CHEMISTRY PAPER 1
(THEORY)

Maximum Marks: 70

Time Allowed: Three Hours

*(Candidates are allowed **additional 15 minutes** for **only** reading the paper.*

*They must **NOT** start writing during this time.)*

This paper is divided into four sections – A, B, C and D.
*Answer **all** questions.*
***Section – A** consists of **one** question **having sub-parts** of **one** mark each.*
***Section – B** consists of **ten** questions of **two** marks each.*
***Section – C** consists of **seven** questions of **three** marks each, and*
***Section – D** consists of **three** questions of **five** marks each.*
Internal choices have been provided in one question each in Section B,
Section C and Section D.
All working, including rough work, should be done on the same sheet as, and adjacent to the
rest of the answer.
The intended marks for questions or parts of questions are given in brackets [ ].
Balanced equations must be given wherever possible and diagrams where they are helpful.
When solving numerical problems, all essential working must be shown.
In working out problems, use the following data:
Gas constant $R = 1 \cdot 987$ cal deg^{-1} mol^{-1} $= 8 \cdot 314$ JK^{-1} mol^{-1} $= 0 \cdot 0821$ dm^3 atm K^{-1}mol^{-1}
$1 l$ atm $= 1$ dm^3 atm $= 101 \cdot 3$ J. 1 Faraday $= 96500$ coulombs.
Avogadro's number $= 6 \cdot 023 \times 10^{23}$.

SECTION A – 14 MARKS

Question 1

(A)   Fill in the blanks by choosing the appropriate word(s) from those given in the   **[4×1]**
brackets:

[decreases, CN$^-$ ion, activation energy, catalyst, two, Fe^{2+} ion, carbon, lattice energy, enzyme, five, double, halogen, triple, increases]

(i)   In the Haber process, iron changes the _____ of reaction while molybdenum increases the efficiency of the _____.

(ii)   The number of ions that will be produced when potassium ferrocyanide, K$_4$[Fe(CN)$_6$], dissolves in water is _____. This shows that _____ is the ligand in the coordination compound.

(iii) Haloalkenes undergo both nucleophilic and electrophilic reactions due to the presence of _____ bond and the _____ atom.

(iv) In case of alcohols, as the carbon chain length increases, the boiling point _____ and the solubility in water _____.

(B) Select and write the correct alternative from the choices given below: **[7×1]**

(i) A potassium iodide (KI) solution containing starch turns blue on the addition of chlorine. Which one of the following statements explain this?

(P) The reduction potential of Cl_2 is more than that of I_2.

(Q) The oxidation potential of Cl_2 is more than that of I_2.

(R) The product formed when Cl_2 combines with starch is blue.

(S) The product formed when I_2 combines with starch is blue.

(a) Only P and R

(b) Only Q and R

(c) Only Q and S

(d) Only P and S

(ii) Crystal field splitting energy (CFSE) for high spin d^4 octahedral complex is:

(a) $-1 \cdot 6 \, \Delta_o$

(b) $-1 \cdot 2 \, \Delta_o$

(c) $-0 \cdot 8 \, \Delta_o$

(d) $-0 \cdot 6 \, \Delta_o$

(iii) Acidified $K_2Cr_2O_7$ solution turns green when Na_2SO_3 is added to it. This is due to formation of:

(a) CrO_4^{2-}

(b) $Cr_2(SO_3)_3$

(c) Cr_2O_3

(d) $Cr_2(SO_4)_3$

(iv) Which of the following product is formed when benzene diazonium chloride is reduced by hypophosphorous acid (H_3PO_2) in the presence of cuprous ion as catalyst?

(a) Phenol

(b)   Aniline

(c)   Benzene

(d)   Benzene cyanide

(v)   Which of the following aqueous solution has lowest vapour pressure?

   (a)   1M NaCl

   (b)   1M K_2SO_4

   (c)   1M Glucose

   (d)   1M Sucrose

(vi)   **Assertion:** Adding water to two beakers 'A' and 'B' containing NaOH and CH_3COOH solutions respectively will increase the molar conductance (Λ_m) of the solutions sharply in beaker 'A' and slowly in beaker 'B'.

   Reason: Molar conductance (Λ_m) increases with a decrease in concentration or upon dilution.

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

   (b)   Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.

   (c)   Assertion is true but Reason is false.

   (d)   Assertion is false but Reason is true.

(vii) **Assertion:** Aniline is soluble in HCl while it is only slightly soluble in water.

   Reason: Aniline cannot make hydrogen bonds with water but gets protonated easily by acids.

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

   (b)   Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.

   (c)   Assertion is true but Reason is false.

   (d)   Assertion is false but Reason is true.

(C) Read the passage given below carefully and answer the questions that follow. **[3×1]**

During the winter season in a particular year, Kashmir experienced heavy snowfall. It was an unexpected snowfall. Thousands of visitors were stranded because it was dangerous to travel on snowy roads and vehicles could not move as water froze in the car radiators. In such conditions officials decided to sprinkle rock salt or $CaCl_2$ on roads.

(i) Why was it decided to sprinkle rock salt or $CaCl_2$ on the roads?

(ii) A mixture of ethylene glycol and water is used as coolant in car radiators. Why?

(iii) How many grams of ethylene glycol (mol. wt. = 62 g mol^{-1}) should be added to 10 kg of water so that the solution freezes at -10°C?
(K$_f$ for water = 1$^.$86 K kg mol^{-1})

SECTION B – 20 MARKS

Question 2 **[2]**

(i) Arrange the following alcohols in order of decreasing activity towards Lucas' reagent.
2-butanol, 2-methyl-2-propanol and 1-butanol

(ii) Ethanol has a higher boiling point than methoxymethane. Justify the statement.

Question 3 **[2]**

Give a reason for each of the following:

(i) The size of the trivalent cations in Lanthanoid series decreases steadily as the atomic number increases.

(ii) The third ionization energy of manganese (Z = 25) is unexpectedly high.

Question 4 **[2]**

Give balanced chemical equations to convert the following:

(i) Benzene to biphenyl

(ii) Propene to propane -1-ol

Question 5 [2]

Account for the following:

(i) Salts of cuprous (Cu^+) ion are colourless whereas the salts of cupric (Cu^{2+}) ion are coloured.

(ii) Zinc is not regarded as a transition element. (at. no. of Zn = 30)

Question 6 [2]

Two compounds, D-2-chlorobutane and L-2-chlorobutane, are enantiomers of each other.

Name one physical property that is:

(i) same for D-2-chlorobutane and L-2-chlorobutane.

(ii) different for D-2-chlorobutane and L-2-chlorobutane.

Question 7 [2]

(i) A rusted piece of iron undergoes electrochemical reactions. Write the chemical reaction taking place at:

    (a) the electrode that behaves as an anode.

    (b) the electrode that behaves as a cathode.

(ii) Given that the standard reduction potential for Al^{3+}/Al = -1·66 V and ½ I_2/I^- = 0·54V, what will be the standard potential of the cell made by using Al^{3+} and I^-?

Question 8 [2]

(i) What happens when (write chemical reactions only)

    (a) Diethyl ether is treated with phosphorous pentachloride.

    (b) Ethyl alcohol is treated with methyl magnesium bromide.

OR

(ii) An organic compound [A] having molecular formula C_6H_6O gives a characteristic colour with aqueous $FeCl_3$ solution. [A] on treatment with CO_2 and NaOH at 400K under pressure gives [B] which on acidification gives compound [C]. [C] reacts with acetyl chloride to give [D] which is a popular pain killer.

Identify the compounds [A], [B], [C] and [D].

Question 9 [2]

John was making noodles in boiling water. When he added common salt (NaCl) to boiling water, the water stopped boiling for a short while. If John had added 15·0g of NaCl to 250·0g of water, calculate the boiling point of solution assuming that NaCl dissociates completely in water. (K_b for water = 0·512K kg mol^{-1}, molecular mass of NaCl = 58·44 g mol^{-1}).

Question 10 [2]

(i) Aromatic aldehydes do not give a reddish-brown precipitate on heating with Fehling solution. Give a reason.

(ii) Why is benzaldehyde less reactive to electrophilic substitution reactions than benzene?

Question 11 [2]

(i) Give a reason to explain why transition metals can act as a good catalyst.

(ii) Scandium (Z = 21) does not exhibit variable oxidation states and yet it is regarded as transition element. Why?

SECTION C – 21 MARKS

Question 12 [3]

The data in the table given below was obtained in a series of experiments on the rate of the reaction between compounds [A] and [B] at a constant temperature:

Experiment	The initial concentration of [A] mol dm^{-3}	The initial concentration of [B] mol dm^{-3}	Initial rate mol dm^{-3} s^{-1}
1	0·15	0·30	1·10 x 10^{-4}
2	0·30	0·30	4·40 x 10^{-4}
3	0·60	0·15	8·80 x 10^{-4}

Show how this data can be used to deduce the rate expression for the reaction between [A] and [B].

Question 13 [3]

Arrange the following compounds:

$C_6H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$, $C_2H_5NH_2$.

(i)   in the increasing order of their basic strength in water.

(ii)   in a decreasing order of their basic strength in gas phase.

Question 14 [3]

(i)   What products are obtained when sucrose is subjected to acid hydrolysis?

(ii)   Why are Vitamin B and Vitamin C essential for us?

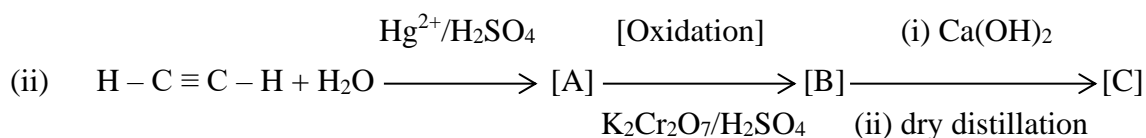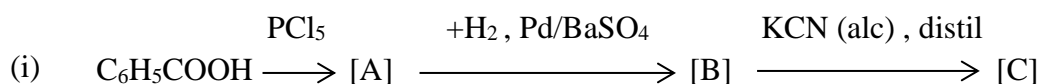(iii) On being heated, egg white becomes solid and opaque. Give a reason.

Question 15 [3]

Water vapour and liquid water are in equilibrium in a container. At room temperature, the vapour pressure of water is 25 mm of Hg. The volume of water is V ml.

(i)   What will be the vapour pressure of water if the volume of water is reduced to V/4 ml without any change in temperature? Give a reason.

(ii)   Will there be a change in vapour pressure if more water (at room temperature) is added to the container? Give a reason.

Question 16 [3]

Identify the compounds [A], [B] and [C].

(i) $C_6H_5COOH \xrightarrow{\text{PCl}_5} [A] \xrightarrow{\text{+H}_2 \text{, Pd/BaSO}_4} [B] \xrightarrow{\text{KCN (alc) , distil}} [C]$

(ii) $H-C \equiv C-H + H_2O \xrightarrow[\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4]{\text{Hg}^{2+}/\text{H}_2\text{SO}_4} [A] \xrightarrow{\text{[Oxidation]}} [B] \xrightarrow[\text{(ii) dry distillation}]{\text{(i) Ca(OH)}_2} [C]$

Question 17   **[3]**

(i)   How will the following be obtained? (Give chemical equation)

   (a)   Picric acid from Phenol

   (b)   Ethyl acetate from ethanol

   (c)   Anisole from sodium phenoxide

OR

(ii)   Explain the mechanism of acid catalysed dehydration of ethanol to yield the corresponding alkene.

Question 18   **[3]**

(i)   The half-life period (t ½) for decay of radioactive ^{14}C is 5730 years. An ancient piece of wood has only 80% of the ^{14}C found in a living tree. Calculate the age of the piece of wood.

(ii)   The rate of most of the reactions becomes double when the temperature is raised from 298K to 308K. Calculate the activation energy. (R = $8 \cdot 314$ J K^{-1} mol^{-1})

SECTION D – 15 MARKS

**Question 19**   **[5]**

(i)   Give a reason for each of the following:

   (a)   Formaldehyde does not undergo aldol condensation, but acetaldehyde does.

   (b)   Chloroacetic acid is stronger acid than acetic acid.

   (c)   Both aldehydes and ketones undergo a number of nucleophilic addition reactions.

(ii)   An organic compound with the molecular formula C_7H_6O gets oxidised by Tollens' reagent. It does not respond to Fehling test but can undergo the Cannizzaro reaction.

   Identify the compound. Show how you used the above information to identify the compound.

Question 20 **[5]**

(i) When one mole of an isomer of the complex $[Cr(H_2O)_6]Cl_3$ is treated with $AgNO_3$, it produces 1 mole of a white precipitate of AgCl.

Write the formula of this isomer of the complex and show how the metal-ligand bonding differs in the isomers.

(ii) A coordination compound shows d^2sp^3 hybridisation. Identify the nature of ligand as weak or strong. What will be the geometry of the compound?

Question 21 **[5]**

(i)

(a) Calculate the value of E^o cell and ΔG^o that can be obtained from the following cell under the standard conditions at 25^oC
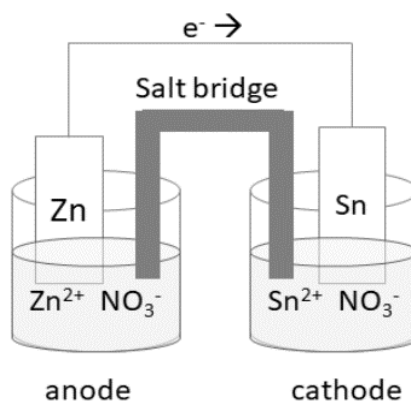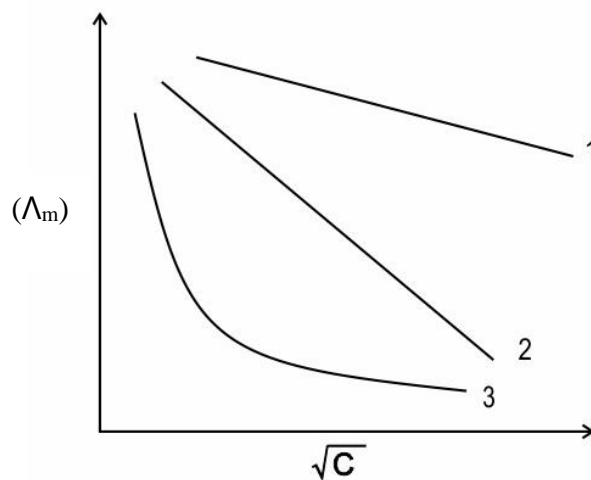

Given $E^o_{Zn^{2+}/Zn} = -0.76V$; $E^o_{Sn^{2+}/Sn} = -0.14V$
1 Faraday = 96500 C mol^{-1}

(b) How much electricity in Faraday is required for the complete reduction of MnO_4^- ions present in 500 ml of 0.5 M solution to Mn^{2+}?

OR

(ii)

(a) The molar conductivity vs √C curve for Na_2SO_4, H_2SO_4, and NH_4OH are shown below in random order.

(Λ_m)

1

2

3

√C

Identify the curve that corresponds to Na_2SO_4, H_2SO_4, and NH_4OH. Justify your answer.

(b) The molar conductivity (Λ_m) of a dilute solution of methanoic acid is $34\cdot1$ S cm^2/mol. Calculate its degree of dissociation.

(Given $\lambda^0(H^+) = 349\cdot6$ S cm^2/mol and $\lambda^0(HCOO^-) = 54\cdot6$ S cm^2/mol)