-}$ is a paramagnetic complex.

$$\mu_{s.o} = \sqrt{n(n+2)} = \sqrt{4(4+2)} = 2\sqrt{6} \approx 4.9 \text{ B.M.}$$

(1 Mark)

29. For 1st order reaction, $t_{1/2} = \frac{0.693}{k}$

At 300k, $(t_{1/2})_1 = \frac{0.693}{k_1}$; $k_1 = Ae^{-Ea/RT_1}$ **(½ Mark)**

$\therefore\ k_1 = \frac{0.693}{30\times 60}$; $k_1 = Ae^{-Ea/R.320}$ ... (i) **(½ Mark)**

At 320k, $(t_{1/2})_2 = \frac{0.693}{k_2}$; $k_2 = Ae^{-Ea/RT_2}$

$\therefore\ k_2 = \frac{0.693}{10\times 60}$; $k_2 = Ae^{-Ea/R.320}$ ... (ii) **(½ Mark)**

$\therefore$ Eq. (ii) ÷ Eq. (i)

$$\frac{k_2}{k_1} = \frac{Ae^{-Ea/R.320}}{Ae^{-Ea/R.300}} = \frac{\frac{0.693}{10\times 60}}{\frac{0.693}{30\times 60}}$$ **(½ Mark)**

or $e^{\frac{Ea}{R}\left(\frac{1}{300}-\frac{1}{320}\right)} = 3$

or $\frac{Ea}{R}\times\frac{\cancel{20}}{300\times\underset{16}{\cancel{320}}} = 2.303\log 3$ **(½ Mark)**

or $Ea = 8.314\times 4800\times 2.303\times 0.4771\times 10^{-3}$ kJ

$= 43.848 \text{ kJ} \approx 43.85 \text{ kJ}$ **(½ Mark)**

30. 19.5 g of $F-CH_2-COOH : n_1 = \frac{19.5}{78} = 0.25$ mol

(½ Mark)

Molality of solution $(m) = \frac{0.25}{0.5} = 0.5\ (m)$

Depression of freezing point due to dissociation = 1°

$\therefore\ \Delta T_f = imK_f$

$\therefore\ i = \frac{1}{0.5\times 1.86} = 1.075$ **(½ Mark)**

$$\underset{\substack{0.25\text{ mol}\\0.25(1-x)\text{ mol}}}{F-CH_2-COOH} \rightleftharpoons \underset{0.25x\text{ mol}}{F\,CH_2\,COO^-} + \underset{0.25x\text{ mol}}{H^+}$$

[Suppose x is the degree of dissociation]

$\therefore$ Total no. of particles

$= 0.25(1-x) + 0.25x + 0.25x$ **(½ Mark)**

$= 0.25 + 0.25x$

$$i = \frac{\text{Total no. of moles of particles after dissociation}}{\text{Total no. of moles of particles before dissociation}}$$ **(½ Mark)**

$\therefore\ i = \frac{0.25(1+x)}{0.25} = 1.075$ **(½ Mark)**

or $1 + x = 1.075$

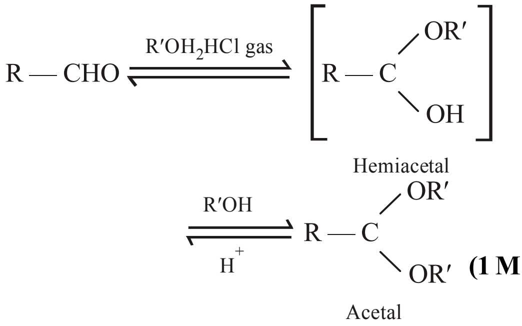
or $x = 1.075 - 1 = 0.075$

$\therefore$ Degree of dissociation of $F-CH_2-COOH = 0.075$.

(½ Mark)

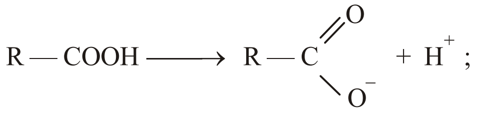
SECTION - D

31. (a) Aldehyde + $\underset{\text{(excess)}}{\text{Alcohol}} \xrightarrow[\text{HCl}]{\text{Dry}}$ Acetal

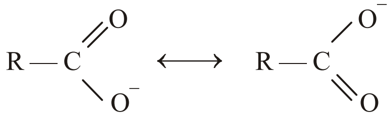


(1 Mark)

(b) Acidity of a substance is judged by the stability of its conjugate base.



Conjugate base

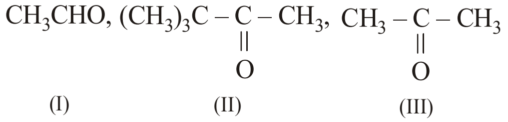


Two equivalent cannonical structures of conjugate base

Further, in these two cannonical structures, the negative charge is symmetrically distributed over the more electronegative atom 'O'.

Therefore, carboxylic acids are the most acidic organic compound among the other organic substances. **(1 Mark)**

(c) (i)



$\underset{(I)}{CH_3CHO}$, $\underset{(II)}{(CH_3)_3C-\underset{\substack{\|\\ O}}{C}-CH_3}$, $\underset{(III)}{CH_3-\underset{\substack{\|\\ O}}{C}-CH_3}$

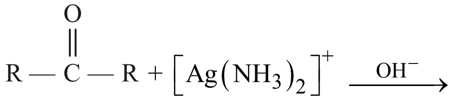
Increasing order of reactivity toward CH_3MgBr

(II) < (III) < (I)

+I effect of alkyl group(s) reduces the electrophilicity of carbonyl carbon. **(1 Mark)**

(ii) The mild oxidizing agents, e.g. Tollen's reagent, Fehling's reagent can easily oxidize aldehydes but not ketones.

$$R-CHO + 2\underset{\substack{\text{(Freshly prepared}\\\text{ammoniacal silver}\\\text{nitrate solution)}}}{\left[Ag(NH_3)_2\right]^+} + 3OH^- \longrightarrow RCOO^- + 2Ag + 4NH_3 + 2H_2O$$

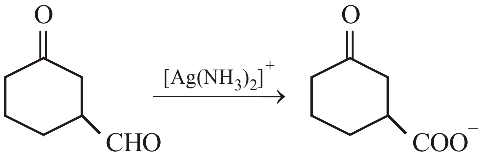


$$R-\overset{\substack{O\\ \|}}{C}-R + \left[Ag(NH_3)_2\right]^+ \xrightarrow{OH^-} \text{no reaction}$$

(1 Mark)

OR

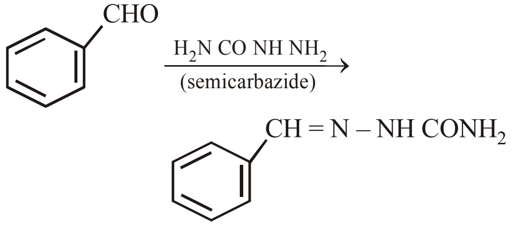
(c) (i)



(keto group remains unaffected with mild oxidizing agent)

(1 Mark)

(ii)



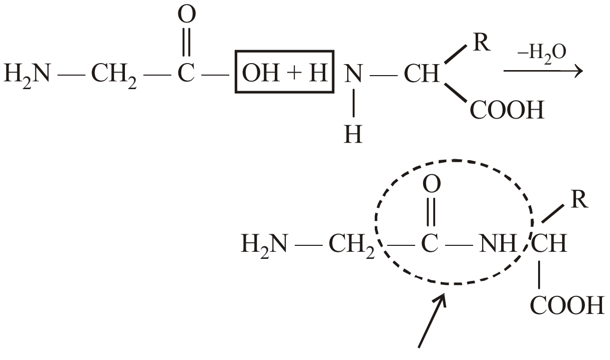
semicarbazonc.

(1 Mark)

32. **(a)** Pentacetate of glucose does not react with hydroxylamine (NH_2OH). This indicates the absence of aldehyde (–CHO) group. **(1 Mark)**

(b) Vitamin C is a water soluble vitamin. That is why it cannot be stored in body but excreted in urine. **(1 Mark)**

(c) (i) Peptide linkage is nothing but the amide linkage which is formed between – COOH group and – NH_2 group of two same or different amino acid molecules. This results to the elimination of a water molecule and formation of a peptide bond – CO – NH – .



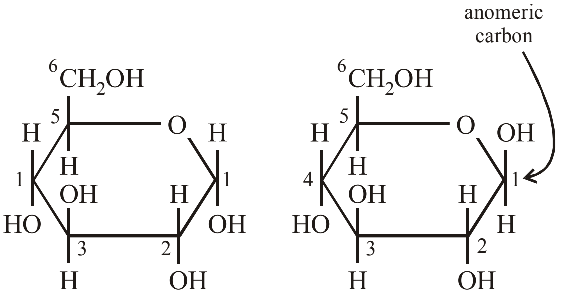
Peptide linkage

(1 Mark)

(ii) Denaturation: When a protein, in its native form, is subjected to a physical or chemical change like change in temperature, or pH, the native conformation of the molecule is disrupted as the secondary and tertiary linkages get destroyed but primary linkage remains intact. This phenomenon is known as denaturation of protein. **(1 Mark)**

OR

(c) (i) Anomers: Carbohydrates which differ in configuration at the glycosidic carbon (i.e., C_1 in aldoses and C_2 in ketoses) are called anomers. e.g. α-D-Glucose and β-D-Glucose are anomers.

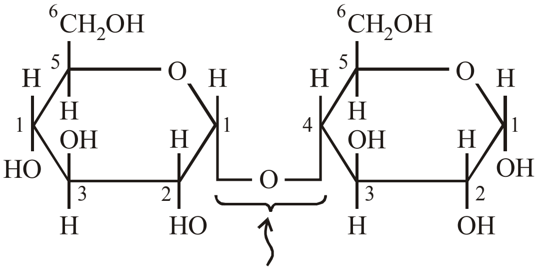


anomeric carbon

α-D-Glucose β-D-Glucose

(1 Mark)

(ii) Glycosidic Linkage:

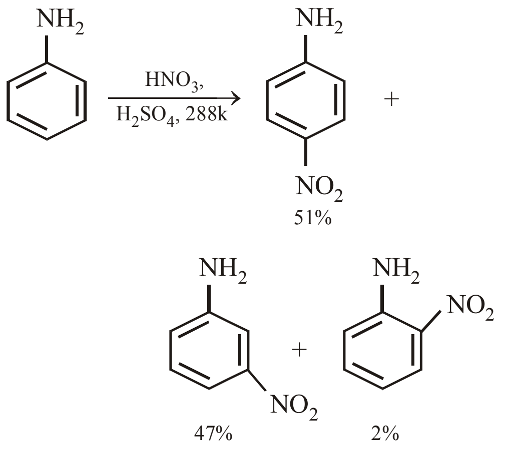


α-1, 4-Glycosidic linkage

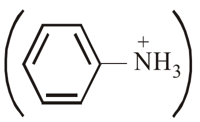
The two monosaccharides are joined together by an oxide linkage formed by the loss of a water molecule. Such a linkage between two monosaccharide units through oxygen atom is called glycosidic linkage. **(1 Mark)**

SECTION - E

33. **(a)** (i)

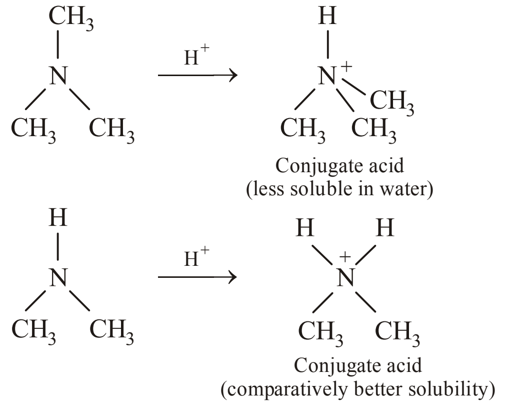


In a strong acidic medium, aniline gets protonated to form anilinium ion



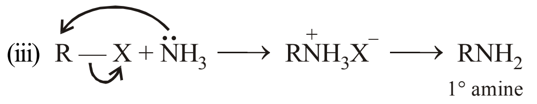
which is meta directing. **(1 Mark)**

(ii) In aqueous solution $(CH_3)_3N$ is less basic than $(CH_3)_2NH$ due to the difficulty in solvation of tertiary amine group than secondary amine after protonation. Therefore, the instability of conjugate acids of t-amines leads to the less basicity.



So, $(CH_3)_2NH$ is more basic than $(CH_3)_3N$.

(1 Mark)

(iii)


$$R-X+\ddot{N}H_3 \longrightarrow R\overset{+}{N}H_3\overset{-}{X} \longrightarrow \underset{1^\circ \text{ amine}}{RNH_2}$$

Primary amine or 1° amine obtained by ammonolysis of alkyl halide further reacts as nucleophile to react with alkyl halide and leads to the formation of secondary and tertiary amines and finally, quaternary amines.

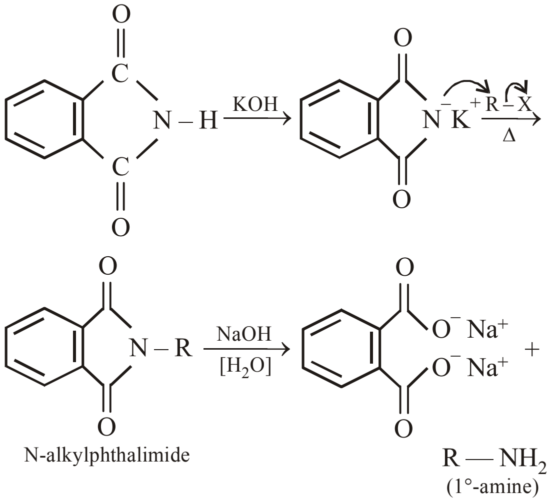
$$R-NH_2 \xrightarrow{RX} R_2NH \xrightarrow{RX} R_3N \xrightarrow{RX} R_4\overset{+}{N}\overset{-}{X}$$

(1 Mark)

(II) (i) Carbylamine Test or Isocyanide Test:
This reaction is used for primary amine test.

$$R-NH_2+CHCl_3+3KOH \xrightarrow{\Delta} RNC+3KCl+3H_2O$$ **(1 Mark)**

(ii) Gabriel Phthalimide Synthesis:



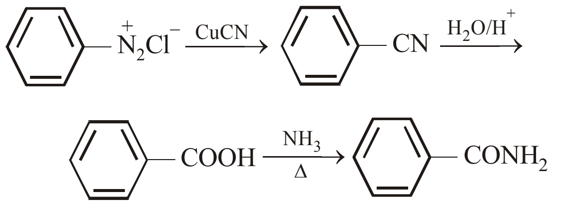
(1 Mark)

Note

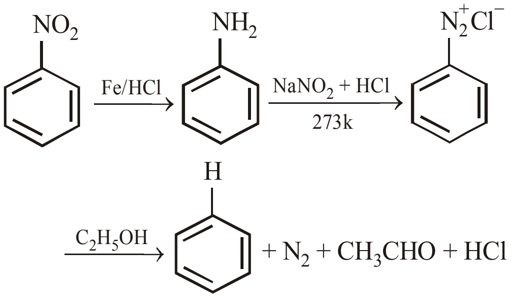
Aromatic primary amines cannot be prepared by this method.

OR

(b) (I) (i)



(1½ Marks)

(ii)


(1½ Marks)

(II) Aniline acts as Lewis base and forms salt with Lewis acid ($AlCl_3$) used in Friedel Craft reaction. **(1 Mark)**

(III)

C_2H_5OH,	$C_2H_5NH_2$,	$(C_2H_5)_3N$
(I)	(II)	(III)
78.37°C	16 – 20°C	88.6 – 89.8°C

Boiling pt. $\propto$ molecular wt.; $\propto$ H-bonded substance

$\therefore$ order = (II) < (I) < (III) **(1 Mark)**

34. (a) $HCOOH \rightleftharpoons HCOO^- + H^+$

$K = 8\times10^{-5}\ S\ cm^{-1}$ for concentration $= 2\times10^{-3}$ M

$$\therefore \text{ Molar conductivity } (\Lambda_m) = \frac{K}{C} = \frac{8\times10^{-5}}{2\times10^{-3}}$$ **(1 Mark)**

$$= 4\times10^{-2}\ S\ M^{-1}\ cm^{-1}$$
$$= 4\times10^{-2}\ S\ mol^{-1}\ L\ cm^{-1}$$
$$= 4\times10^{-2}\times10^{3}\ S\ mol^{-1}\ cm^{2}$$
$$= 40\ S\ cm^2\ mol^{-1}$$ **(½ Mark)**

$$\therefore \propto = \frac{\Lambda_m}{\Lambda_m^0} = \frac{40}{404} \approx 0.099$$ **(1 Mark)**

Degree of dissociation = 0.099 **(½ Mark)**

(b) $Ni\,(s) + 2Ag^+\,(aq) \rightleftharpoons Ni^{2+}\,(aq) + 2Ag\,(s)$

Anodic reaction: $Ni \longrightarrow Ni^{2+} + 2e$

Cathodic reaction: $2Ag^+ + 2e \longrightarrow 2Ag$ **(½ Mark)**

$$\Delta_rG^0 = -nFE^0_{cell}$$
$$= -2\times96500\times1.05\ J\ mol^{-1}$$
$$= -202{,}650\ J\ mol^{-1}$$
$$= -202.65\ kJ\ mol^{-1}$$ **(½ Mark)**

$$E^0_{cell} = E^0_{Ni/Ni^{2+}} + E^0_{Ag^+/Ag}$$
$$= (0.25+0.80)\ V$$
$$= 1.05\ V$$ **(½ Mark)**

$\therefore \quad \Delta_r G^0 = -RT \ln K_C = -202.65$

$$\text{or,} \quad \log K_C = \frac{202.65 \times 10^3}{2.303 \times 8.314 \times 298} = 35.52$$

$\Delta_r G^0 = -202.65 \text{ kJ mol}^{-1}$

$\log K_C = 35.52$ **(½ Mark)**

35. (a) (I) (i) The third ionization energy of Mn is very large compare to Cr. The 3rd ionization of Mn corresponds to Mn^{2+} $(d^5) \longrightarrow Mn^{3+}$ (d^4) which implies the stability of d^5 (half - filled) system, hence, more positive Mn^{3+}/Mn^{2+} reduction potential. **(1 Mark)**

(ii) $Sc\,(21) \longrightarrow 3d^1 4s^2;\; Sc^{3+} \longrightarrow 3d^0\, 4s^0$

$Ti\,(22) \longrightarrow 3d^2 4s^2;\; Ti^{3+} \longrightarrow 3d^1\, 4s^0$

Ti^{3+} shows the d-d transition in its aqueous complex, $[Ti(H_2O)_6]^{3+}$ and this is responsible for colour of the aqueous solution. **(1 Mark)**

(iii) Actinoids show in general (+3) oxidation state. The elements, in the first half of the series frequently exhibit higher oxidation states because they have 5f, 6d, 7s orbitals of comparable energies. **(1 Mark)**

(II) $KMnO_4$ is prepared by fusion of MnO_2 with an alkali metal hydroxide and an oxidizing agent like KNO_3.

$$2MnO_2 + 4KOH + O_2 \longrightarrow \underset{\text{(dark green)}}{2K_2MnO_4} + 2H_2O$$

$$3K_2MnO_4^- + 4H^+ \longrightarrow 2KMnO_4 + MnO_2 + 2H_2O$$

(1 Mark)

OR

(b) (I) (i) Alloys are solid solutions. The transition elements have minimal difference in their atomic sizes. So, the lattice points are replacable by atoms of different elements in solid states. **(1 Mark)**

(ii) Ce^{4+} $(4f^0)$ has a tendency to form Ce^{3+} $(4f^1)$.

$$\left(E^0_{Ce^{4+}/Ce^{3+}} = +1.74\text{ V}\right)$$

It has very high positive standard electrode potential which favours the formation of Ce^{3+}. However, $Ce^{4+} \longrightarrow Ce^{3+}$ conversion is slow enough to use as oxidizing agent in analytical chemistry. **(1 Mark)**

[**Note:** $4f^0 \rightarrow$ the empty orbital gets extra stability like half-filled and full filled subshells]

(b) (II) **Similarities:**

(i) Both series of elements experience contraction in atomic sizes from left to right.

(ii) The general oxidation state shown by these elements (+3). **(1 Mark)**

Differences:

(i) Most of the actinoids are radioactiars in comparison to lanthanoids.

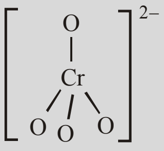
(ii) Actinoids are highly reactive metals why they are finely divided.

(iii) Magnetic properties of actinoids are more complex than lanthanoids. **(1 Mark)**

(b) (III) $$\underset{\text{(dichromate)}}{\overset{+6}{Cr_2}\, O_7^{2-}} + 2OH^- \longrightarrow \underset{\text{(chromate)}}{2\overset{+6}{Cr}\, O_9^{2-}} + H_2O$$

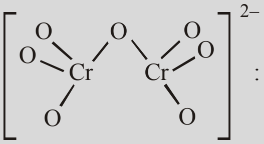
This reaction is dependent on pH. **(1 Mark)**

Note



: Tetrahedral ;

Chromate



: Two tetrahedral

Dichromate