SAMPLE PAPER 3

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:**
[mol $L^{-1}\ s^{-1}$, 4, s^{-1}, 2, $mol^{-1}\ L\ s^{-1}$, s^{-1}, Lucas, 6, L mol $^{-1}\ s^{-1}$, white, nucleophilic, yellow, iodoform, electrophilic]

(i) For a second-order reaction, the unit of rate is _____ and that of the rate constant is _____.
(ii) The coordination number of the complex $K_4[Fe(CN)_6]$ is _____, and the oxidation state of the metal ion in that complex is _____.
(iii) The carbon-halogen bond in alkyl halides is polarized, with the carbon being _____ and the halogen being _____.
(iv) Propan-2-ol on reaction with iodine and sodium hydroxide gives _____ precipitate and the reaction is called _____test.

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

(i) For the reaction $A + B \rightarrow C$, it is found that doubling the concentration of A increases the rate by four times and doubling the concentration of B doubles the reaction rate. What is the overall order of the reaction?

    (a) 4

    (b) 3/2

    (c) 3

    (d) 1

(ii) Correct relationship between pairing energy (P) and C.F.S.E. (Δ_o) in complex ion $[Ir(H_2O)_6]^{3+}$ is

(a) $\Delta_o < P$

(b) $\Delta_o > P$

(c) $\Delta_o = P$

(d) Cannot comment

(iii) Among Sc(III), Ti(IV), Pd(II) and Cu(II) ions

    (a) All are paramagnetic

    (b) All are diamagnetic

    (c) Sc (III), Ti (IV) are paramagnetic and Pd(II), Cu(II) are diamagnetic

    (d) Sc (III), Ti (IV) are diamagnetic and Pd(II), Cu(II) are paramagnetic

(iv) Which of the following statements is not correct for amines?

    (a) Most alkyl amines are more basic than ammonia solution.

    (b) pK_b value of ethylamine is lower than benzylamine.

    (c) CH_3NH_2 on reaction with nitrous acid releases NO_2 gas.

    (d) Hinsberg's reagent reacts with secondary amines to form sulphonamides.

(v) The vant's Hoff factor for 0.1 M $Ba(NO_3)_2$ solution is 2.74. The degree of dissociation is

    (a) 91.3%

    (b) 87%

    (c) 100%

    (d) 74%

(vi) **Assertion**: Coating iron with zinc prevents rusting.

Reason: The coating of zinc prevents moist air to come in contact with the metal.

(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>: Aniline forms significant amount of meta derivative on nitration with con. HNO_3 and Con. H_2SO_4.

<u>Reason</u>: The ortho and para positions in aniline is electron rich due to the activating nature of -NH_2 group.

(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.

At 298 K, the vapour pressure of pure benzene, C_6H_6 is 0.256 bar and the vapour pressure of pure toluene $C_6H_5CH_3$ is 0.0925 bar. Two mixtures were prepared as follows:

(I) 7.8 g of C_6H_6 + 9.2 g of toluene

(II) 3.9 g of C_6H_6 + 13.8 g of toluene

(i) Calculate the total vapour pressure of solution-I.

(ii) Calculate the mole fraction of benzene in vapour phase in solution-I.

(iii) State True or False: Mole fraction of benzene in vapour phase is less in solution-II.

SECTION B – 20 MARKS

Question 2

(i) Arrange the following compounds in the increasing order of their acid strengths:
4-nitrophenol, phenol, 2,4,6-trinitrophenol

(ii) The $C - O$ bond is much shorter in phenol than in ethanol. Give reason.

Question 3

Answer the following:

(i) Which trivalent ion has maximum size in the Lanthanide series i.e., Lanthanum ion (La^{3+}) to Lutetium ion (Lu^{3+})? (at. no. of Lanthanum = 57 and Lutetium = 71)

(ii) Explain why Cu^{2+} is paramagnetic but Cu^+ is diamagnetic. (at. no. of Cu = 29)

Question 4

(i) Arrange the following in decreasing order of their acidic strength. Give explanation for the arrangement. $C_6H_5COOH, FCH_2COOH, NO_2CH_2COOH$.

(ii) How will you convert toluene to benzoic acid?

Question 5

Give a reason for each of the following:

(i) Transition metals sand their compounds act as catalysts.

(ii) Transition metals exhibit higher enthalpies of atomization.

Question 6

(i) Which one of the following compounds is more easily hydrolysed by KOH and why?
$CH_3CHClCH_2CH_3$ and $CH_3CH_2CH_2Cl$

(ii) Which compound in each of the following pairs will react faster in S_N2 reaction with $-OH$?
CH_3Br or CH_3I

Question 7

(i) When acidulated water (dil. H_2SO_4 solution) is electrolysed, will the pH of the solution be affected? Justify your answer.

(ii) Can E_{cell} or Δ_rG for cell reaction ever be equal to zero?

Question 8

What happens when (write chemical reactions only)

(i) Phenol reacts with CO_2 in presence of sodium hydroxide

(ii) Ethyl chloride is treated with alcoholic potassium hydroxide.

Question 9

What mass of ethylene glycol (molar mass $= 62.0$ g mol^{-1}) must be added to 5.50 kg of water to lower the freezing point of water from $0°C$ to $10.0°C$?

(K_f for water 1.86 K kg mol^{-1})

Question 10

(i) Electrophilic substitution in benzaldehyde takes place at *meta* position. Give reason.

(ii) Which acid of each pair shown below will be stronger?

(a)

OH

(benzene ring with OH)   Or CH_3COOH

(b) $F-CH_2-COOH$ Or $Cl-CH_2-COOH$
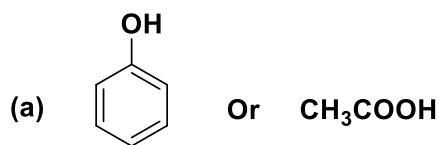
Question 11

(i) Which metal in the first transition series (3d series) exhibits +1 oxidation state most frequently and why?

(ii) Which of the following cations are coloured in aqueous solutions and why?
Sc^{3+}, V^{3+}, Ti^{4+}, Mn^{2+}
(At. Nos. Sc=21, V=23, Ti=22, Mn=25)

SECTION C – 21 MARKS

Question 12

(a) A first order reaction takes 100 minutes for completion of 60% of the reaction. Find the time when 90% of the reaction will be completed.

(b) With the help of a diagram explain the role of activated complexes in a reaction.
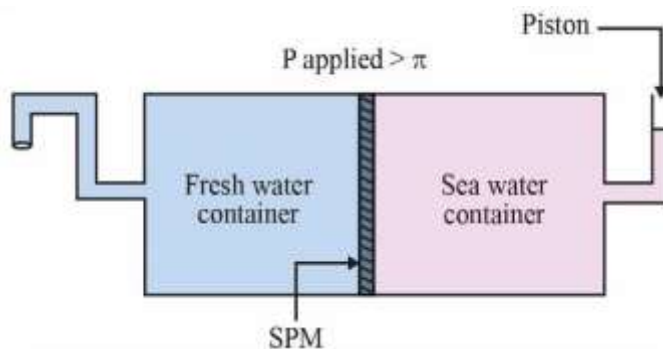
Question 13

(i) Arrange the following compounds in an increasing order of basic strengths in their aqueous solutions: NH_3, CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$

(ii) Arrange the following in increasing order of basic strength:
Aniline, *p*-nitroaniline and *p*-toluidine

Question 14

(i) Name the base that is found in nucleotide of RNA only.

(ii) Explain what is meant by a peptide linkage.

(iii) What is the basic structural difference between starch and cellulose?
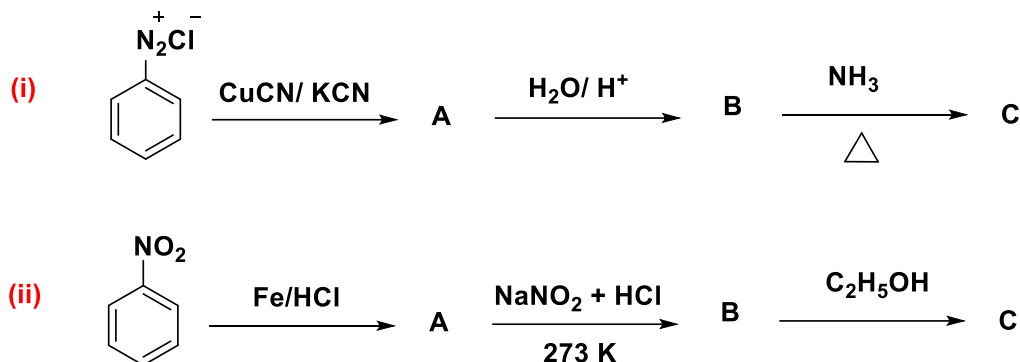
Question 15

Given below is the sketch of a plant for carrying out a process.

(i) Name the process occurring in the above plant.

(ii) To which container does the net flow of sol-vent take place?

(iii) Give one practical use of the plant.

Question 16

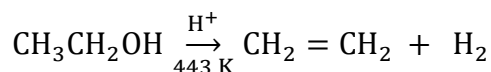Identify the compounds [A], [B] and [C].

(i)

$\overset{+}{N_2}\overset{-}{Cl}$

$\xrightarrow{\text{CuCN/ KCN}}$ A $\xrightarrow{H_2O/\ H^+}$ B $\xrightarrow[\triangle]{NH_3}$ C

(ii)

NO_2

$\xrightarrow{\text{Fe/HCl}}$ A $\xrightarrow[\text{273 K}]{NaNO_2 + HCl}$ B $\xrightarrow{C_2H_5OH}$ C

Question 17

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

    (a) Phenol to 2,4,6-trinitrophenol

    (b) Propene to Propan-2-ol

    (c) Ethyl magnesium chloride to Propan-1-ol

OR

(ii) Write the mechanism of the following reaction:

$$CH_3CH_2OH \xrightarrow[443\ K]{H^+} CH_2 = CH_2\ +\ H_2$$

Question 18

(a) A first order gas phase reaction:

$A_2 B_2(g) \rightarrow 2\ A(g) + 2\ B(g)$ at the temperature $400°C$ has the rate constant $k = 2.0 \times 10^{-4}\ sec^{-1}$. What percentage of $A_2 B_2$ is decomposed on heating for 900 seconds? [Antilog $0.0781 = 1.197$]

(b) What is the effect of catalyst on

    (i) Gibbs energy (ΔG) and

    (ii) activation energy of a reaction?

SECTION D – 15 MARKS

Question 19

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

    (a) Aromatic carboxylic acids do not undergo Friedel Crafts reaction. Explain

    (b) Methanal is more reactive towards nucleophilic addition reaction than ethanal

    (c) pKa value of 4-nitrobenzoic acid is lower than that of benzoic acid. Explain.

(ii) A ketone A (C_4H_8O) which undergoes a haloform reaction gives compound B on reduction, heating with sulphuric acid gives a compound C which forms mono-ozonide D. D on hydrolysis with zinc dust gives only E. Identify A, B, C, D and E and also give reactions involved.

Question 20

(i) Draw the structures of $[Co(NH_3)_6]^{3+}$, $[Ni(CN)_4]^{2-}$ and $[Ni(CO)_4]$. Write the hybridization of atomic orbitals of the transition metal in each case.

(ii) Provide the IUPAC name for the coordination complex ion $[Co(NH_3)_6]^{3+}$ and specify the oxidation number of cobalt in this complex ion.

Question 21

    (i) (a) The standard electrode potential (E°) for Daniell cell is +1.1 V. Calculate the ΔG° for the reaction.

        $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
        $(1\ F = 96500\ C\ mol^{-1})$
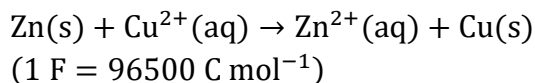
    (b) Write the name of the cell which is generally used in inverters. Write the reactions taking place at the anode and the cathode of this cell.

    (c) The conductivity of a 0.01M solution of acetic acid at 298 K is 1.65×10^{-4} S cm^{-1}. Calculate molar conductivity (Λ_m) of the solution.

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

    (ii) (a) Calculate the molar conductivity and degree of dissociation.

    Conductivity of 2.5×10^{-4}M methanoic acid is 5.25×10^{-5} S cm^{-1}.

    Given: $\Lambda°(H^+) = 349.5$ S cm^2 mol^{-1} and $\Lambda°(HCOO^-) = 50.5$ S cm^2 mol^{-1}.

    (b) Write the cell reaction and calculate the e.m.f. of the following cell at 298 K : Sn(s) | Sn^{2+}(0.004M) ‖ H$^+$(0.020 M) | H$_2$ (g) (1 bar) | Pt (s) (Given: E°Sn^{2+}/Sn = −0.14 V)

    (c) Conductivity of CH_3COOH decreases on dilution. Why?

*************************** The End ***************************