



SAMPLE PAPER 7

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 $R = 1.987 \text{ cal deg}^{-1} \text{ mol}^{-1} = 8.314 \text{ JK}^{-1} \text{ mol}^{-1} = 0.0821 \text{ dm}^3 \text{ atm K}^{-1} \text{ mol}^{-1}$

$1 \text{ L atm} = 1 \text{ dm}^3 \text{ atm} = 101.3 \text{ J}$, $1 \text{ Faraday} = 96500 \text{ coulombs}$, $\text{Avogadro's number} = 6.023 \times 10^{23}$

SECTION A – 14 MARKS

Question 1

(A) Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:

[Oxidation, isocyanides, reduction, tetrahedral, octahedral, trigonal bipyramidal, square planar, p-benzoquinone, alkyl cyanides, o-benzoquinone]

(i) A positive catalyst _____ the rate of reaction by lowering the _____ energy.

(ii) The geometry of $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{Cu}(\text{CN})_4]^{2-}$ are respectively _____ and _____.

(iii) Phenol on _____ with chromic acid gives _____.

(iv) Haloalkanes react with KCN to form _____ main product while AgCN form _____ as the chief product.

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

(i) Molar conductivity of 0.15 M solution of KCl at 298 K, if its conductivity of 0.0152 S cm^{-1} will be

- (a) $124 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$
- (b) $204 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$
- (c) $101 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$
- (d) $300 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$

(ii) The coordination number and oxidation state of Cr in $K_3Cr(C_2O_4)_3$ are respectively

- (a) 3 and +3
- (b) 3 and 0
- (c) 6 and +3
- (d) 4 and +2

(iii) Which of the following characteristics of transition metals is associated with higher catalytic activity?

- (a) High enthalpy of atomisation
- (b) Variable oxidation states
- (c) Paramagnetic behaviour
- (d) Colour of hydrated ions

(iv) Reduction of $\text{CH}_3\text{CH}_2\text{NC}$ with hydrogen in presence of Ni or Pt as catalyst gives

- (a) $\text{CH}_3\text{CH}_2\text{NH}_2$
- (b) $\text{CH}_3\text{CH}_2\text{NHCH}_3$
- (c) $\text{CH}_3\text{CH}_2\text{NHCH}_2\text{CH}_3$
- (d) $(\text{CH}_3)_3\text{N}$

(v) Ethylene glycol is used as an antifreeze in a cold climate. Mass of Ethylene glycol which should be added to 4 kg water to prevent it from freezing at -60°C will be (K_f for water = $1.86 \text{ Kkg/mol}^{-1}$, Molar mass of Ethylene glycol = 62 g/mol)

- (a) 204.30 g
- (b) 800 g
- (c) 304.60 g
- (d) 400 g

(vi) Assertion: Leclanche cell gives constant voltage throughout its life.

Reason: The overall reaction of button cell does not involve any ion in solution whose concentration can change during its life time.

- (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: Alkylation of amines gives polysubstituted product whereas acylation of amines gives a monosubstituted product

Reason: Steric hindrance of an acyl group prevents the approach of further acyl groups.

- (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.

An ideal solution of two liquids is a solution in which each component obeys Raoult's law which states that the vapour pressure of any component in the solution depends on the mole fraction of that component in the solution and the vapour pressure of that component in the pure state. However, there are many solutions which do not obey Raoult's law. In other words, they show deviations from ideal behaviour which may be positive or negative. However, in either case, corresponding to a particular composition, they form a constant boiling mixture called azeotropes.

- (i) The mole fraction of Ethyl alcohol in its solution with Methyl alcohol is 0.80. The vapour pressure of pure Ethyl alcohol at this temperature is 40 mm of Mercury. What is its vapour pressure in the solution if the solution is ideal?
(ii) Why pure Ethyl alcohol cannot be obtained from rectified spirit even by fractional distillation?
(iii) Why do a solution of Phenol and Aniline exhibit negative deviation from ideal behaviour?

SECTION B – 20 MARKS

Question 2

- (i) How is aspirin (acetyl salicylic acid) prepared from salicylic acid?
(ii) What happens when propene is treated with B_2H_6 followed by H_2O_2/OH^- ?

Question 3

- (i) Why is mercury liquid?
(ii) Which lanthanoid shows +4 oxidation state and why?

Question 4

Give balanced chemical equations to convert the following:

- (i) Benzyl chloride to benzyl alcohol
(ii) Phenol to salicylic acid

Question 5

- (i) The atomic radii of the metals of the third (5d) series of transition elements are virtually the same as those of the corresponding members of the second (4d) series. Give reason.
(ii) E° value for Mn^{3+}/Mn^{2+} couple is much more positive than that for Fe^{3+}/Fe^{2+} .

Question 6

Among all the isomers of molecular formula C_4H_9Br , identify

- (a) the one isomer which is optically active.
- (b) the one isomer which is highly reactive towards S_N2 .

Question 7

A strip of nickel metal is placed in a 1 molar solution of $Ni(NO_3)_2$ and a strip of silver metal is placed in a 1 molar solution of $AgNO_3$. An electrochemical cell is created when the two solutions are connected by a salt bridge and the two strips are connected by wires to a voltmeter.

- (i) Write the balanced equation for the overall reaction occurring in the cell.
- (ii) Calculate the cell potential, E , at $25^\circ C$ for the cell if the initial concentration of $Ni(NO_3)_2$ is 0.100 molar and the initial concentration of $AgNO_3$ is 1.00 molar.

$$\left[E_{Ni^{2+}/Ni}^0 = -0.25V; E_{Ag^+/Ag}^0 = 0.80V, \log 10^{-1} = -1 \right]$$

Question 8

- (i) What happens when
 - (a) Anisole is treated with CH_3COCl / anhydrous $AlCl_3$?
 - (b) Phenol is treated with benzene diazonium chloride?(Write chemical reactions only)

OR

- (ii) An organic compound A with the molecular formula $C_9H_{10}O$:
 - (i) forms the 2,4-DNP derivative.
 - (ii) does not reduce Tollens' reagent.
 - (iii) forms iodoform when reacted with sodium hypoiodite.
 - (iv) gives 1,2-benzenedicarboxylic acid on oxidation.

Identify the organic compound A.

Question 9

A solution containing 1.9 g per 100 mL of KCl ($M = 74.5 \text{ g mol}^{-1}$) is isotonic with a solution containing 3 g per 100 mL of urea ($M = 60 \text{ g mol}^{-1}$). Calculate the degree of dissociation of KCl solution. Assume that both the solutions have same temperature.

Question 10

- (i) Give a possible explanation why sodium benzoate and methanol are not formed in the crossed Cannizzaro reaction.
- (ii) Can 2,2-dimethylpropanal $(CH_3)_3CCHO$ undergo Cannizzaro reaction? Give a reason for your answer.

Question 11

Account for the following

- (i) d^1 configuration is very unstable in ions.
- (ii) E^0 value for the Mn^{2+}/Mn much more than expected.

SECTION C – 21 MARKS

Question 12

For the first order thermal decomposition reaction, the following data were obtained:



Time /sec	Total pressure /atm
0	0.30
300	0.50

Calculate the rate constant. (Given: $\log 2 = 0.3010$, $\log 3 = 0.4771$, $\log 4 = 0.6021$)

Question 13

Arrange the following in increasing order of their basic strength:

- (i) $C_2H_5NH_2$, $C_6H_5NH_2$, NH_3 , $C_6H_5CH_2NH_2$, $(C_2H_5)_2NH$
- (ii) $C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$, $C_6H_5NH_2$

Question 14

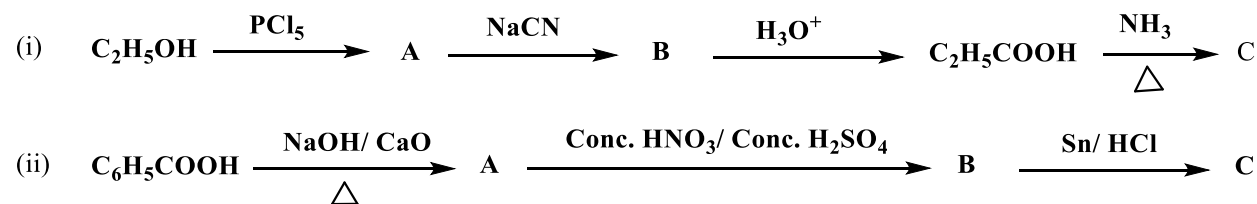
- (a) Write the product when D – glucose reacts with $Br_2(aq)$.
- (b) What type of bonding provides stability to α -helix structure of protein?
- (c) Name the vitamin whose deficiency causes pernicious anaemia.

Question 15

An aqueous solution of sodium chloride freezes below 273 K. Explain the lowering in freezing points of water with the help of a suitable diagram.

Question 16

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



Question 17

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

- (a) Acetophenone to benzoic acid
- (b) Ethanamine to acetic acid
- (c) benzene diazonium chloride to phenol

OR

(ii) $(\text{CH}_3)_3\text{CBr}$ reacts with KOH to give $(\text{CH}_3)_3\text{COH}$. Write the mechanism of the reaction and mention which is rate determining step?

Question 18

- (a) The rate of the chemical reaction doubles for an increase of 10 K in absolute temperature from 298 K. Calculate E_a .
- (b) What value of k is predicted for the rate constant by Arrhenius equation if temperature is infinite? Is this value physically responsible?
- (c) Why does equilibrium constant not change with presence of a catalyst?

SECTION D – 15 MARKS**Question 19**

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

- (a) Carboxylic acids have higher boiling point than alcohols as both have intermolecular hydrogen bonding.
- (b) PCC cannot oxidize methanol to methanoic acid while KMnO_4 can.
- (c) pK_a of $\text{Cl-CH}_2\text{-COOH}$ is lower than the pK_a of $\text{CH}_3\text{-COOH}$.

(ii) A and B are two functional isomers of compound $\text{C}_3\text{H}_6\text{O}$. On heating with NaOH and I_2 , isomer A forms yellow precipitate of iodoform whereas isomer B does not form any precipitate. Write the formula of A and B.

Question 20

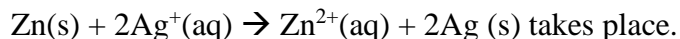
(i) A metal ion M^{n+} having d4 valence electronic configuration combines with three bidentate ligands to form a complex compound. Assuming $\Delta_0 > P$.

- (a) Draw the diagram showing d orbital splitting during this complex formation and write the electronic configuration of the valence electrons of the metal M^{n+} ion in terms of t_{2g} and e_g .
 - (b) What type of hybridisation will M^{n+} ion have?
 - (c) Name the type of isomerism exhibited by this complex.
- (ii) (a) Using IUPAC norms write the systematic name of the $[\text{Co}(\text{en})_3]^{3+}$
- (b) Draw the structures of optical isomers of: $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$

Question 21

(i) Write the chemistry of recharging the lead storage battery, highlighting all the materials that are involved during recharging.

(ii) Depict the galvanic cell in which the reaction

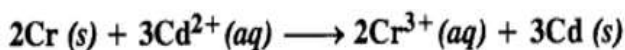


Further show:

- (a) Which of the electrode is negatively charged?
- (b) The carriers of the current in the cell.
- (c) Individual reaction at each electrode.

OR

(ii) (a) Calculate the standard cell potentials of the galvanic cells in which the following reactions take place.



Given $E^\circ_{\text{Cr}^{3+}/\text{Cr}} = -0.74 \text{ V}$; $E^\circ_{\text{Cd}^{2+}/\text{Cd}} = -0.40 \text{ V}$

Also calculate ΔG° and equilibrium constant for the reaction.

(b) The molar conductivity of 0.025 mol L^{-1} methanoic acid is $46.1 \text{ S cm}^2 \text{ mol}^{-1}$. Calculate its degree of dissociation and dissociation constant.

Given $\lambda^\circ(\text{H}^+) = 349.6 \text{ S cm}^2 \text{ mol}^{-1}$ and $\lambda^\circ(\text{HCOO}^-) = 54.6 \text{ S cm}^2 \text{ mol}^{-1}$.

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