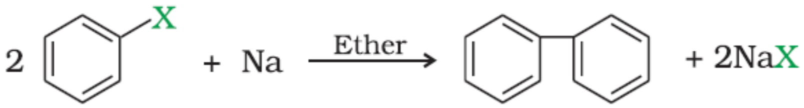
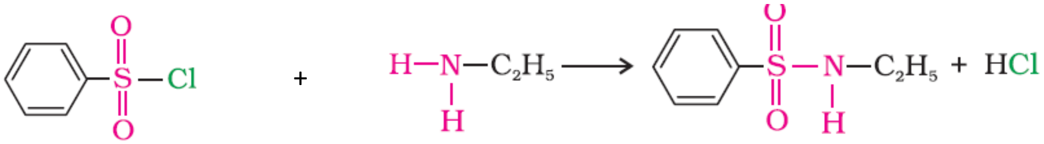
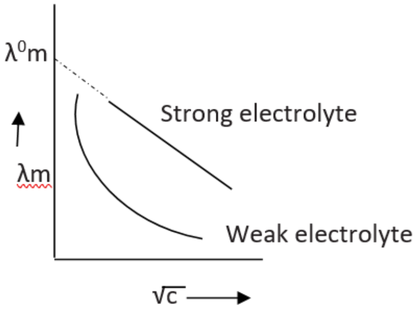
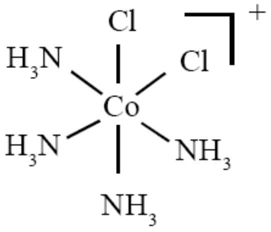
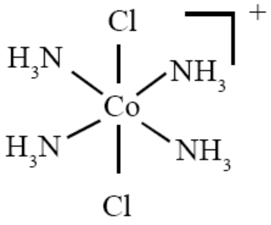
SUBJECT: CHEMISTRY **Qn. Code: 225**

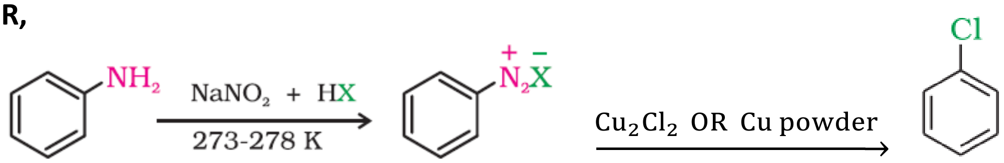
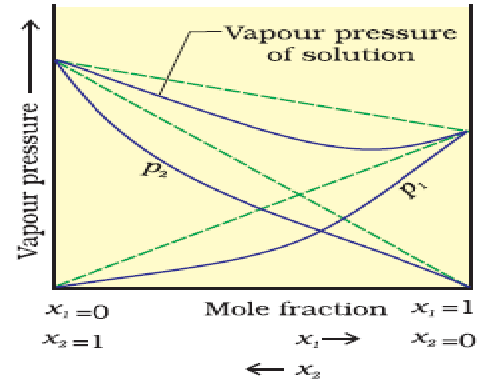
Qn. No.	Sub Qns.	Answer Key/Value Points	Score	Total
Answer any 4 questions from 1 to 5. Each carries 1 score				
1.		(b) 3	1	1
2.		Dry cell/Mercury cell (Button cell)	1	1
3.		Linkage isomerism	1	1
4.		(d) $SOCl_2$	1	1
5.		Vitamin C	1	1
Answer any 8 questions from 6 to 15. Each carries 2 scores				
6.	(i) (ii)	van't Hoff factor (i) is defined as: $i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$ **OR**, $i = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$ **OR**, $i = \frac{\text{Total number of moles of particles after association/dissociation}}{\text{Number of moles of particles before association/dissociation}}$ i = 2	1 1	2
7.	(i) (ii)	Galvanic cells are devices that convert chemical energy of some redox reactions to electrical energy. **OR**, these are cells which produce electricity by some chemical reactions. $Zn(s)\|Zn^{2+}(aq)\|\|Cu^{2+}(aq)\|Cu(s)$ **OR**, $Zn\|Zn^{2+}\|\|Cu^{2+}\|Cu$	1 1	2
8.		These are reactions which appear to follow higher order but actually follow first order kinetics. E.g.: Hydrolysis of ester **OR,** Inversion of cane sugar **OR,** Any hydrolysis reaction	1 1	2
9.	(i) (ii)	The factors affecting rate of a chemical reaction are nature of the reactants, concentration of the reactants, temperature, pressure, catalyst and radiation or light. ***[Any 2 required]*** $r = k[NH_3]^0$ **OR**, r = k	1 1	2
10.	(i) (ii)	Finkelstein reaction: Alkyl chlorides or bromides when treated with NaI in dry acetone, alkyl iodides are formed. This reaction is known as Finkelstein reaction. $R\text{-}X + NaI \longrightarrow R\text{-}I + NaX$ (where X = Cl or Br) Fittig Reaction: Aryl halides when treated with sodium in dry ether, we get diaryls (diphenyls). **OR**, Chlorobenzene when treated with sodium in dry ether, we get diphenyl. 	1 1	2

<table>
<tr>
<td>11.</td>
<td></td>
<td>
<table>
<tr><th>S_N1 Reaction</th><th>S_N2 Reaction</th></tr>
<tr><td>Proceeds in 2 steps</td><td>Proceeds in a single step</td></tr>
<tr><td>An intermediate (carbocation) is formed</td><td>No intermediate is formed</td></tr>
<tr><td>Order of the reaction is 1</td><td>Order is 2</td></tr>
<tr><td>For optically active compounds, the reaction proceeds through retention of configuration.</td><td>For optically active compounds, the reaction proceeds through inversion of configuration.</td></tr>
<tr><td>The order of reactivity of alkyl halide is $3^0 > 2^0 > 1^0$</td><td>The order of reactivity of alkyl halide is $1^0 > 2^0 > 3^0$</td></tr>
</table>

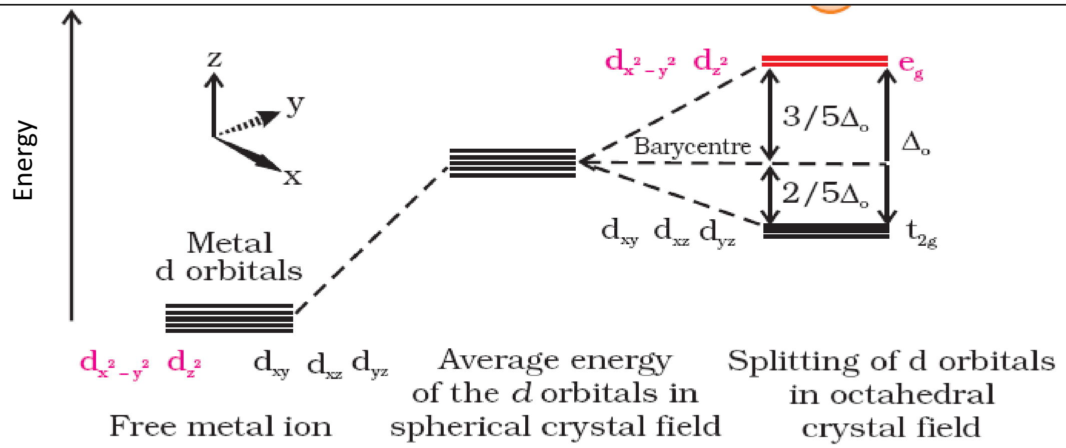
[Any 2 required]
</td>
<td>2 x 1
= 2</td>
<td>2</td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td>Chloroform is stored in closed dark coloured bottles filled up to the neck in order to prevent its oxidation to the poisonous gas carbonyl chloride ($COCl_2$) or phosgene.
OR, the equation: $2CHCl_3 + O_2 \xrightarrow{light} 2COCl_2 + HCl$</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>*Fermentation of Molasses*: The sugar in molasses is converted to glucose and fructose, in the presence of an enzyme, invertase. Glucose and fructose undergo fermentation in the presence of another enzyme, zymase to give ethanol and carbon dioxide.
OR, the equations:
$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{invertase} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$
$C_6H_{12}O_6 \xrightarrow{zymase} 2\,\underset{\text{Ethanol}}{C_2H_5OH} + 2\,CO_2$</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td>A is CH_3-OH (Methanol)
B is H-COONa (Sodium formate)</td>
<td>1
1</td>
<td>2</td>
</tr>
<tr>
<td>15.</td>
<td>(i)
(ii)</td>
<td>Hinsberg's reagent is Benzenesulphonyl chloride **OR,** $C_6H_5SO_2Cl$.
Primary amines react with benzenesulphonyl chloride to form a precipitate of N-alkyl benzenesulphonamide, which is soluble in alkail.
OR,

Benzene sulphonyl chloride Ethanamine N-ethylbenzenesulphonamide</td>
<td>1
1</td>
<td>2</td>
</tr>
<tr>
<td colspan="5">**Answer any 8 questions from 16 to 26. Each carries 3 scores**</td>
</tr>
<tr>
<td>16.</td>
<td>(i)
(ii)</td>
<td>Osmotic pressure is the excess pressure that must be applied on solution side to stop osmosis. **OR,** it is the pressure that just stops the flow of solvent molecules through semi-permeable membrane. **OR**, It is the pressure developed on the solution side that just prevent osmosis.
Reverse Osmosis: The direction of osmosis can be reversed if a pressure larger than the osmotic pressure is applied to the solution side. Now the pure solvent flows out of the solution through the semi permeable membrane.
OR, It is the flow of solvent molecules from solution side to solvent side through a semi-permeable membrane, when pressure larger than osmotic pressure is applied on solution side.</td>
<td>1
1</td>
<td>3</td>
</tr>
</table>

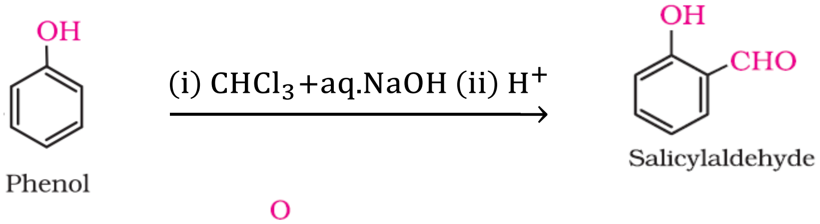
		Application: Desalination of sea water **OR,** Purification of water.	1	
17.	(i)	Molar conductivity is the conductivity of 1 mole of an electrolytic solution kept between two electrodes of a conductivity cell with unit area of cross section and at a distance of unit length. **OR,** Molar conductivity of a solution at a given concentration is the conductance of 'V' volume of a solution containing one mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length. **OR,** Molar conductivity, $\Lambda_m = \kappa.V$ **OR,** $\Lambda_m = \frac{\kappa}{c}$ (where κ is the conductivity and c is the concentration of the electrolytic solution in mol/m^3). **OR,** Molar conductivity, $\Lambda_m = \frac{1000\ \kappa}{M}$ [Where M is the molarity of the solution].	1	3
	(ii)		1	
	(iii)	$\Lambda_m = \Lambda^0_m - A\sqrt{c}$	1	
18.	(i)	Here k = 5.5×10^{-14} s^{-1} $t½ = \frac{0.693}{k}$ $= \frac{0.693}{5.5 \times 10^{-14}}$ = **1.26×10^{13} s**	1 1	3
	(ii)	mol^{-1} L s^{-1} **OR,** M^{-1} s^{-1} **OR,** mol^{-1} L min^{-1} **OR,** M^{-1} min^{-1}	1	
19.	(i)	Because of the presence of partially filled d-orbitals **OR,** due to d-d transition.	1	3
	(ii)	Electronic configuration of element with atomic number 25 is: [Ar] $3d^5\ 4s^2$ For divalent ion, the configuration becomes [Ar] $3d^5$ So there are 5 unpaired electrons (i.e. n = 5) Magnetic moment (μ_s) = $\sqrt{n(n+2)} = \sqrt{5(5+2)} = \sqrt{35}$ = 5.91 BM	½ ½ 1	
20.		Potassium dichromate is prepared from chromite ore ($FeCr_2O_4$). The preparation involves the following three steps: 1. Conversion of chromite ore to sodium chromate by fusing it with sodium carbonate in presence of air. $4 FeCr_2O_4 + 8 Na_2CO_3 + 7 O_2 \rightarrow 8 Na_2CrO_4 + 2 Fe_2O_3 + 8 CO_2$ 2. Acidification of sodium chromate with sulphuric acid to sodium dichromate. $2Na_2CrO_4 + 2 H^+ \rightarrow Na_2Cr_2O_7 + 2 Na^+ + H_2O$ 3. Conversion of sodium dichromate to potassium dichromate by treating with potassium chloride. $Na_2Cr_2O_7 + 2 KCl \rightarrow K_2Cr_2O_7 + 2 NaCl$ ***[Explanation or equation required]***	1 1 1	3

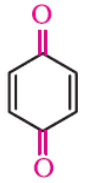
21.	(i)	Tetraamminedichloridocobalt(III) chloride	1	3
	(ii)	Geometrical isomers of $[Co(NH_3)_4Cl_2]^+$ are:  cis isomer $[Co(NH_3)_4Cl_2]$  trans $[Co(NH_3)_4Cl_2]$	1	
	(iii)	None of the geometrical isomers of this complex can show optical activity. [Both cis and trans isomers of $[Co(NH_3)_4Cl_2]^+$ have plane of symmetry. So they are optically inactive. Also, optical isomerism is commonly shown by octahedral complexes containing didentate ligands].	1	
22.	(i)	A co-ordination compound or complex salt keeps its identity both in solid and solution states. While a double salt keeps its identity only in solid state. OR, A complex ion does not get ionized in solution, while a double salt gets ionized.	1	3
	(ii)	Chelating ligands are ligands which can bind to the central atom in more than one position and form ring complexes. **OR,** Di- or polydentate ligands can bind to the central atom through two or more donor atoms and form ring complexes. Such ligands are called chelating ligands.	1	
	(iii)	Ethane-1,2-diamine **OR,** ethylene diamine (en) and Oxalate ion ($C_2O_4^{2-}$ or Ox^{2-}).	1	
23.	(i)	Due to the presence of inter molecular hydrogen bonding in alcohols OR, due to the absence of hydrogen bonding in haloalkanes.	1	3
	(ii)	Phenols are acidic, due to the greater electronegativity of sp^2 hybridized carbon atom to which -OH group is bonded **OR,** due to the greater stability of phenoxide ion compared to phenol.	1	
	(iii)	Because the alkoxy group is ortho-para directing **OR,** due to greater electron density at ortho and para positions, the electrophile enters at these positions.	1	
24.	(i)	Aldehydes are more reactive than ketones in nucleophilic addition reactions due to steric reason and electronic reason. **OR,** due to the presence of + I effect (electron donating inductive effect) and steric hindrance of 2 alkyl groups in ketones.	1	3
	(ii)	Clemmensen reduction **OR,** Wolff-Kishner reduction.	1	
	(iii)	Esterification: Carboxylic acids (or, acid chlorides or acid anhydrides) when heated with alcohols or phenols in the presence of a mineral acid like concentrated H_2SO_4 or HCl gas, we get esters. **OR,** $R\text{-}COOH + R'\text{-}OH \xrightleftharpoons{H^+} R\text{-}COOR' + H_2O$ **OR,** $CH_3\text{-}COOH + CH_3\text{-}OH \xrightleftharpoons{H^+} CH_3\text{-}COO\text{-}CH_3 + H_2O$ Acetic acid Methanol Methyl acetate	1	
25.	(i)	Aniline when treated with $NaNO_2$ and HCl to form Benzenediazonium salt, which on treating with Cuprous chloride or copper powder to give chlorobenzene.	2	

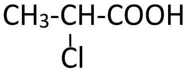
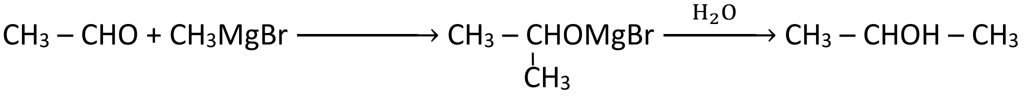
		OR, diazotization of Aniline followed by Sandmeyer's reaction or Gattermann's reaction. **OR,** 		3
	(ii)	Hoffmann Bromamide degradation reaction: When an amide is treated with bromine and alcoholic NaOH, we get a primary amine with one carbon atom less than that present in the amide. **OR,** $R\text{-}CO\text{-}NH_2 + Br_2 + 4\ NaOH \longrightarrow R\text{-}NH_2 + Na_2CO_3 + 2\ NaBr + 2\ H_2O$ **OR,** $CH_3\text{-}CO\text{-}NH_2 + Br_2 + 4\ NaOH \longrightarrow CH_3\text{-}NH_2 + Na_2CO_3 + 2\ NaBr + 2\ H_2O$ Ethanamide Methanamine **OR,** any other example	1	
26.	(i)	The amino acids which cannot be synthesized in the body and must be obtained through diet, are known as ***essential amino acids***. E.g.: Valine, Leucine, Isoleucine, Arginine, Lysine, Threonine, Methionine, Phenylalanine, Tryptophan and Histidine. ***[Any 2 examples required]***	1 1	3
	(ii)	E.g. for fibrous protein: Keratin and myosin E.g. of globular proteins Insulin and albumins ***[Any 1 example for each is required]***	½ ½	
Answer any 4 questions from 27 to 31. Each carries 4 scores				
27.	(i)	Non-ideal solutions: Solutions which do not obey ideal gas equation at all concentrations. **OR,** solutions for which $p_1 \neq p_1^0.\chi_1$ and $p_2 \neq p_2^0.\chi_2$ are known as non-ideal solutions. **OR,** these are solutions for which vapour pressure is either higher or lower than that predicted by Raoult's law.	1	4
	(ii)	For solutions which show negative deviation from Raoult's law, $p_1 < p_1^0.\chi_1$, $p_2 < p_2^0.\chi_2$, $\Delta_{mix}H < 0$ and $\Delta_{mix}V < 0$ Here the solute-solvent interactions (A-B interactions) are stronger than solute-solute interaction (A-A interaction) and solvent-solvent interaction (B-B interaction). The vapour pressure – composition graph for such a solution is: 	1½	

		E.g. solution of phenol and aniline, chloroform and acetone. ***[Any one example is required]***	½	
	(iii)	The solutions which show a large positive deviation from Raoult's law form minimum boiling azeotrope at a particular composition. E.g. 95% aqueous ethanol solution by volume.	1	
28.	(i)	Kohlrausch's law states that the limiting molar conductivity of an electrolyte is the sum of the individual contributions of the anion and the cation of the electrolyte. **OR,** For an electrolyte like A_xB_y which dissociates as: $A_xB_y \rightarrow xA^{y+} + yB^{x-}$ $\Lambda^0{}_{m(A_xB_y)} = x.\lambda^0_{(A^{y+})} + y.\lambda^0_{(B^{x-})}$ Application: Determination of limiting molar conductivity ($\Lambda^0{}_m$) of weak electrolytes, Determination of degree of dissociation and dissociation constant of weak electrolytes. ***[Any one application is required]***	1 1	4
	(ii)	$\Lambda_m = \frac{1000\ x\ \kappa}{M}$ Here κ = 0.01148 S cm^{-1} and M = 0.05 mol L^{-1} So, $\Lambda_m = \frac{1000\ x\ 0.01148}{0.05}$ = **229.6 S cm^2 mol^{-1}**	1 1	
29.	(i)	In $[Ni(CN)_4]^{2-}$, in presence of CN^- ligands, electron pairing in d-orbitals of Ni^{2+} occurs. So, Ni^{2+} is in **dsp^2 hybridisation**. So it has a **square planar structure**. Due to the **absence of unpaired electrons**, it is **diamagnetic**. But in $[NiCl_4]^{2-}$, in presence of Cl^- ligands, electron pairing in d-orbitals of Ni^{2+} does not occur. So, Ni^{2+} is in **sp^3 hybridisation**. So it has a **tetrahedral structure**. Due to the **presence of unpaired electrons**, it is **paramagnetic**. **OR,** **$[Ni(CN)_4]^{2-}$:** Here the central atom Ni is in +2 oxidation state. The electronic configuration of Ni^{2+} is: Ni^{2+} - $[Ar]3d^8 4s^0 4p^0$ Here the co-ordination number of Ni is 4 and hence the no. of vacant orbitals required = 4. In presence of the ligand CN^-, the electrons in 3d level get paired. Now one 3d orbital, one 4s orbital and two 4p orbitals undergo **dsp^2 hybridization** to form 4 new orbitals. Thus, the complex has ***square planar* geometry** and is ***diamagnetic,* due to the absence of unpaired electron**. **$[NiCl_4]^{2-}$:** Here also the central atom Ni is in +2 oxidation state. Ni^{2+} - $[Ar]3d^8 4s^0 4p^0$ Here the co-ordination number of Ni is 4 and hence the no. of vacant orbitals required = 4. In presence of the ligand Cl^-, the electrons in 3d level do not get paired. Now one 4s orbitals and three 4p orbitals undergo **sp^3 hybridization** to form 4 new orbitals. Thus, the complex has ***tetrahedral* geometry** and is ***paramagnetic*** **because of the presence of unpaired electron**.	1½ 1½ (1½) (1½)	4

<table>
<tr><td></td><td>(ii)</td><td>


</td><td>1</td><td></td></tr>
<tr><td>30.</td><td>(i)</td><td>Lucas Test: Lucas reagent is a mixture of conc. HCl and anhydrous $ZnCl_2$.
Tertiary alcohols react with Lucas reagent to form immediate turbidity; secondary alcohols form turbidity within 5 minutes, while primary alcohols do not produce turbidity at room temperature. They give turbidity only on heating.</td><td>1½</td><td rowspan="3">4</td></tr>
<tr><td></td><td>(ii)</td><td>Reimer-Tiemann Reaction: When Phenol is treated with chloroform in the presence of sodium hydroxide, followed by acidification, we get Salicylaldehyde (o-hydroxybenzaldehyde).
OR,


</td><td>1½</td></tr>
<tr><td></td><td>(iii)</td><td>Benzoquinone OR,


</td><td>1</td></tr>
<tr><td>31.</td><td>(i)</td><td>

$CH_3-\underset{\underset{Cl}{|}}{CH}-COOH$ OR, 2-chloropropanoic acid OR, α-chloropropionic acid</td><td>1</td><td rowspan="3">4</td></tr>
<tr><td></td><td>(ii)</td><td>$CH_3-CHCl-COOH$ is more acidic than CH_3-CH_2-COOH.</td><td>1</td></tr>
<tr><td></td><td>(iii)</td><td>By treating acetaldehyde (ethanal) with methyl magnesium bromide followed by hydrolysis, we get propan-2-ol.
OR,

$CH_3-CHO + CH_3MgBr \longrightarrow CH_3-\underset{\underset{CH_3}{|}}{CH}OMgBr \xrightarrow{H_2O} CH_3-CHOH-CH_3$
</td><td>2</td></tr>
</table>

###