General Instructions :

Read the following instructions carefully and follow them :

(i) *This question paper contains **33** questions. **All** questions are **compulsory**.*

(ii) *This question paper is divided into **five** sections – **Section A, B, C, D** and **E**.*

(iii) ***Section A** – questions number **1** to **16** are multiple choice type questions. Each question carries **1** mark.*

(iv) ***Section B** – questions number **17** to **21** are very short answer type questions. Each question carries **2** marks.*

(v) ***Section C** – questions number **22** to **28** are short answer type questions. Each question carries **3** marks.*

(vi) ***Section D** – questions number **29** and **30** are case-based questions. Each question carries **4** marks.*

(vii) ***Section E** – questions number **31** to **33** are long answer type questions. Each question carries **5** marks.*

(viii) *There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except Section A.*

(ix) *Kindly note that there is a separate question paper for Visually Impaired candidates.*

(x) *Use of calculator is **not** allowed.*

SECTION A

*Questions no. **1** to **16** are Multiple Choice type Questions, carrying **1** mark each.* *16×1=16*

1. Which of the following transition metal ion is ***not*** coloured ?

(A) Cu^{+}

(B) Ni^{2+}

(C) Co^{2+}

(D) V^{3+}

2. Which of the following solutions will have the highest boiling point in water ?

(A) 1% KCl

(B) 1% glucose

(C) 1% urea

(D) 1% $CaCl_2$

3. During electrolysis of dilute H_2SO_4, using platinum electrodes, the gas evolved at the anode is :

(A) H_2 gas

(B) O_2 gas

(C) SO_2 gas

(D) SO_3 gas

4. The activation energy (E_a) of a reaction can be determined from the slope of which of the following plots ?

(A) $ln\ k$ vs. T

(B) $\frac{ln\ k}{T}$ vs. T

(C) $ln\ k$ vs. $\frac{1}{T}$

(D) $\frac{T}{ln\ k}$ vs. $\frac{1}{T}$

5. Which of the following represents the fraction of molecules with energies equal to or greater than E_a ?

(A) $\frac{-E_a}{RT}$

(B) $e^{-E_a/RT}$

(C) $e^{+E_a/RT}$

(D) $\frac{+E_a}{RT}$

6. The number of moles of AgCl precipitated when excess $AgNO_3$ solution is mixed with one mole of $[Co(NH_3)_3Cl_3]$ is :

(A) 0

(B) 1

(C) 2

(D) 3

7. Which of the following haloalkanes react with aqueous KOH most rapidly by S_N1 reaction ?

(A) 2-Chlorobutane

(B) 1-Bromobutane

(C) 2-Bromo-2-Methylpropane

(D) 2,2-Dimethyl-1-Chloropropane

8. The reaction

$$R - OH + Na \longrightarrow RO^-Na^+ + \frac{1}{2}H_2\,(g)$$

suggests that alcohols are :

(A) Acidic

(B) Basic

(C) Neutral

(D) Amphoteric

9. At low temperature, phenol reacts with Br_2 in CS_2 to form :

(A) 2,4,6-tribromophenol

(B) *p*-bromophenol

(C) *o*-and *p*-bromophenol

(D) 2,4-dibromophenol

10. When alkyl iodide is treated with large excess of ammonia, the major product obtained is :

(A) Tertiary amine

(B) Quaternary ammonium salt

(C) Secondary amine

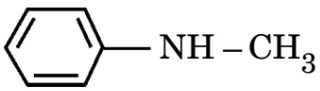
(D) Primary amine

11. An amine 'X' reacts with Hinsberg reagent and the product obtained is soluble in alkali. The amine 'X' is :

(A) $CH_3 - NH_2$

(B) $(CH_3)_2NH$

(C) $(CH_3)_3N$

(D)  $NH - CH_3$

12. α-helix structure refers to :

(A) primary structure of protein

(B) secondary structure of protein

(C) tertiary structure of protein

(D) quaternary structure of protein

For Questions number 13 to 16, two statements are given — one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

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

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is ***not*** the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

13. *Assertion (A) :* A mixture of *o*-nitrophenol and *p*-nitrophenol can be separated by steam distillation.

Reason (R) : *o*-nitrophenol is steam volatile due to intermolecular hydrogen bonding.

14. *Assertion (A) :* Cooking time is reduced in pressure cooker.

Reason (R) : Boiling point of water inside the pressure cooker is elevated.

15. *Assertion (A) :* Actinoids show irregularities in their electronic configurations.

Reason (R) : Actinoids are radioactive in nature.

16. *Assertion (A) :* Vitamin K can be stored in our body.

Reason (R) : Vitamin K is a water soluble vitamin.

SECTION B

17. What is meant by positive deviation from Raoult's law ? Give an example. What type of azeotrope is formed by positive deviation ? *2*

18. State a condition under which a bimolecular reaction is kinetically first order reaction. Give an example. For which type of reactions, do order and molecularity have the same value ? *2*

19. (a) Write the IUPAC name of the complex $[Pt(en)_2Cl_2]^{2+}$. Draw the structure of geometrical isomer of this complex which is optically inactive. *2*

OR

(b) (i) Write the formula of the following coordination compound :

Pentaamminecarbonatocobalt(III)chloride

(ii) Write the IUPAC name of the linkage isomer of the complex $[Co(NH_3)_5(NO_2)]Cl_2$. *1+1=2*

20. Why are haloarenes less reactive towards nucleophilic substitution reaction ? How does the presence of nitro ($-NO_2$) group at ortho- and para-positions in haloarenes increase the reactivity towards nucleophilic substitution reaction ? *2*

21. The two strands in DNA are not identical but complementary. Explain. What products would be formed when DNA is hydrolysed ? *2*

SECTION C

22. 0·3 g of acetic acid (Molar mass = 60 g mol^{-1}) dissolved in 30 g of benzene shows a depression in freezing point equal to 0·45°C. Calculate the percentage association of acid if it forms a dimer in the solution. *3*

(Given : K_f for benzene = 5·12 K kg mol^{-1})

23. (a) Write the name of the cell which is generally used in inverters. Write the reactions taking place at anode and cathode of this cell, when it is in use. *3*

OR

(b) Explain why electrolysis of an aqueous solution of NaCl gives H_2 gas at cathode and Cl_2 gas at anode ? Write overall reaction. *3*

(Given : $E^\circ_{Na^+/Na} = -2{\cdot}71$ V, $E^\circ_{H_2O/H_2} = -0{\cdot}83$ V,

$E^\circ_{Cl_2/2Cl^-} = +1{\cdot}36$ V, $E^\circ_{H^+/O_2/H_2O} = +1{\cdot}23$ V)

24. The following data were obtained during the first order thermal decomposition of N_2O_5 (g) at constant volume : *3*

$2N_2O_5\,(g) \longrightarrow 2N_2O_4\,(g) + O_2\,(g)$

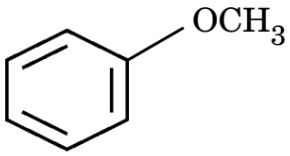
S.No.	Time/s	Total Pressure/atm
1	0	0·5
2	100	0·625

Calculate rate constant.

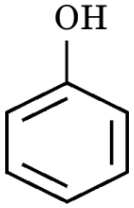
[Given : log 2 = 0·3010, log 10 = 1]

25. A compound (A) with molecular formula C_4H_9I which is a primary alkyl halide, reacts with alcoholic KOH to give compound (B). Compound (B) reacts with HI to give (C) which is an isomer of (A). When (A) reacts with Na metal in the presence of dry ether, it gives a compound (D), C_8H_{18}, which is different from the compound formed when n-butyl iodide reacts with sodium. Write the structures of (A), (B), (C) and (D). Write the chemical equation when compound (A) is reacted with alcoholic KOH. *3*

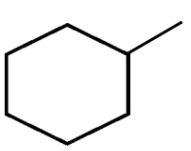
26. Write structure of the products of the following reactions : *3×1=3*

(a) 

$+ HI \longrightarrow$

(b) 

$+$ conc. $HNO_3 \longrightarrow$

(c) 

$+ HCHO \xrightarrow{H^+/H_2O}$

27. Give reasons for the following : *3×1=3*

(a) Benzoic acid does not undergo Friedel-Crafts reaction.

(b) HCHO is more reactive than CH_3CHO towards addition of HCN.

(c) Vinyl group directly attached with carboxylic acid should decrease the acidity of corresponding carboxylic acid due to resonance, but on the contrary it increases the acidity.

28. Write the reaction of D-Glucose with the following : *3×1=3*

(a) HCN (b) Br_2 water (c) $(CH_3CO)_2O$

SECTION D

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

29. The Crystal Field Theory (CFT) of coordination compounds is based on the effect of different crystal fields (provided by the ligands taken as point charges) on the degeneracy of d-orbital energies of the central metal atom/ion. The splitting of the d-orbitals provides different electronic arrangements in strong and weak crystal fields. In tetrahedral coordination entity formation, the d-orbital splitting is smaller as compared to the octahedral entity.

Answer the following questions :

(a) On the basis of CFT, explain why $[Ti(H_2O)_6]Cl_3$ complex is coloured ? What happens on heating the complex $[Ti(H_2O)_6]Cl_3$? Give reason. *2*

[Atomic no. : Ti = 22]

(b) (i) What is crystal field splitting energy ? *1*

OR

(b) (ii) On the basis of Δ_o and P (pairing energy), how can you differentiate between a strong field ligand and a weak field ligand ? *1*

(c) Why are low spin tetrahedral complexes rarely observed ? *1*

30. Amines are usually formed from amides, imides, halides, nitro compounds, etc. They exhibit hydrogen bonding which influences their physical properties. In alkyl amines, a combination of electron releasing, steric and H-bonding factors influence the stability of the substituted ammonium cations in protic polar solvents and thus affect the basic nature of amines. Alkyl amines are found to be stronger bases than ammonia. Amines being basic in nature, react with acids to form salts. Aryldiazonium salts, undergo replacement of the diazonium group with a variety of nucleophiles to produce aryl halides, cyanides, phenols and arenes.

Answer the following questions :

(a) How can you convert the following ? *2*

(i) Ethanoic acid to methanamine

(ii) Propanenitrile to 1-aminopropane

(b) Why is pK_b value of aniline more than that of methylamine ? *1*

(c) (i) Arrange the following in increasing order of their basic strength in aqueous solution : *1*

$CH_3 - NH_2$, $(CH_3)_2NH$, $(CH_3)_3N$

OR

(c) (ii) Give the structures of A and B in the following reaction : *1*

$$C_6H_5NO_2 \xrightarrow{Fe/HCl} A \xrightarrow[273\,K]{HNO_2} B$$

SECTION E

31. (a) (i) Account for the following :

(I) The $E^{\circ}_{Mn^{2+}/Mn}$ value for manganese is highly negative, whereas $E^{\circ}_{Mn^{3+}/Mn^{2+}}$ is highly positive. *1*

(II) Actinoids show wide range of oxidation states. *1*

(III) Transition metals have high melting points. *1*

(ii) Complete the following ionic equations :

(I) $5SO_3^{2-} + 2MnO_4^- + 6H^+ \longrightarrow$ *1*

(II) $2MnO_4^- + H_2O + I^- \longrightarrow$ *1*

OR

(b) Answer the following questions : *5×1=5*

(i) Name two elements of 3d series for which the third ionisation enthalpies are quite high.

(ii) Out of $KMnO_4$ and K_2MnO_4, which one is paramagnetic and why ?

(iii) Write any one consequence of lanthanoid contraction.

(iv) How do you prepare potassium manganate from pyrolusite ore ?

(v) Why is the ability of oxygen more than fluorine to stabilise higher oxidation states of transition metals ?

32. (a) (i) An organic compound (X) having molecular formula $C_5H_{10}O$ can show various properties depending on its structures. Draw each of the structures if it :

(I) shows Cannizzaro reaction. *1*

(II) reduces Tollens' reagent and has a chiral carbon. *1*

(III) gives positive iodoform test. *1*

(ii) Write the reaction involved in the following : *2*

(I) Clemmensen reduction

(II) Etard reaction

OR

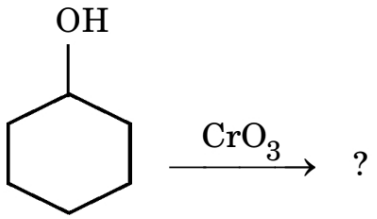
(b) Answer the following questions : *5×1=5*

(i) Draw structure of the methyl hemiacetal of methanal.

(ii) There are two $-NH_2$ groups in semicarbazide. However only one is involved in the formation of semicarbazones. Give reason.

(iii) How will you convert ethanol to 3-hydroxybutanal ?

(iv) Complete the following equation :



(v) Write the final product formed when phthalic acid is treated with NH_3 followed by strong heating.

33. (a) (i) Calculate the emf of the following cell at 25°C : *3*

$Zn(s) \mid Zn^{2+}$ (0·1 M) $\| H^+$ (0·01 M) $\mid H_2(g)$ (1 bar), Pt(s)

[Given : $E^\circ_{Zn^{2+}/Zn} = -0{\cdot}76$ V, $E^\circ_{2H^+/H_2} = 0{\cdot}00$ V, log 10 = 1]

(ii) State Faraday's second law of electrolysis. How much electricity is required in terms of Faraday for the reduction of 1 mol of $Cr_2O_7^{2-}$ to Cr^{3+} ? *2*

OR

(b) Answer the following questions :

(i) The conductivity of 0·20 M solution of KCl is $2{\cdot}48 \times 10^{-2}$ S cm^{-1}. Calculate its molar conductivity and degree of dissociation (α).

[Given : $\lambda^\circ_{(K^+)} = 73{\cdot}5$ S cm^2 mol^{-1}

$\lambda^\circ_{(Cl^-)} = 76{\cdot}5$ S cm^2 mol^{-1}]

(ii) Calculate $\Delta_r G^\circ$ of the following cell :

$Mg(s) + Cu^{2+}(aq) \longrightarrow Mg^{2+}(aq) + Cu(s)$

[Given : $E^\circ_{Mg^{2+}/Mg} = -2{\cdot}37$ V, $E^\circ_{Cu^{2+}/Cu} = +0{\cdot}34$ V

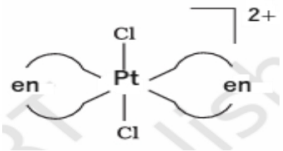
1 F = 96500 C mol^{-1}]

(iii) What type of cell is mercury cell ? Why is it more advantageous than dry cell ? *2+2+1=5*

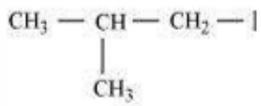
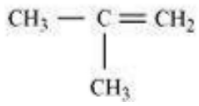
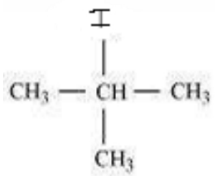
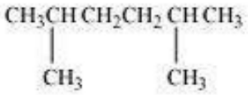
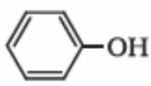
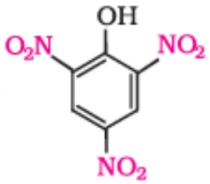
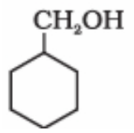
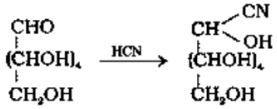
MARKING SCHEME 2024-25

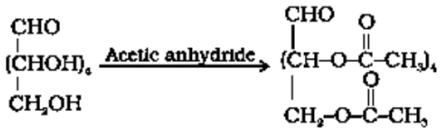
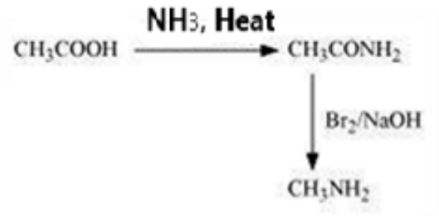
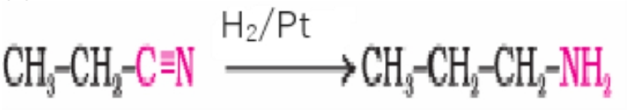
CHEMISTRY (Theory)- 043

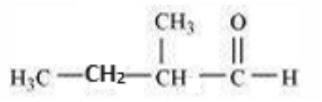
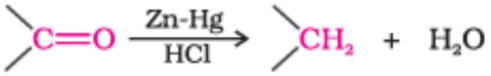
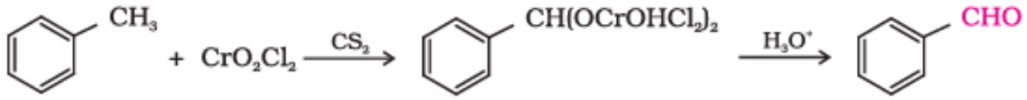
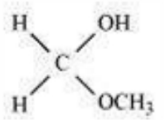
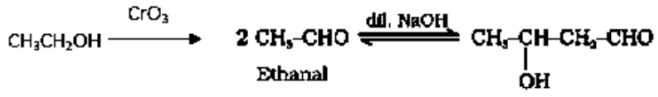
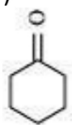
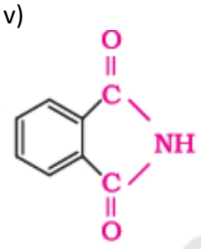
QP CODE 56/7/1 **MM: 70**

Q.No	Value points	Mark
	SECTION A	
1	**A**	**1**
2	**D**	**1**
3	**B**	**1**
4	**C**	**1**
5	**B**	**1**
6	**A**	**1**
7	**C**	**1**
8	**A**	**1**
9	**C**	**1**
10	**D**	**1**
11	**A**	**1**
12	**B**	**1**
13	**C**	**1**
14	**A**	**1**
15	**B**	**1**
16	**C**	**1**
	SECTION B	
17	When vapour pressure of the solution is higher than expected from the ideal behaviour. Example : ethanol and acetone/ carbon disulphide and acetone (or any other suitable example) Minimum boiling azeotrope	1 ½ ½
18	When one of the reactant is present in excess Hydrolysis of an ester/ sucrose (or any other suitable example) For elementary reaction, which takes place in a single step.	1 ½ ½
19	a) Dichloridobis(ethane-1,2-diamine)platinum(IV) ion  	1 1
	OR	
19	i) $[Co(NH_3)_5(CO_3)]Cl$ ii) Pentaamminenitrito-O-cobalt(III) chloride	1 1
20	-Because C—X bond acquires a partial double bond character due to resonance/ sp^2 hybridized carbon of C-X bond leading to shorter bond length (Or any other suitable reason). -Nitro group withdraws the electron density from the benzene ring and thus facilitates the attack of the nucleophile on haloarene / $-NO_2$ group being electron withdrawing stabilises the intermediate carbanion.	1 1
21	Because the hydrogen bonds are formed between specific pairs of bases 2-deoxyribose sugar , base and phosphoric acid	1 1

	SECTION C	
22	$\Delta T_f = iK_f m$ $\Delta T_f = i \times \frac{K_f \times w_2 \times 1000}{M_2 \times w_1}$ $0.45 = \frac{i\ X\ 5.12\ X\ 0.3\ X\ 1000}{60\ X\ 30}$ $i = 0.527$ $\alpha = \frac{i-1}{1/n-1}$ $\alpha = \frac{0.527-1}{1/2-1}$ (n=2) α= 0.946 or 94.6% (Or any other suitable method)	½ 1 ½ ½ ½
23	(a) Lead storage battery **Anode:** $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$ **Cathode:** $PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$	1 1 1
	OR	
23	(b)Because at cathode the reaction with higher value of E° is preferred and therefore, the reduction of H_2O to H_2 gas is preferred whereas at anode water should get oxidised in preference to Cl^- (aq), however, on account of overpotential of oxygen, oxidation of Cl^- to Cl_2 gas is preferred. $NaCl(aq) + H_2O(l) \rightarrow Na^+(aq) + OH^-(aq) + \frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g)$	1 1 1
24	$2N_2O_5(g) \rightarrow 2N_2O_4(g) + O_2(g)$ Start $t = 0$: P_i atm; 0 atm; 0 atm At time t: $(P_i - 2x)$ atm; 2x atm; x atm $P_t = P_i - 2x + 2x + x = P_i + x$ $x = = P_t - P_i$ $p_A = P_i - 2x$ $= P_i - 2(P_t - P_i)$ $= 3P_i - 2P_t$ $k = \frac{2.303}{t} \log \frac{p_i}{p_A}$ Where pi=0.5 atm, $p_A = 3p_i - 2p_t$ = (3X 0.5)-(2x0.625) =0.25atm $k = \frac{2.303}{100\,s} \log \frac{0.5\,atm}{0.25\,atm}$ $= \frac{2.303}{100\,s} \times 0.3010$ = 6.93 X 10^{-3} s^{-1}	1 1 1

25	A=  B=  C=  D=  	½ ½ ½ ½ 1
26	a) CH_3I +  b)  c) 	1 1 1
27	a) Because the carboxyl group is deactivating and the catalyst aluminium chloride (Lewis acid) gets bonded to the carboxyl group.(forms salt) b) Because carbonyl carbon of HCHO is more electrophilic than CH_3CHO/ due to +I effect of methyl group/ steric effect of methyl group, CH_3CHO is less reactive. c) Because of greater electronegativity of sp^2 hybridised carbon to which carboxyl carbon is attached.	1 1 1
28	a)  b) 	1 1

	c)  	1
	SECTION D	
29	a) Due to presence of one unpaired electron in t_{2g} which gets excited to e_g / Due to excitation energy $t_{2g}^{1} \rightarrow e_g^{1}$, it gives colour. (d-d transition) When heated, water is lost therefore crystal field splitting does not occur and it becomes colourless. b) The energy required to split the degenerate d-orbitals into two sets of orbitals (t_{2g} and e_g). /The difference of energy between the two sets of d-orbitals t_{2g} and eg due to the presence of ligands in a definite geometry . **OR** b) (ii) $\Delta_o < P$, weak filed ligand $\Delta_o > P$, strong field ligand c) Because the orbital splitting energies are not sufficiently large for forcing pairing / Due to low crystal field splitting energy.	1 1 1 ½ + ½ 1
30	a) (i)  (ii)  (or by any other method) **b)** Aniline undergoes resonance and as a result the electrons on the N-atom are less available for donation. **c)** (i) $(CH_3)_3N < CH_3NH_2 < (CH_3)_2NH$ OR c) (ii) A= $C_6H_5NH_2$; B= $=C_6H_5N_2^+Cl$	1 1 1 ½ + ½
	SECTION E	
31	(a) (i) (I) Because Mn^{2+} is more stable than Mn^{3+} due to extra stable half-filled d^5 configuration. (II) Due to comparable energies of 5f, 6d and 7s orbitals (III) Due to the involvement of greater number of electrons from (n-1)d in addition to the ns electrons in the inter-atomic metallic bonding. (ii) (I) $5SO_3^{2-} + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{2+} + 3H_2O + 5SO_4^{2-}$ (II) $2MnO_4^- + H_2O + I^- \longrightarrow 2MnO_2 + 2OH^- + IO_3^-$	1 1 1 1 1
	OR	
31	b) (i) Mn, Zn, Ni, Cu (any two) (ii) K_2MnO_4, due to presence of one unpaired electron (iii) Similar radii of 4d and 5d series elements/ similar properties/ difficulty in separation of lanthanoids (or any other relevant consequence)	½ , ½ ½ , ½ 1

	(iv) It is prepared by fusion of MnO_2 with an alkali metal hydroxide and an oxidising agent / $2MnO_2 + 4KOH + O_2 \rightarrow 2K_2MnO_4 + 2H_2O$ (v) because of the ability of oxygen to form multiple bonds with metal	1 1
32	(a) (i) (I) $(CH_3)_3C\text{-}CHO$ (II)  (III) $CH_3\text{-}CO\text{-}CH_2CH_2CH_3$ (ii) (I)  (II) 	1 1 1 1 1
	OR	
32.	(b) i)  ii) Because semicarbazide undergoes resonance involving only one of the two - NH_2 groups, which is attached directly to the carbonyl-carbon atom. iii)  iv)  v) 	1 1 1 1 1
33	**(a) (i)** $E_{Cell} = (E^o{}_c - E^o{}_a) - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[H^+]^2}$	1

	$= [(0) - (-0 \cdot 76)] - \frac{0 \cdot 059}{2} log \frac{0 \cdot 1}{(0 \cdot 01).^2}$ = 0.76 - 0.0295 log 10^3 = 0.76 – 0.0885 = 0.6715 V or 0.67 V (Deduct ½ mark for no or incorrect unit) (ii) The amounts of different substances liberated by the same quantity of electricity passing through the electrolytic solution are proportional to their chemical equivalent weights. 6F	1 1 1 1
	OR	
33	(b) (i) $\Lambda_m = \frac{K}{C} \times 1000$ $\Lambda_m = \frac{2.48 \times 10^{-2}}{0.2} \times 1000$ ***= 124 S cm² mol⁻¹*** $\Lambda^\circ_m = \lambda^\circ_{K^+} + \lambda^\circ_{Cl^-}$ ***=73.5 +76.5*** ***= 150 S cm² mol⁻¹*** $\alpha = \frac{\Lambda_m}{\Lambda^\circ_m}$ $= \frac{\mathbf{124}}{\mathbf{150}}$ =0.827 (ii) $E^0_{cell} = E^0_{cathode} - E^0_{anode}$ = 0.34-(-2.37) =2.71V $\Delta_r G^0 = -nFE^0_{cell}$ = -2 X 96500 X 2.71 = -523030 $Jmol^{-1}$ or -523.03 $kJmol^{-1}$ (iii) Primary cell Maintains constant potential throughout its usage/ longer lifespan	½ ½ ½ ½ ½ ½ ½ ½ ½ ½

	= -523030 $Jmol^{-1}$ or -523.03 $kJmol^{-1}$ (iii) • प्राथमिक सेल • अपने संपूर्ण अवधिकाल में विभव को स्थिर बनाए रखता है / लंबा जीवनकाल	½ ½ ½