SAMPLE PAPER 4

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 = 1.987 cal deg^{-1} mol^{-1} = 8.314 JK^{-1} mol^{-1} = 0.0821 dm^3 atm K^{-1}mol^{-1}
1 L atm = 1 dm^3 atm = 101.3 J, 1 Faraday = 96500 coulombs,   Avogadro's number = 6.023 x 10^{23}

SECTION A – 14 MARKS

Question 1

(A) Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:
[*tetragonal bipyramidal, sp^2, sp^3, longer, shorter, slower, tetrahedral, octahedral, sp^{3}d^2, sp^{3}d^3, d^{2}sp^3, zero, one, two, greater*]

(i) When the concentration of a reactant of first order reaction is doubled, the rate of reaction becomes _____ times, but for a _____ order reaction, the rate of reaction remains the same.

(ii) The complex $[Ni(H_2O)_6]^{2+}$ has a _____geometry and the type of hybridization involved in the metal ion of this complex is _____ .

(iii) The _____the steric hindrance around the carbon atom, the _____the rate of nucleophilic substitution.

(iv) The –OH group in phenol is directly attached to the benzene ring's _____ hybridized carbon atom. The carbon-oxygen bond length in phenol is _____ than that in alkyl alcohol.

(B) Select and write the correct alternative from the choices given below:

(i) For the reaction A→B, the rate expression is r=k[A]^n. When the concentration of A is doubled, the rate of reaction is quadrupled. The value of n is
    (a) 1
    (b) Zero
    (c) 3
    (d) 2

(ii) The following complexes the one which shows zero crystal field stabilization energy (CFSE) is
    (a) $[Mn(H_2O)_6]^{3+}$
    (b) $[Fe(H_2O)_6]^{3+}$
    (c) $[Co(H_2O)_6]^{2+}$
    (d) $[Co(H_2O)_6]^{3+}$

(iii) Zn does not show variable valency because of
    (a) Complete d-subshell
    (b) Inert pair effect
    (c) $4s^2$ orbital
    (d) None of these

(iv) Hofmann's bromamide reaction is to convert
    (a) Acid to alcohol
    (b) Alcohol to acid
    (c) Amide to amine
    (d) Amine to amide

(v) The average osmotic pressure of human blood is 7.8 bar at 37 °C. What is the concentration of an aqueous NaCl solution that could be used in the blood steam?
    (a) 0.16 mol/L
    (b) 0.31 mol/L
    (c) 0.60 mol/L
    (d) 0.45 mol/L

(vi) <u>Assertion</u>: More negative the electrode potential greater is the power to act as oxidising agent.
<u>Reason</u>: As the electrode potential becomes more negative there is greater tendency to undergo oxidation
(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) <u>Assertion</u>: Carbyl amine reaction cannot be used as a test to distinguish between aniline and methanamine.

<u>Reason</u>: Both aniline and methanamine are primary amines.

(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.

Few colligative properties are:

(a) *relative lowering of vapour pressure*: depends only on molar concentration of solute (mole fraction) and independent of its nature.

(b) *depression in freezing point:* it is proportional to the molal concentration of solution.

(c) *elevation of boiling point:* it is proportional to the molal concentration of solute.

(d) *osmotic pressure*: it is proportional to the molar concentration of solute.

A solution of glucose is prepared with 0.052 g at glucose in 80.2 g of water.

$$\left(Given, K_f = 1.86 \text{ K kg mol}^{-1} \text{ and } K_b = 5.2 \text{ K kg mol}^{-1}\right)$$

(i)   Calculate the molality of the given solution.

(ii)   Calculate the depression in freezing point of solution.

(iii)   Calculate the mole fraction of glucose in the given solution.

SECTION B – 20 MARKS

Question 2

(i) Arrange the following alcohols in order of increasing reactivity towards sodium metal.
        $(CH_3)_3C-OH$, $(CH_3)_2CH-OH$, CH_3CH_2OH

(ii) Among three isomeric nitro phenols, ortho isomer is steam volatile, it has the lowest boiling point and is least soluble in water. Give reason.

Question 3

Give a reason for each of the following:

   (i) Mn and Tc have abnormally low melting and boiling points.

   (ii) Zn and Hf have similar atomic radii although these elements belong to different periods.

Question 4

Give balanced chemical equations to convert the following:

   (i) Phenol to toluene
   (ii) Ethanal to propan-2-ol

Question 5

Answer for the following:

(i) Why are Zn^{2+} ions are colourless while Ni^{2+} ions are green in colour?

(ii) Which divalent metal ion has the maximum paramagnetic character among the first transition metals?

Question 6

For the complex $[Fe(CO)_5]$, write the hybridization of Fe and magnetic character of the complex.
(At. number: $Fe = 26$)

Question 7

Value of standard electrode potential for the oxidation of Cl^-ions is more positive than that of water, even then in the electrolysis of aqueous sodium chloride, why is Cl^-oxidised at anode instead of water? Explain.

Question 8

(i) What happens when
    (a) Anisole is treated with HI?
    (b) Phenol is treated with *bromine water*?
    (Write chemical reactions only)

OR

(ii) An organic compound A with molecular formula C_2H_6O gives compound 'B' on oxidation with alkaline $KMnO_4$. 'A' an heating with conc. H_2SO_4 gives 'C' which on reaction with phosphoric acid and water gives back 'A' Compound 'C' gives addition product with Br_2 and H_2. Identify A, B, C and write chemical equations involved.

Question 9

A 4% solution (w/w) of sucrose ($M = 342$ g mol^{-1}) in water has a freezing point of 271.15 K. Calculate the freezing point of 5% glucose ($M = 180$ g mol^{-1}) in water. Given: Freezing point of pure water $= 273.15$ K)

Question 10

(i) CH_3CHO is more reactive than CH_3COCH_3 towards reaction with HCN. Why?

(ii) Carboxylic acid is stronger acid than phenol. Why?

Question 11

(i) Why inner transition elements are difficult to separate?

(ii) Of the d^4 species, Cr^{2+} is strongly reducing while Mn^{3+} is strongly oxidising. Explain.

SECTION C – 21 MARKS

Question 12

In a pseudo first order hydrolysis of ester in water, the following results were obtained:

t/s	0	30	60	90
[Ester]/mol L^{-1}	0.55	0.31	0.17	0.085

(i) Calculate the average rate of reaction between the time interval 30 to 60 seconds.

(ii) Calculate the pseudo first order rate constant for the hydrolysis of ester.

Question 13

(i) An aromatic compound ' A ' on treatment with aqueous ammonia and heating forms compound ' B ' which on heating with Br_2 and KOH forms a compound ' C ' of molecular formula C_6H_7 N. Write the structures and IUPAC names of compounds A, B and C.

(ii) Write IUPAC name of the following compound:

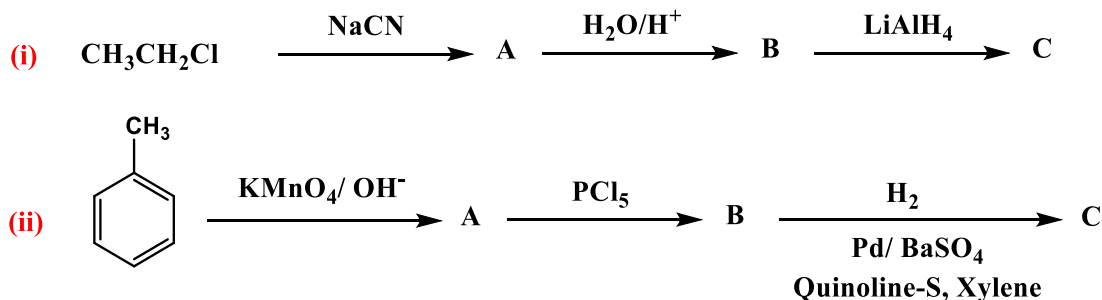$(CH_3CH_2)_2NCH_3$
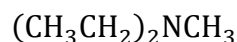
Question 14

(i) What are reducing sugars?

(ii) What are essential and non - essential amino acids? Give two examples of each type.

Question 15

(i) What are the differences between ideal and non-ideal solutions?

(ii) Two liquids A and B are mixed and the resulting solution is found to be cooler. What do you conclude about deviation from ideal behavior?

(iii) The vapour pressure of ethyl alcohol at 298 K is 40 mm of Hg. Its mole fraction in a solution with methyl alcohol is 0.80. What is its vapour pressure in solution if the mixture obeys Raoult's law?

Question 16

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

(i) CH_3CH_2Cl $\xrightarrow{\text{NaCN}}$ A $\xrightarrow{\text{H}_2\text{O/H}^+}$ B $\xrightarrow{\text{LiAlH}_4}$ C

(ii)

$\xrightarrow{\text{KMnO}_4/\text{OH}^-}$ A $\xrightarrow{\text{PCl}_5}$ B $\xrightarrow[\substack{\text{Pd/ BaSO}_4 \\ \text{Quinoline-S, Xylene}}]{\text{H}_2}$ C

Question 17

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

    (a) Ethanal to but-2-enal

    (b) 2-Bromopropane to 1-bromopropane

    (c) Ethyl chloride to propanoic acid

<div align="center">**OR**</div>

(ii) Write the mechanism of the reaction of HI with methoxy methane.

Question 18

(i) Write the rate law for a first order reaction. Justify the statement that half-life for a first order reaction is independent of the initial concentration of the reactant.

(ii) For a first order reaction, show that the time required for 99% completion of a first order reaction is twice the time required for the completion of 90%.

SECTION D – 15 MARKS

Question 19

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

    (a) Benzoic acid is stronger acid than acetic acid.

    (b) There is a large difference in the boiling points of butanal and butan-1-ol.

    (c) Carboxylic acid does not give reactions of carbonyl group.

(ii) A compound A with molecular formula $C_5H_{12}O$ on oxidation forms compound B with molecular formula $C_5H_{10}O$. The compound B gives iodoform test but does not reduce ammoniacal silver nitrate. The compound B on reduction with $Zn - Hg/HCl$ gives compound C with molecular formula C_5H_{12}. Identify A, B, C & give the chemical reactions involved.

Question 20

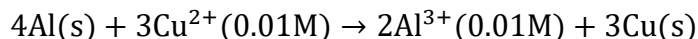**(i)** How is a double salt different from a complex?

(ii) Write IUPAC names of the following:

    (a) $K_3[Fe(C_2O_4)_3]$

    (b) $[Pt(NH_3)_6]Cl_4$

(iii) Draw the structure of cis-isomer of $[Co(NH_3)_4Cl_2]^+$.

Question 21

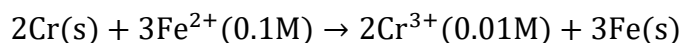**(i) (a)** Calculate E^0_{cell} for the following reaction at 298 K :

$$4Al(s) + 3Cu^{2+}(0.01M) \rightarrow 2Al^{3+}(0.01M) + 3Cu(s)$$

Given : $E_{cell} = 1.98$ V

(b) Using the E° values of A and B, predict which is better for coating the surface of iron $[E°(Fe^{2+}/Fe) = -0.44$ V] to prevent corrosion and why?

Given $E°(A^{2+}/A) = -2.37$ V: $E°(B^{2+}/B) = -0.14$ V

OR

(ii) (a) Calculate e.m.f. of the following cell at 298 K :

$2Cr(s) + 3Fe^{2+}(0.1M) \rightarrow 2Cr^{3+}(0.01M) + 3Fe(s)$

Given, $E°(Cr^{3+} \mid Cr) = -0.74$

$E°(Fe^{2+} \mid Fe) = -0.44$ V

$(1F = 96500$ C, $R = 8.314$ JK⁻¹mol⁻¹

(b) Following reactions occur at cathode during the electrolysis of aqueous silver chloride solution:

$Ag^+(aq) + e^- \rightarrow Ag(s)$
$E° = +0.80$ V

$H^+(aq) + e^- \rightarrow \dfrac{1}{2}H_2(g)$
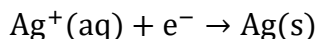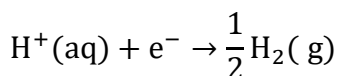
$E° = 0.00$ V

On the basis of their standard reduction electrode potential (E°) values, which reaction is feasible at the cathode and why?