

CHEMISTRY

Maximum Marks : 70

Time Allowed : 3 Hours

General Instructions :

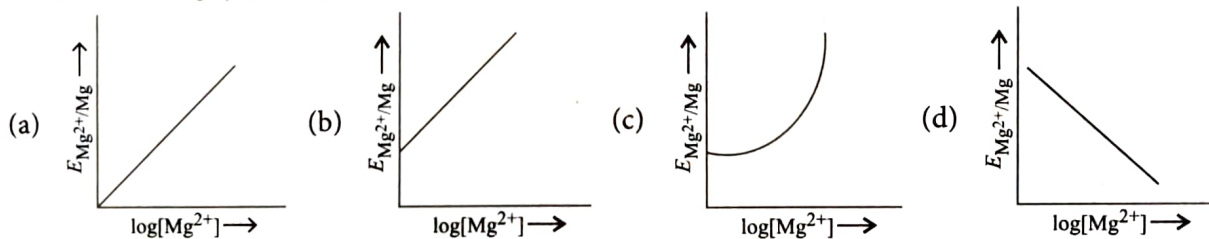
Read the following instructions carefully.

- There are 33 questions in this question paper with internal choice.
- SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
- SECTION B consists of 5 short answer questions carrying 2 marks each.
- SECTION C consists of 7 short answer questions carrying 3 marks each.
- SECTION D consists of 2 case-based questions carrying 4 marks each.
- SECTION E consists of 3 long answer questions carrying 5 marks each.
- All questions are compulsory.
- Use of log tables and calculators is not allowed.

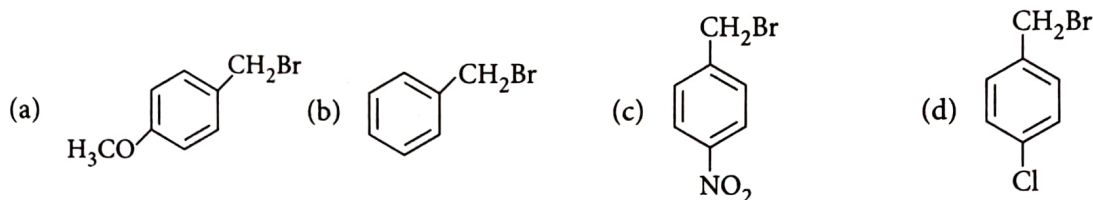
SECTION A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. Electrode potential for Mg electrode varies according to the equation, $E_{\text{Mg}^{2+}|\text{Mg}} = E_{\text{Mg}^{2+}|\text{Mg}}^{\circ} - \frac{0.059}{2} \log \frac{1}{[\text{Mg}^{2+}]}$. The graph of $E_{\text{Mg}^{2+}|\text{Mg}}$ vs $\log [\text{Mg}^{2+}]$ is



2. Which one of the following compounds most readily undergoes $\text{S}_{\text{N}}1$ reaction?



3. Among the following series of transition metal ions, the one where all metal ions have $3d^2$ electronic configuration is

- (a) $\text{Ti}^{3+}, \text{V}^{2+}, \text{Cr}^{3+}, \text{Mn}^{4+}$ (b) $\text{Ti}^{+}, \text{V}^{4+}, \text{Cr}^{6+}, \text{Mn}^{7+}$
 (c) $\text{Ti}^{4+}, \text{V}^{3+}, \text{Cr}^{2+}, \text{Mn}^{3+}$ (d) $\text{Ti}^{2+}, \text{V}^{3+}, \text{Cr}^{4+}, \text{Mn}^{5+}$

4. Which of the following is the correct representation of relative lowering of vapour pressure?

(a) $\frac{P^{\circ}}{\Delta P} = \frac{P^{\circ} - P}{P^{\circ}}$ (b) $\frac{\Delta P}{P^{\circ}} = \frac{P - P^{\circ}}{P^{\circ}}$ (c) $\frac{P^{\circ}}{\Delta P} = \frac{P^{\circ}}{P^{\circ} - P}$ (d) $\frac{\Delta P}{P^{\circ}} = \frac{P^{\circ} - P}{P^{\circ}}$

5. Among the following which is least acidic?
 (a) Phenol (b) *o*-Cresol
 (c) *p*-Nitrophenol (d) *p*-Chlorophenol
6. Predict the order of Δ_o for the following compounds and select the correct option.
 I. $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ II. $[\text{Fe}(\text{CN})_2(\text{H}_2\text{O})_4]$
 III. $[\text{Fe}(\text{CN})_4(\text{H}_2\text{O})_2]^{2-}$
 (a) (I) < (II) < (III) (b) (II) < (I) < (III)
 (c) (III) < (II) < (I) (d) (II) < (III) < (I)
7. Identify X in the following reaction sequence :

$$X \xrightarrow[\text{H}_2\text{SO}_4]{\text{K}_2\text{Cr}_2\text{O}_7} \text{C}_3\text{H}_6\text{O} \xrightarrow[\text{I}_2 + \text{NaOH}]{\text{Warm}} \text{CHI}_3$$

 (a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (b) $\text{CH}_3\text{CHOHCH}_3$
 (c) $\text{CH}_3\text{OCH}_2\text{CH}_3$ (d) $\text{CH}_3\text{CH}_2\text{CHO}$
8. A solution containing 2.675 g of $\text{CoCl}_3 \cdot 6\text{NH}_3$ (molar mass = 267.5 g mol^{-1}) is passed through a cation exchanger. The chloride ions obtained in solution were treated with excess of AgNO_3 to give 4.75 g of AgCl (molar mass = 143.5 g mol^{-1}). The formula of the complex is
 (a) $[\text{CoCl}_3(\text{NH}_3)_3]$ (b) $[\text{CoCl}(\text{NH}_3)_5]\text{Cl}_2$
 (c) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ (d) $[\text{CoCl}_2(\text{NH}_3)_4]\text{Cl}$
9. Identify the correct statement about lactose.
 (a) It consists of one galactose and one glucose unit.
 (b) Mutarotation is not possible.
 (c) Anomeric carbon of galactose is attached to carbon-1 of glucose which is β -1, 4-glycosidic bond.
 (d) All of these.
10. Consider the following statements :
 (i) Increase in concentration of reactant increases the rate of a zero order reaction.
 (ii) Rate constant k is equal to collision frequency A , if $E_a = 0$.
 (iii) Rate constant k is equal to collision frequency A , if $E_a = \infty$.
 (iv) $\ln k$ vs $1/T$ graph is a straight line.
 Correct statements are
 (a) Only (i) and (iii) (b) Only (ii) and (iv) (c) Only (iii) and (iv) (d) Only (ii) and (iii)

11. Match the column-I with column-II and mark the appropriate choice.

Column-I		Column-II	
(A)	Hydrolysis of benzene diazonium chloride	(i)	<i>p</i> -Cresol
(B)	Phenol + methyl chloride in presence of anhy. AlCl_3	(ii)	Salicylic acid
(C)	Reaction of sodium phenoxide with CO_2	(iii)	Picric acid
(D)	Phenol + Conc. HNO_3	(iv)	Phenol

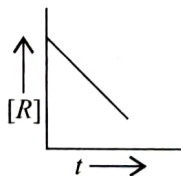
- (a) (A) \rightarrow (i), (B) \rightarrow (iii), (C) \rightarrow (ii), (D) \rightarrow (iv)
 (b) (A) \rightarrow (ii), (B) \rightarrow (iii), (C) \rightarrow (iv), (D) \rightarrow (i)
 (c) (A) \rightarrow (iv), (B) \rightarrow (i), (C) \rightarrow (ii), (D) \rightarrow (iii)
 (d) (A) \rightarrow (iii), (B) \rightarrow (iv), (C) \rightarrow (i), (D) \rightarrow (ii)
12. The IUPAC name of $\text{K}_2[\text{Cr}(\text{CN})_2\text{O}_2(\text{O})_2\text{NH}_3]$ is
 (a) potassium amminedicyanidodioxoperoxochromate(VI)
 (b) potassium amminedicyanidotetroxochromium(III)
 (c) potassium amminedicyanidochromate(IV)
 (d) potassium amminecyanidooxoperoxochromate(VI).

13. **Assertion (A)** : *m*-Bromotoluene can be prepared from *m*-toluidine.
Reason (R) : Amino group is *meta*-directing.
 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.
14. **Assertion (A)** : The maximum oxidation state of chromium in its compounds is +6.
Reason (R) : Chromium has only six electrons in *ns* and $(n - 1)d$ orbitals.
 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)** : Sucrose is a non-reducing sugar.
Reason (R) : It has a glycosidic linkage (between C-1 of glucose and C-2 of fructose).
 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.
16. **Assertion (A)** : Anisole undergoes electrophilic substitution at *ortho* and *para*-positions.
Reason (R) : Anisole is more reactive than phenol towards electrophilic substitution reactions.
 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.

SECTION B

This section contains 5 questions with internal choice in two questions. The following questions are very short answer type and carry 2 marks each.

17. For a chemical reaction, $R \rightarrow P$, the variation in the concentration $[R]$ vs. time (t) is given then



- (i) Predict the order of the reaction. Give one example of such type of reactions.
 (ii) What is the slope of the curve?

OR

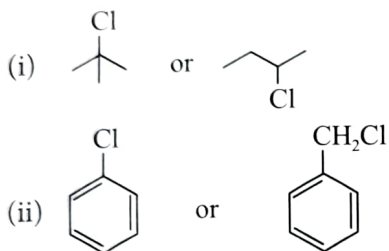
- (i) For a reaction, $A + B \rightarrow \text{product}$, the rate law is given by, $\text{rate} = k[A]^1[B]^2$. What is the order of the reaction?
 (ii) Write the integrated rate expression and unit of rate constant ' k ' for the first order reaction.
18. What type of azeotropic mixture will be formed by a solution of acetone and chloroform? Justify on the basis of strength of intermolecular interactions that develop in the solution.

19. The geometry of $[\text{Ni}(\text{CO})_4]$ is not same as that of $[\text{Ni}(\text{CN})_4]^{2-}$. Give reason.
20. How are the following reactions carried out? Write the equations and conditions. (any 2) :
- Acetic acid to ethylamine
 - Bromocyclohexane to cyclohexanamine.
 - Acetanilide to ethylphenyl amine
21. What are the points of differences between $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ reactions?

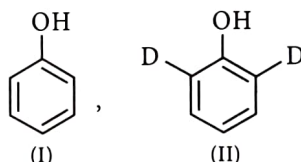
SECTION C

This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

22. Assuming complete dissociation, calculate the expected freezing point of a solution prepared by dissolving 6.00 g of Glauber's salt, $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ in 0.100 kg of water. (K_f for water = $1.86 \text{ K kg mol}^{-1}$, atomic masses : Na = 23, S = 32, O = 16, H = 1)
23. (a) Identify the compound which will undergo $\text{S}_{\text{N}}1$ reaction.



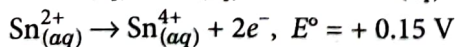
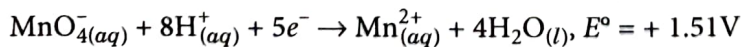
- (b) Under what condition 2-methyl propene can be converted into isobutyl bromide?
24. (a) Which has higher value of K_a ?



- (b) *Ortho*-nitrophenol is more acidic than *ortho*-cresol. Why?
25. Suggest chemical reactions for the following conversions :
- Aniline to benzoic acid
 - n*-Hexanenitrile to 1-aminopentane
 - p*-Chloroaniline to *p*-chlorobenzylamine
26. The electrical resistance of a column of 0.05 M NaOH solution of diameter 1 cm and length 50 cm is 5.5×10^3 ohm. Calculate its resistivity, conductivity and molar conductivity.

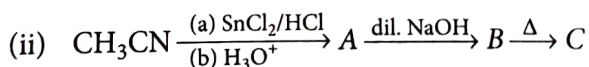
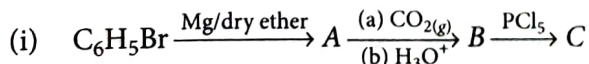
OR

Two half-reactions of an electrochemical cell are given below :



Construct the redox equation from the standard potential of the cell and predict if the reaction is reactant favoured or product favoured.

27. Write the structures of compounds A, B and C in each of the following reactions :

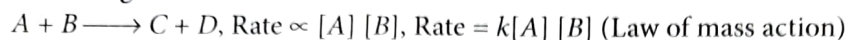


28. Explain the following cases giving appropriate reasons :
- Nickel does not form low spin octahedral complexes.
 - The π -complexes are known for the transition metals only.
 - Co^{2+} is easily oxidised to Co^{3+} in the presence of a strong ligand.

SECTION D

The following questions are case-based questions. Each question has an internal choice and carries 4 (2+1+1) marks each. Read the passage carefully and answer the questions that follow.

29. The rate of reaction is directly proportional to the product of the define mass (molar concentration) of the reactants raised to powers equal to the numbers of their respective molecules in the stoichiometric equation describing the reaction.

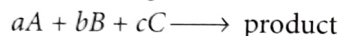


Where, k is constant of proportionality or rate constant.

If $[A] = [B] = 1$ then rate of reaction = k

So, rate constant is the rate of the reaction when concentration of each of the reactants is unity. It is also known as specific rate.

Consider a general reaction,

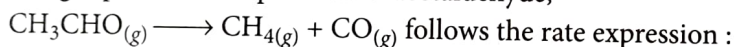


$$\text{Rate} = k[A]^a[B]^b[C]^c \text{ (law of mass action)}$$

$$\text{Rate} = k[A]^p[B]^q[C]^r \text{ (rate law expression)}$$

p , q and r are determined experimentally and may or may not be equal to a , b and c . p , q , r represents the order of reaction with respect to A , B , C .

- (a) The gas phase decomposition of acetaldehyde,



$$\text{Rate} = -d[\text{CH}_3\text{CHO}] / dt = k[\text{CH}_3\text{CHO}]^{3/2}$$

In terms of the partial pressure of acetaldehyde, it can be expressed as

$$-\frac{dp_{\text{CH}_3\text{CHO}}}{dt} = k(p_{\text{CH}_3\text{CHO}})^{3/2}$$

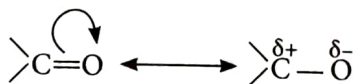
If the pressures are measured in the units of atmosphere and time in minutes then,

- what is the unit of rate of reaction?
 - what is the unit of the rate constant, k ?
- (b) Explain why the rate of a reaction in the remaining mixture is not affected when a portion is removed for analysis.
- (c) For a reaction $A + B \rightarrow P$, the rate law is given by, $r = k[A]^{1/2}[B]^2$
What is the order of this reaction?

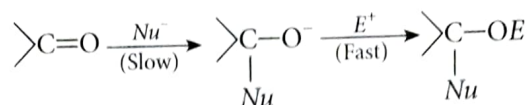
OR

The rate constant for a first order reaction is 60 s^{-1} . How much time will it take to reduce the initial concentration of the reactant to its $1/16^{\text{th}}$ value?

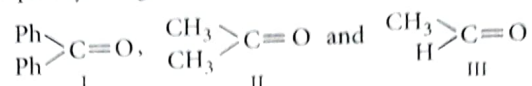
30. Carbonyl compounds have $>\text{C}=\text{O}$ group which are polar because of more electronegative oxygen atom. This results in polarization of π -electrons as



By resonating structure it is clear that there is nucleophilic addition over carbonyl compounds. The attack of nucleophile precedes the attack of electrophile as anion formed here after nucleophilic attack is more stable than the cation. Thus rate determining step is the attack of nucleophile over carbonyl carbon atom.



- (a) What happens when CH_3CHO reacts with HCN and the products are hydrolysed? Give chemical equation and state whether the product formed is optically active or not and why?
- (b) The order of reactivity of phenyl magnesium bromide (PhMgBr) with the following compounds:

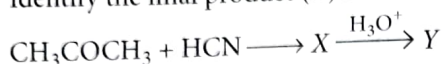


- (i) $\text{III} > \text{II} > \text{I}$
 (iii) $\text{I} > \text{III} > \text{II}$

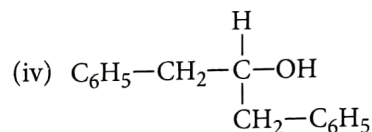
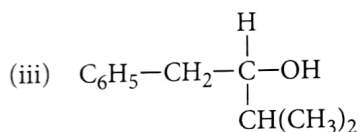
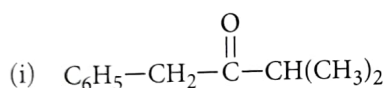
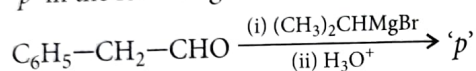
- (ii) $\text{II} > \text{I} > \text{III}$
 (iv) $\text{I} > \text{II} > \text{III}$

OR

Identify the final product (Y) in the following reaction series.



- (i) $(\text{CH}_3)_2\text{C(OH)(COOH)}$ (ii) $(\text{CH}_3)_2\text{C(OH)(CN)}$
 (iii) $(\text{CH}_3)_2\text{C(OH)(NH}_2\text{)}$ (iv) $\text{CH}_3\text{CH=CHCOOH}$
- (c) 'p' in the following conversion is



SECTION E

The following questions are long answer types and carry 5 marks each. All questions have an internal choice.

31. (a) Why is *D*-fructose used only for sweetening cold drinks and not hot ones?
 (b) How will you distinguish 1° and 2° hydroxyl groups present in glucose? Explain with reactions.
 (c) How do you explain the presence of all the six carbon atoms in glucose in a straight chain?

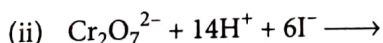
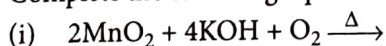
OR

- (a) Explain why glycine exists as a zwitter ion ($\text{NH}_3^+\text{CH}_2\text{COO}^-$) but anthranilic acid does not.
 (b) State the significance of primary and secondary structures of proteins.
 (c) Differentiate between peptide linkage and glycosidic linkage.

32. (a) Account for the following :

- (i) Mn shows the highest oxidation state of +7 with oxygen but with fluorine it shows the highest oxidation state of +4.
 (ii) Cr^{2+} is a strong reducing agent.
 (iii) Cu^{2+} salts are coloured while Zn^{2+} salts are white.

- (b) Complete the following equations :



OR

- (a) Following are the transition metal ions of 3d series :

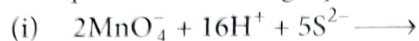


(Atomic numbers : Ti = 22, V = 23, Mn = 25, Cr = 24)

Answer the following :

- Which ion is most stable in aqueous solution and why?
- Which ion is strong oxidising agent and why?
- Which ion is colourless and why?

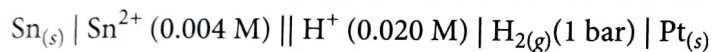
- (b) Complete the following equations :



33. (a) What type of battery is mercury cell? Why is it more advantageous than dry cell?
- (b) (i) Why is chromium used for coating iron?
(ii) Iron is galvanised for protecting it from rusting. Explain.
- (c) Describe the nickel-cadmium cell.

OR

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



(Given : $E^\circ_{\text{Sn}^{2+}/\text{Sn}} = -0.14 \text{ V}$)

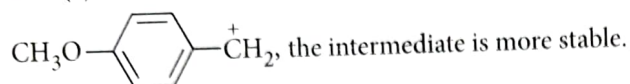
- (b) Give reasons :

- On the basis of E° values, O_2 gas should be liberated at anode but it is Cl_2 gas which is liberated in the electrolysis of aqueous NaCl.
- Conductivity of CH_3COOH decreases on dilution.

1. (b): $E = E^\circ + \frac{0.059}{2} \log[\text{Mg}^{2+}]$

Hence, plot of E vs $\log [\text{Mg}^{2+}]$ will be linear with positive slope and intercept = E° .

2. (a): Due to more resonance stabilisation of



3. (d): $\text{Ti}(Z=22) \rightarrow 3d^2 4s^2$; $\text{Ti}^{2+} \rightarrow 3d^2$
 $\text{V}(Z=23) \rightarrow 3d^3 4s^2$; $\text{V}^{3+} \rightarrow 3d^2$
 $\text{Cr}(Z=24) \rightarrow 3d^5 4s^1$; $\text{Cr}^{4+} \rightarrow 3d^2$
 $\text{Mn}(Z=25) \rightarrow 3d^5 4s^2$; $\text{Mn}^{5+} \rightarrow 3d^2$

4. (d)

5. (b): When an electron withdrawing group (like $-\text{NO}_2$, $-\text{Cl}$) is attached to the phenol ring, it stabilises the negative charge on the oxygen of phenoxide ion. Due to this reason, acidic character of phenol increases. But when an electron donating group (like $-\text{CH}_3$) is attached to the phenol ring, it destabilises the ring and hence, acidic character of phenol decreases. Thus, the correct order of acidic character is p -nitrophenol $>$ p -chlorophenol $>$ phenol $>$ o -cresol.

6. (a): The value of Δ_o for mixed ligands depends on the additive contributions of the ligand strengths. Since, CN^- has greater ligand strength than H_2O , the strength increases as the number of CN^- ions increases. Hence, the correct order of Δ_o is $\text{III} > \text{II} > \text{I}$.

7. (b): Since, $\text{C}_3\text{H}_6\text{O}$ on treatment with $\text{I}_2 + \text{NaOH}$ gives CHI_3 , therefore, $\text{C}_3\text{H}_6\text{O}$ must be a dimethyl ketone, i.e., CH_3COCH_3 . If this is so then, X must be $\text{CH}_3\text{CHOHCH}_3$.

8. (c): Moles of $\text{CoCl}_3 \cdot 6\text{NH}_3$ complex

$$= \frac{2.675}{267.5} = 0.01 \text{ moles}$$

$$\text{Moles of AgCl precipitated} = \frac{4.75}{143.5} = 0.033 \text{ moles}$$

Thus, 1 mole of the complex will precipitate

$$= \frac{0.033}{0.01} = 3 \text{ moles of AgCl}$$

This means that 1 molecule of the complex contains 3 ionisable Cl-ions. Hence, the formula is $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$.

9. (a)

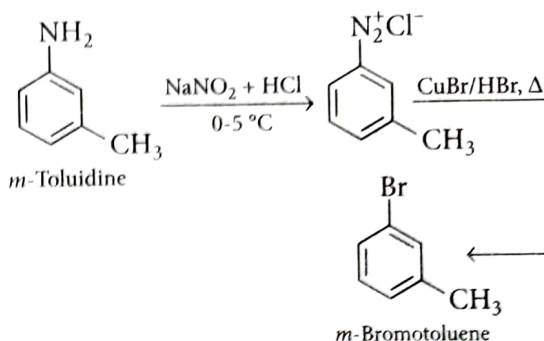
10. (b): (i) For a zero order reaction, the rate is independent of concentration of reactant.

(iii) When $E_a = \infty$, $k < A$

11. (c)

12. (a)

13. (c): m -Bromotoluene can be prepared from m -toluidine.



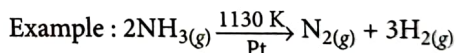
Amino group ($-\text{NH}_2$) is o - and p -directing group.

14. (a)

15. (a): Sucrose is a non-reducing sugar as it does not reduce Tollens' or Fehling's reagent due to absence of free aldehyde or ketone group. It contains stable acetal or ketal structure which cannot be opened into a free carboxyl group. Sucrose is composed of α -D-glucopyranose unit and β -D-fructofuranose unit. These units are joined by α , β -glycosidic linkage between C-1 of the glucose unit and C-2 of the fructose unit.

16. (c)

17. (i) The reaction is of zero order.



(ii) Slope = $-k = \frac{d[R]}{dt}$

OR

(i) Order of the reaction is sum of powers of concentration terms of reactants.

$$\text{Rate} = K[\text{A}]^1 [\text{B}]^2$$

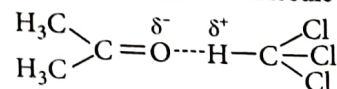
$$\therefore \text{Order of reaction} = 1 + 2 = 3$$

(ii) $k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$

where, $[R]_0$ = Initial concentration, k = Rate constant, $[R]$ = Concentration at time t .

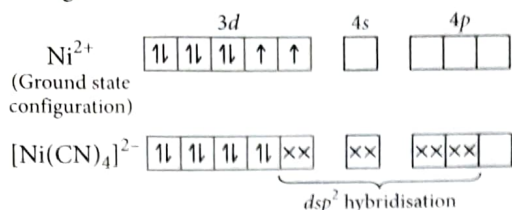
Unit of rate constant for first order reaction is s^{-1} .

18. Mixture of chloroform and acetone shows negative deviation from Raoult's law, thus it forms maximum boiling azeotrope. This is because chloroform molecule is able to form hydrogen bond with acetone molecule as shown:



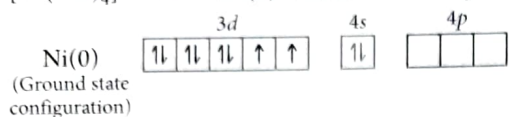
This decreases the escaping tendency of molecules for each component and consequently the vapour pressure decreases resulting in negative deviation from Raoult's law.

19. In $[\text{Ni}(\text{CN})_4]^{2-}$, Ni is present as Ni^{2+} with $3d^8$ configuration.

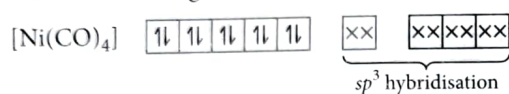


The complex ion has square planar geometry.

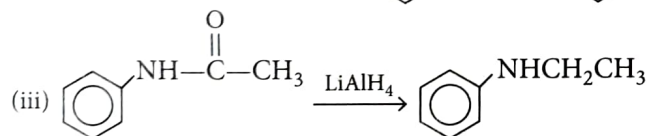
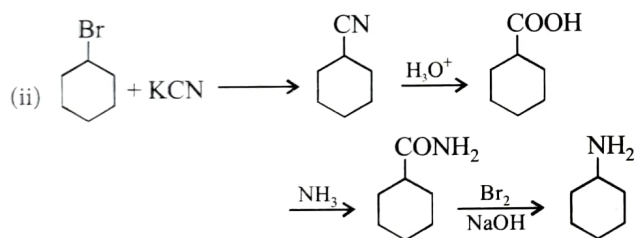
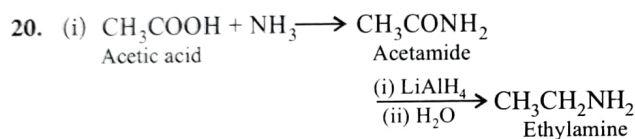
$[\text{Ni}(\text{CO})_4]$ contains $\text{Ni}(0)$ with $3d^8 4s^2$ configuration.



CO is a strong field ligand hence, $4s$ -electrons will shift to $3d$ -orbital making $4s$ -orbital vacant.



The complex ion has tetrahedral geometry.



21.

	S_N1	S_N2
1.	It is two step process, carbocation intermediate is formed.	It is single step process. No intermediate is formed.
2.	It obeys 1 st order kinetics. Rate = $k[\text{Reactant}]$	It obeys 2 nd order kinetics. Rate = $k[\text{Reactant}][\text{Nucleophile}]$
3.	Order of reactivity is $3^\circ > 2^\circ > 1^\circ$	Order of reactivity is $1^\circ > 2^\circ > 3^\circ$
4.	Optically inactive products are formed (Racemic mixture).	Inversion of configuration takes place in product formation.

22. Molecular mass of Glauber's salt ($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$)
 $= [2 \times 23 + 32 + 16 \times 4 + 10 \times (2 \times 1 + 16)]$
 $= (46 + 32 + 64 + 180) \text{ g mol}^{-1} = 322 \text{ g mol}^{-1}$

$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ ionises as :



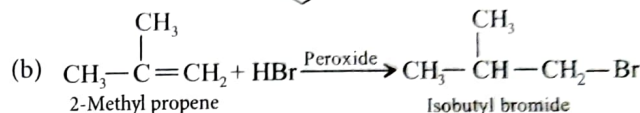
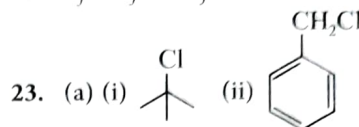
$\Rightarrow i = 3$

$$m = \frac{n_B}{W_A} = \frac{W_B}{M_B \times W_A} = \frac{6.00 \text{ g}}{322 \text{ g mol}^{-1} \times 0.1 \text{ kg}}$$

$$= 0.186 \text{ mol kg}^{-1} = 0.186 \text{ m}$$

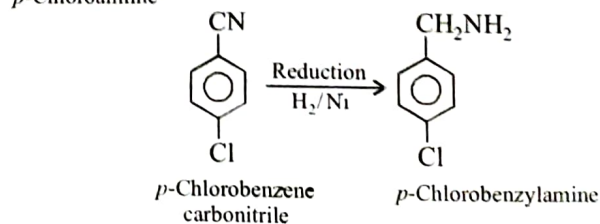
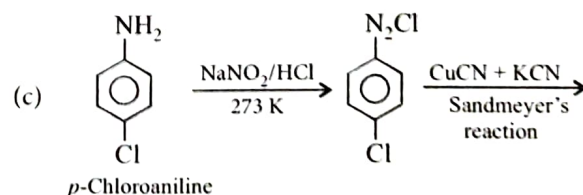
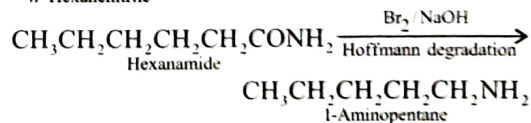
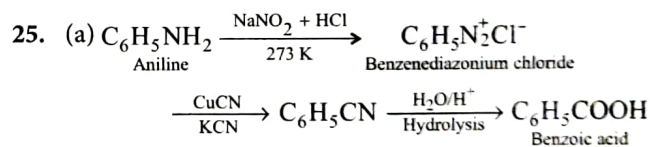
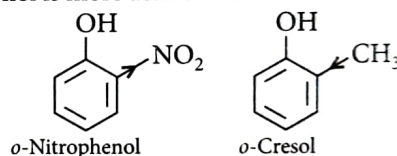
Also, $\Delta T_f = i K_f \cdot m = 3 \times 1.86 \text{ K m}^{-1} \times 0.186 \text{ m} = 1.04 \text{ K}$

$$\Rightarrow T_f = T_f^\circ - \Delta T_f = (273 - 1.04) \text{ K} = 271.96 \text{ K}$$



24. (a) (II) < (I), because more +I effect of D than H.

(b) The electron withdrawing groups enhance the acidic character of phenols by the stabilisation of phenoxide ion through dispersing negative charge. Nitro group is an electron withdrawing group whereas methyl group destabilise the phenoxide ion by intensifying the negative charge. Thus, *o*-nitrophenol is more acidic than *o*-cresol.



26. Given : Diameter = 1 cm, length = 50 cm
 $R = 5.5 \times 10^3 \text{ ohm}$, $M = 0.05 \text{ M}$, $\rho = ?$, $\kappa = ?$, $\Lambda_m = ?$

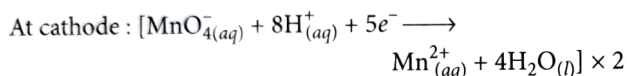
$$\text{Area of the column, } a = \pi r^2 = 3.14 \times \left(\frac{1}{2} \text{ cm}\right)^2 = \frac{3.14}{4} \text{ cm}^2$$

$$\text{Resistivity } (\rho) = R \cdot \frac{a}{l} = 5.5 \times 10^3 \text{ ohm} \times \frac{3.14 \text{ cm}^2}{4 \times 50 \text{ cm}} = 86.35 \text{ ohm cm}$$

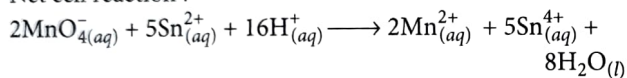
$$\text{Again, conductivity } (\kappa) = \frac{1}{\rho} = \frac{1}{86.35} = 1.158 \times 10^{-2} \text{ ohm}^{-1} \text{ cm}^{-1}$$

$$\text{and molar conductivity } (\Lambda_m) = \kappa \cdot \frac{10^3}{M} = 1.158 \times 10^{-2} \times \frac{10^3}{5 \times 10^{-2}} = 231.6 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

OR



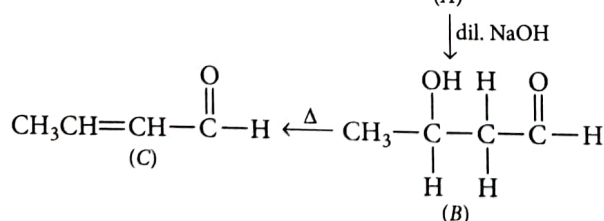
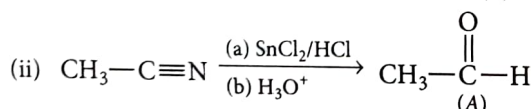
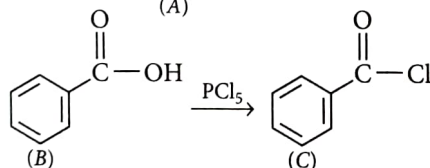
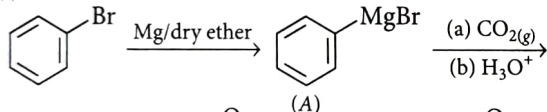
Net cell reaction :



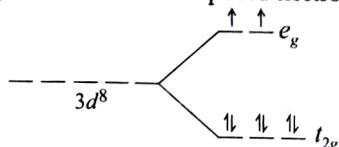
$$E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ} = 1.51 \text{ V} - 0.15 \text{ V} = 1.36 \text{ V}$$

Since, cell potential is positive therefore the reaction is product favoured.

27. (i)



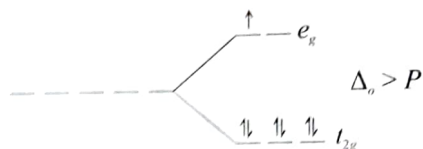
28. (i) Nickel forms octahedral complexes mainly in +2 oxidation state which has $3d^8$ configuration. In presence of strong field ligand also it has two unpaired electrons in e_g orbital.



Hence, it does not form low spin octahedral complexes.

(ii) The transition metals/ions have empty d -orbitals into which the electron pairs can be donated by ligands containing π electrons. For example, $\text{CH}_2 = \text{CH}_2$ and C_6H_6 .

(iii) In presence of strong field ligand Co(II) has electronic configuration, $t_{2g}^6 e_g^1$.



It can easily lose only electron of e_g orbital to give stable t_{2g}^6 configuration. This is why Co^{2+} is easily oxidised to Co^{3+} in the presence of strong field ligand.

$$29. \text{ (a) (i) Rate of reaction} = -\frac{dp_{\text{CH}_3\text{CHO}}}{dt}$$

$$= \frac{\text{Change in pressure}}{\text{Change in time}} = \frac{\text{atm}}{\text{min}} = \text{atm min}^{-1}$$

(ii) Unit of rate constant k can be obtained as follows.

$$k = \frac{\text{Reaction rate}}{(p_{\text{CH}_3\text{CHO}})^{3/2}} = \frac{\text{atm min}^{-1}}{(\text{atm})^{3/2}} = \text{atm}^{-1/2} \text{ min}^{-1}$$

(b) Because rate of reaction is affected by change in concentration, not on amount.

(c) $A + B \rightarrow \text{Product}$

$$\text{Rate law, } r = k[A]^{1/2} [B]^2$$

Order of reaction is sum of powers of concentration terms,

$$\therefore \text{Order of reaction} = \frac{1}{2} + 2 = \frac{5}{2} = 2.5$$

OR

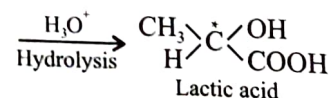
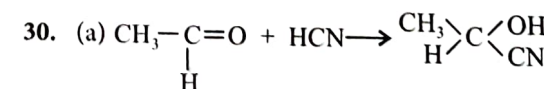
Let, initial conc. of the reactant = a

$$\text{Final conc. of the reactant} = \frac{1}{16} \times a = \frac{a}{16}$$

For a first order reaction,

$$k = \frac{2.303}{t} \log \frac{[A_0]}{[A_t]}$$

$$\therefore t = \frac{2.303}{k} \log \frac{a}{a/16} = \frac{2.303}{60 \text{ s}^{-1}} \log 16 = 0.046 \text{ s}$$



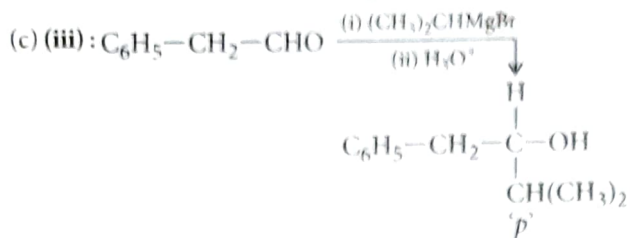
The product is optically active because it contains a chiral carbon.

(b) (i) : Greater the number of alkyl groups attached to the carbonyl groups, lower will be its reactivity. III > II > I.

OR



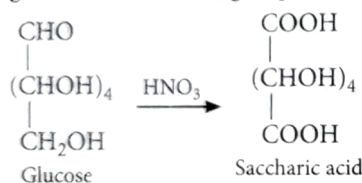
(X)



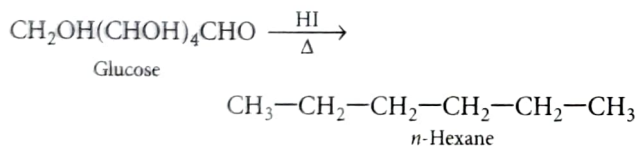
31. (a) Fructopyranose is the sweeter form of fructose. At higher temperatures, the equilibrium shifts towards the less sweet furanose form.

pyranose \rightleftharpoons furanose

(b) On oxidation with nitric acid, glucose yields a dicarboxylic acid, saccharic acid. This indicates presence of one primary (-OH) alcoholic group in glucose because only 1°(-OH) groups are oxidised to (-COOH) group with a mild oxidising agent such as HNO₃ while 2°(-OH) groups need drastic conditions to oxidise. Thus, rest four (-OH) groups in glucose are 2°(-OH) groups.



(c) On prolonged heating with HI, glucose gives *n*-hexane which shows it has six carbon atoms in a straight chain.



OR

(a) In anthranilic acid (*p*-aminobenzoic acid), the electron-withdrawing nature of benzene ring suppresses the transfer of proton from the weak -COOH group to the -NH₂ group. Glycine has no such effect, hence it exists as a zwitter ion.

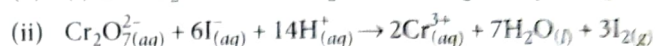
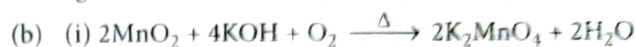
(b) The significance of primary structure of proteins is that the amino acid sequence of a protein determines its function and is critical to its biological activity. Even a change of just one amino acid can drastically alter the properties of the entire protein molecule. For example, change of glutamic acid by valine in the protein sequence causes sickle cell anaemia. Secondary structure of proteins gives information about the manner in which the protein chain is folded and bent and about the nature of the bonds which stabilise the structure.

(c) Peptide linkage is an amide linkage formed between -COOH group of one α -amino acid and -NH₂ group of the other amino acid by loss of a molecule of water whereas a linkage between two monosaccharides units through oxygen atom is called glycosidic linkage.

32. (a) (i) Manganese can form $p\pi - d\pi$ bond with oxygen by utilising $2p$ -orbital of oxygen and $3d$ -orbital of manganese due to which it can show highest oxidation state of +7. While with fluorine it cannot form such $p\pi - d\pi$ bond thus, it can show a maximum of +4 oxidation state.

(ii) Cr²⁺ is reducing since its configuration is converted to d^3 from d^4 . d^3 has half filled t_{2g} configuration with higher stability.

(iii) Cu²⁺ (d^9) ions have incompletely filled d -orbitals. Hence it can undergo $d-d$ transition and salts are coloured. Zn²⁺ (d^{10}) ions have completely filled $3d$ -orbitals. Hence it does not undergo $d-d$ transition and salts are colourless.



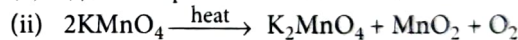
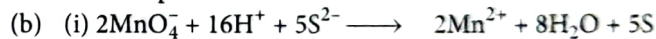
OR

(a) (i) Ti⁴⁺ has highest oxidation state among the given ions. Ti⁴⁺ has stable inert gas configuration and hence, most stable in aqueous solution.

On the other hand, V²⁺, Mn³⁺, Cr³⁺ have unstable electronic configuration and hence, are less stable.

(ii) Due to stable half-filled d^5 configuration of Mn²⁺, Mn³⁺ readily accepts one electron and behaves as strongest oxidising agent among the given ions.

(iii) Electronic configuration of Ti⁴⁺ = [Ar]3d⁰4s⁰ due to absence of unpaired electron in Ti⁴⁺, it is a colourless ion.



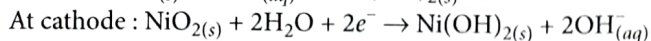
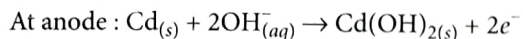
33. (a) Mercury cell is a primary battery. Hence, it can be used only once and cannot be recharged.

Advantage : The cell potential remains constant during its life time. Hence, it is useful for devices requiring constant current, e.g., hearing aids and watches.

(b) (i) Chromium is a non-corroding metal which forms a protective layer on iron.

(ii) The more active metal zinc is used for covering the surface of iron protecting it from rusting. The zinc layer on the surface of iron, when it comes in contact with mixture of oxygen and carbon dioxide in air, a protective thin layer of basic zinc carbonate, ZnCO₃·Zn(OH)₂ is formed. Thus, galvanised iron sheet lose their lustre and also protect it from further corrosion.

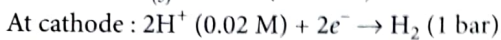
(c) This is a rechargeable cell having longer life than lead storage cell. It consist of a cadmium electrode (as anode) and a metal grid containing nickel (IV) oxide immersed in KOH solution. The electrode reactions occurring during discharge are as follows :



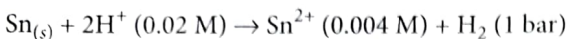
The potential of each Ni-Cd cell is approx 1.4 V.

OR

(a) The electrode reactions are



Net reaction :



$$E_{\text{cell}}^{\circ} = E_{\text{H}^+|\text{H}_2}^{\circ} - E_{\text{Sn}^{2+}|\text{Sn}}^{\circ}$$

$$= 0.00 \text{ V} - (-0.14 \text{ V}) = +0.14 \text{ V}$$

The Nernst equation of this cell at 25 °C is

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{[\text{Sn}^{2+}](p_{\text{H}_2})}{[\text{H}^+]^2}$$

$$\text{or, } E_{\text{cell}} = E_{\text{cell}}^{\circ} - 0.0296 \log \frac{0.004 \times 1}{(0.02)^2}$$

$$= 0.14 - 0.0296 \log \left(\frac{0.004}{0.0004} \right)$$

$$= 0.14 - 0.0296 (\log 10) = 0.14 - 0.0296 \times 1 = 0.14 - 0.0296$$

$$\Rightarrow E_{\text{cell}} = 0.14 - 0.0296 = 0.1104 \text{ V}$$

(b) (i) The reaction at anode with lower value of E° is preferred *i.e.*, O_2 gas should be liberated but on account of overpotential of oxygen reaction at anode.

Preferred reaction is $\text{Cl}^-_{(aq)} \rightarrow \frac{1}{2} \text{Cl}_{2(g)} + e^-$ *i.e.*, Cl_2 gas is liberated at anode in the electrolysis of *aq.* NaCl.

(ii) Conductivity of CH_3COOH (weak electrolyte) decreases with dilution because the number of current carrying particles *i.e.*, ions present per cm^3 of the solution becomes less and less on dilution.

