CHEMISTRY

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

General Instructions :

1. There are **33** questions in this question paper with internal choice.
2. **SECTION A** consists of **16 multiple-choice questions** carrying **1 mark** each.
3. **SECTION B** consists of **5 short answer questions** carrying **2 marks** each.
4. **SECTION C** consists of **7 short answer questions** carrying **3 marks** each.
5. **SECTION D** consists of **2 case-based questions** carrying **4 marks** each.
6. **SECTION E** consists of **3 long answer questions** carrying **5 marks** each.
7. **All questions are compulsory.**
8. **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. A compound undergoes complete tetramerization in a given organic solvent. The Van't Hoff factor 'q' is : **[1]**

(a) 4.0 (b) 0.25

(c) 0.125 (d) 2.0

2. The following experimental rate data were obtained for a reaction carried out at 25 ºC : **[1]**

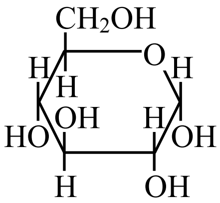
$A_{(g)} + B_{(g)} \rightarrow C_{(g)} + D_{(g)}$

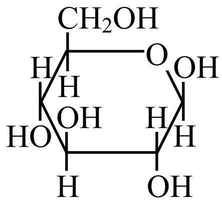
Initial $[A_{(g)}]$/mol dm^{-3}	Initial $[B_{(g)}]$/mol dm^{-3}	Initial rate/mol $dm^{-3}s^{-1}$
3.0×10^{-2}	2.0×10^{-2}	1.89×10^{-4}
3.0×10^{-2}	4.0×10^{-2}	1.89×10^{-4}
6.0×10^{-2}	4.0×10^{-2}	7.56×10^{-4}

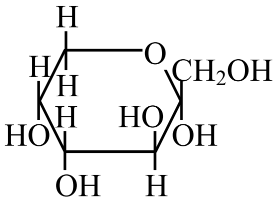
What are the orders with respect to $A_{(g)}$ and $B_{(g)}$?

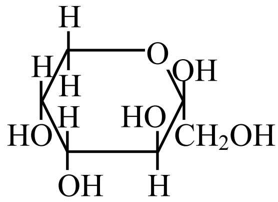
	Order with respect to $A_{(g)}$	Order with respect to $B_{(g)}$
(a)	Zero	Second
(b)	First	Zero
(c)	Second	Zero
(d)	Second	First

3. Which of the following structures represents α-D-glucose ? **[1]**

(a) 

(b) 

(c) 

(d) 

4. The ions of metals of Group 12 (Zn, Cd and Hg) have completely filled d orbitals and so they : **[1]**

(a) behave like semiconductors
(b) are very high melting solids
(c) do not behave like transition metals
(d) behave like superconductors

5. $[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5SO_4]NO_3$ exhibit : **[1]**

(a) linkage isomerism
(b) ionization isomerism
(c) optical isomerism
(d) coordination isomerism

6. The reduction of ethanenitrile with sodium and alcohol gives : **[1]**

(a) 1-aminopropane
(b) 1-aminoethane
(c) Ethanoic acid
(d) Ethanamide

7. How many Faradays are required to reduce 1 mol of MnO_4^- to Mn^{2+} ? **[1]**

(a) 4 (b) 3 (c) 6 (d) 5

8. In a reaction, the initial concentration of the reactants increases four fold and the rate becomes sixteen times its initial value. The order of the reaction is : **[1]**

(a) 2.0 (b) 3.5 (c) 1.5 (d) 2.5

9. On hydrolysis, which of the following carbohydrates gives only glucose ? **[1]**

(a) Maltose
(b) Sucrose
(c) Lactose
(d) Galactose

10. Deficiency of which of the following vitamins causes Pernicious anaemia ? **[1]**

(a) Vitamin B_1
(b) Vitamin B_2
(c) Vitamin B_6
(d) Vitamin B_{12}

11. $C_6H_5CHO + CH_3COCH_3 \xrightarrow[\Delta]{OH^-} C_6H_5CH = CH - COCH_3$ **[1]**

This reaction is known as :

(a) Aldol condensation
(b) Cross-Aldol condensation
(c) Cannizzaro's reaction
(d) Friedel-Crafts reaction

12. In which of the following does the central atom exhibit an oxidation state of +3 ? **[1]**

(a) $K_2[Ni(CN)_4]$
(b) $K_4[Fe(CN)_6]$
(c) $[Fe(C_2O_4)_3]^{3-}$
(d) $[Cu(NH_3)_4]^{2+}$

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) :** When NaCl is added to water, a depression in freezing point is observed. **[1]**

Reason (R) : The lowering of vapour pressure of a solution causes depression in the freezing point.

14. **Assertion (A) :** $\wedge_m$ for weak electrolytes shows a sharp decrease when the electrolytic solution is diluted. **[1]**

Reason (R) : For weak electrolytes, degree of dissociation increases with dilution of solution.

15. **Assertion (A) :** Zr and Hf have almost identical radii. **[1]**

Reason (R) : Both Zr and Hf exhibit similar properties.

16. **Assertion (A) :** Monobromination of aniline can be conveniently done by protecting the amino group by acetylation. **[1]**

Reason (R) : Acetylation decreases the activating effect of the amino group.

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. An alkyl halide (A) of molecular formula $C_6H_{13}Cl$ on treatment with alcoholic KOH gives two isomeric alkenes (B) and (C) of molecular formula C_6H_{12}. Both alkenes on hydrogenation give 2, 3-dimethylbutane.

Write the structures of (A), (B) and (C). **[2]**

18. (a) What type of deviation from Raoult's law is shown by a mixture of ethanol and acetone ? Give reason. **[2]**

OR

(b) Define Azeotrope. What type of azeotrope is formed by negative deviation from Rault's laws of give an example. **[2]**

19. Name the cell which : **[4 × ½ = 2]**

(a) was used in Apollo Space programme.

(b) is used in automobiles and inverters.

(c) is suitable for hearing aids and watches.

(d) does not give a steady potential and is used in transistors.

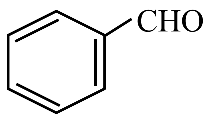
20. The rate constant for the first order decomposition of N_2O_5 is given by the following equation :

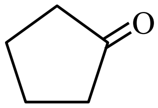
$$\log k = 23.6 - \frac{2 \times 10^4 K}{T}$$

Calculate Ea for this reaction. **[2]**

$[R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}]$

21. (a) Write the products of the following reactions : **[2 × 1 = 2]**

(i)  $\xrightarrow[\Delta]{\text{Conc. NaOH}}$

(ii)  $+ H_2NNH\text{–}CO\text{–}NH_2 \xrightarrow{H^+}$

OR

(b) Do the following conversions in not more than two steps : **[2 × 1 = 2]**

(i) Toluene to Benzoic acid

(ii) Benzaldehyde to 1-Phenylethanol

SECTION – C

This section contains 5 questions with internal choice in two questions. The following questions are short answer type and carry 3 marks each.

22. (a) (i) Write the mechanism of the following reaction : **[2 + 1]**

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

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

OR

(b) What happens when

(i) Anisole is treated with CH_3Cl/anhydrous $AlCl_3$? **[3 × 1]**

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

(iii) $(CH_3)_3C\text{–}OH$ is heated with Cu/573 K ?

Write chemical equation in support of your answer.

23. Account for the following : **[3 × 1 = 3]**

(a) Benzyl chloride is highly reactive towards S_N1 reaction.

(b) (+)-Butan-2-ol is optically inactive, though it contains a chiral carbon atom.

(c) Chloroform is stored in closed dark coloured bottles.

24. Answer any three of the following questions : **[3 × 1 = 3]**

(a) Explain the type of hybridization in $[Fe(CN)_6]^{3-}$ on the basis of valence bond theory. (Given : Atomic number of Fe = 26)

(b) Draw the geometrical isomers of $[PtCl_2(en)_2]^{2+}$ ion.

(c) $[NiCl_4]^{2-}$ is paramagnetic while $[Ni(CO)_4]$ is diamagnetic though both are tetrahedral. Why?

(d) Name the type of isomerism when ambidentate ligands are attached to central metal ion. Give one example of ambidentate ligand.

25. If benzoic acid (M = 122 g mol^{-1}) is associated into a dimer when dissolved in benzene and the osmotic pressure of a solution of 6.1 g of benzoic acid in 100 mL benzene is 6.5 atm at 27°C, then what is the percentage association of benzoic acid ? **[3]**

(Given : R = 0.0821 L atm K^{-1} mol^{-1})

26. The following data were obtained during the first order thermal decomposition of C_2H_5Cl at a constant volume :

$C_2H_5Cl(g) \longrightarrow C_2H_4(g) + HCl(g)$

Experiment	Time (s^{-1})	Total pressure (atm)
1	0	0.4
2	100	0.6

Calculate the rate constant. **[3]**

(Given : log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021)

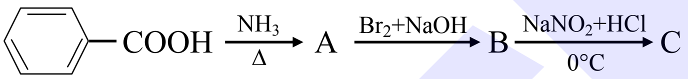
27. Account for the following :

(1) Transition metals form complex compounds.

(2) The $E^\circ_{Mn^{2+}/Mn}$ value for manganese is highly negative whereas $E^\circ_{Mn^{3+}/Mn^{2+}}$ is highly positive.

(3) Cu^+ ion is unstable in aqueous solution.

28. (a) Write the structures of A, B and C in the following reactions : **[2 × 1½ = 3]**

(i) 

(ii) $CH_3CH_2Br \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[0°C]{HNO_2} C$

OR

(b) How will you convert the following : **[3 × 1 = 3]**

(i) Aniline to p-bromoaniline

(ii) Ethanoic acid to methanamine

(iii) Butanenitrile to 1-aminobutane

SECTION – D

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

29. Living systems are made up of various complex biomolecules like carbohydrates, proteins, ucleic acids, lipids, etc. Carbohydrates are optically active polyhydroxy aldehydes or ketones or molecules which provide such units on hydrolysis. They are broadly classified into three groups– monosaccharides, oligosaccharides and polysaccharides.

Monosaccharides are held together by glycosidic linkages to form disaccharides like sucrose, maltose or polysaccharides like starch and cellulose.

Another biomolecule : proteins are polymers of α-amino acids which are linked by peptide bonds. Ten amino acids are called essential amino acids. Structure and shape of proteins can be studied at four different levels i.e. primary, secondary, tertiary and quaternary, each level being more complex than the previous one.

Answer the following questions :

(i) What is the difference between a glycosidic linkage and peptide linkage ? **[1]**

(ii) Which amino acids are called essential amino acids ? **[1]**

(iii) What are the common types of secondary structures of proteins ?

Write any two forces which stabilise the secondary and tertiary structures of protein. **[2]**

OR

(iii) Define denaturation of protein with an example. During denaturation which structures of protein lose their biological activity ? **[2]**

30. Amines are usually formed from nitro compounds, halides, amides, imides, etc. They exhibit hydrogen bonding which influences their physical properties. In alkyl amines, a combination of electron releasing, steric and hydrogen bonding factors influence the stability of the substituted ammonium cations in protic polar solvents and thus affect the basic nature of amines. In aromatic amines, electron releasing and withdrawing groups, respectively increase and decrease their basic character. Influence of the number of hydrogen atoms at nitrogen atom on the type of reactions and nature of products is responsible for identification and distinction between primary, secondary and tertiary amines. Presence of amino group in aromatic ring enhances reactivity of the aromatic amines. Aryl diazonium salts provide advantageous methods for producing aryl halides, cyanides, phenols and arenes by reductive removal of the diazo group.

Answer the following questions :

(i) Arrange the following in the increasing order of their pKb values in aqueous solution : **[1]**

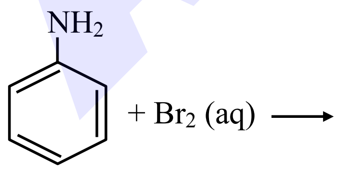
$C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$

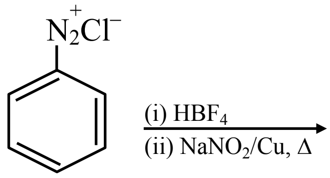
(ii) Aniline on nitration gives a substantial amount of m-nitroaniline, though amino group is o/p directing. Why ? **[1]**

(iii) An aromatic compound 'A' of molecular formula $C_7H_6O_2$ on on treatment with aqueous ammonia and heating forms compound 'B'. Compound 'B' on heating with Br_2 and aqueous KOH gives a compound 'C' of molecular formula C_6H_7N. Write the structures of A, B and C. **[2]**

OR

(iii) Complete the following reactions giving main products : **[2 × 1 = 2]**

(1) 

(2) 

SECTION – E

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

31. (a) (i) Calculate the emf of the following cell at 298 K :

Al (s) | Al^{3+} (0.001 M) || Ni^{2+} (0 1 M) | Ni (s)

$[\text{Given}: E^{\circ}_{Al^{3+}/Al} = -1.66 V, E^{\circ}_{Ni^{2+}/Ni} = -0.25 V, \log 10 = 1]$

(ii) With the help of a graph explain why it is not possible to determine $\wedge^{\circ}_{m}$ for a weak electrolyte by extrapolating the molar conductivity $(\wedge_m)$ versus $C^{1/2}$ curve as for strong electrolyte. **[3 + 2 = 5]**

OR

(b) (i) The molar conductivities of NH_4^+ and Cl^- ion are 73.8 S cm^2 mol^{-1} and 76.2 S cm^2 mol^{-1} respectively. The conductivity of 0.1 M NH_4Cl is 1.29×10^{-2} S cm^{-1}. Calculate its molar conductivity and degree of dissociation.

(ii) Calculate the half-cell potential at 298 K for the reaction

$Zn^{2+} + 2e^- \longrightarrow Zn$

if $[Zn^{2+}] = 0.1$ M and $E^{\circ}_{zn^{+2}/Zn} = -0.76 V$ **[3 + 2 = 5]**

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

(1) Zn^{2+} salts are colourless while Ni^{2+} salts are coloured.

(2) Cr^{2+} is a strong reducing agent.

(3) Transition metals and their compounds show catalytic activities.

(ii) Write the ionic equations for the oxidizing action of MnO_4^- in acidic medium with

(1) I^- ion, and

(2) Fe^{2+} ion. **[3 + 2 = 5]**

OR

(b) (i) Name two oxometal anions of the 3d series of the transition metals in which the metal exhibits the oxidation state equal to its group number.

(ii) What is the effect of increasing pH on a solution of $K_2Cr_2O_7$?

(iii) Write the equations involved in the preparation of $KMnO_4$ from Pyrolusite ore (MnO_2).

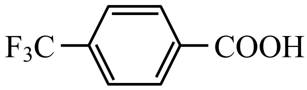
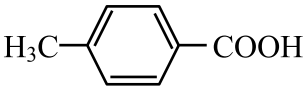
(iv) Name a member of Lanthanoid series which is well-known to exhibit +4 oxidation state.

(v) Name two elements of 3d series which show anomalous electronic configuration.

[5 × 1 = 5]

33. (a) Draw structure of the 2,4-dinitrophenylhydrazone of benzaldehyde.

(b) Which acid of the following pair is a stronger acid ?

 or 

(c) Write the chemical equation involved in Rosen Mund's reduction.

(d) Why are α-hydrogen atoms of aldehydes and ketones acidic in nature ?

(e) Write a chemical test to distinguish between Benzaldehyde and Benzoic acid. **[5 × 1 = 5]**