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 below in the brackets. **[4×1]**

[lead poisoning, zero, phosgene, dependent, cancer, independent, diethyl ether, first, ethyl carbonate, ethene]

(i) For a particular reaction, the value of rate constant is $0{\cdot}05$ sec^{-1}. The reaction is of _______order and will be ______ of the initial concentration.

(ii) EDTA is used in the treatment of ______ while Cisplatin is used in the treatment of ______.

(iii) The addition of small quantity of ethanol to chloroform prevents the formation of ______ and converts it into the harmless compound ______.

(iv) The dehydration of ethyl alcohol with conc. H_2SO_4 at 140°C mainly yields ______ while at 170°C the main product formed is ______.

This Paper consists of 10 printed pages.

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

(i) Which one of the following statements is correct regarding the dry cell?

(P) Zinc container acts as an anode in dry cell.

(Q) Zinc container touches the paste of MnO_2 and carbon.

(R) Dry cell can be charged easily.

(S) Graphite rod acts as a cathode in dry cell.

(a) Only (P) and (R)

(b) Only (Q) and (R)

(c) Only (P) and (S)

(d) Only (Q) and (S)

(ii) The metal complex ion that is paramagnetic is:

(Atomic number of Fe = 26, Cu = 29, Co = 27 and Ni = 28)

(a) $[Fe(CN)_4]^{2-}$

(b) $[Co(NH_3)_6]^{3+}$

(c) $[Ni(CN)_4]^{2-}$

(d) $[Cu(NH_3)_4]^{2+}$

(iii) When $KMnO_4$ is heated with acidified oxalic acid, gas bubbles are evolved. These gas bubbles are evolved due to the formation of:

(a) SO_2

(b) CO_2

(c) SO_3

(d) O_2

(iv) The reaction of ethanamide with alcoholic sodium hydroxide and bromine gives:

(a) ethylamine.

(b) methylamine.

(c) propylamine.

(d) aniline.

(v) An equimolar solution of non-volatile solutes A and B, shows a depression in freezing point in the ratio of 2:1. If A remains in its normal state in the solution, the state of B in the solution will be:

(a) normal.

(b) hydrolysed.

(c) associated.

(d) dissociated.

(vi) **Assertion**: Specific conductivity of all electrolytes decreases on dilution.

Reason: On dilution, the number of ions per unit volume decreases.

(a) Both Assertion and Reason are true and Reason is the correct explanation for 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**: Ammonolysis of alkyl halides involves the reaction between alkyl halides and alcoholic ammonia.

Reason: Ammonolysis of alkyl halides produces secondary amines only.

(a) Both Assertion and Reason are true and Reason is the correct explanation for 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 and answer the questions that follow. **[3×1]**

When two solutions are separated by a semi-permeable membrane, the solvent molecules move from a solution of lower molar concentration to a solution of higher molar concentration through osmosis.

(i) Samar removed the outer hard shell of two different eggs while cooking at home. He then placed one egg in pure water and the other egg in saturated solution of sucrose. What change is he likely to observe in the eggs after few hours?

(ii) Which solution, hypertonic or hypotonic, has a higher amount of solute in same quantity of solution?

(iii) A 5% aqueous solution of glucose (molar mass = 180 g mol^{-1}) is isotonic with 1·66% aqueous solution of urea. Calculate the molar mass of urea.

SECTION B – 20 MARKS

Question 2 **[2]**

(i) Write a chemical test to distinguish between ethanol and phenol.

(ii) Give a chemical reaction to convert acetaldehyde into secondary propyl alcohol.

Question 3 **[2]**

Give a reason for each of the following.

(i) Zinc, cadmium and mercury are considered as d-block elements but not regarded as transition elements.

(ii) Transition metals possess a great tendency to form complex compounds.

Question 4 **[2]**

Convert the following by giving chemical equations for each.

(i) Ethyl bromide to diethyl ether

(ii) Phenol to salicylaldehyde

Question 5 **[2]**

Account for each of the following.

(i) Zirconium (Zr) and Hafnium (Hf) are difficult to separate.

(ii) Salts of Cupric (Cu^{2+}) ion are coloured whereas salts of Cuprous (Cu^{+}) ion are colourless.

Question 6 **[2]**

How will you bring the following conversions?

(i) Benzene to biphenyl

(ii) Iodoform to acetylene

Question 7 **[2]**

Calculate the maximum possible electrical work that can be obtained from a galvanic cell under standard conditions at 298 K.

$Zn \mid Zn^{2+}_{(aq)} \parallel Ag^{+}_{(aq)} \mid Ag$

Given $E^0_{(Zn^{2+}/Zn)} = -0{\cdot}76\ V$; $E^0_{(Ag^{+}/Ag)} = +0{\cdot}80\ V$

Question 8 **[2]**

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

(a) Ethoxy ethane does not react with sodium, but ethanol does.

(b) Methoxy ethane with conc. HI at 373K gives C_2H_5OH and CH_3I but not CH_3OH and C_2H_5I.

OR

(ii) An organic compound [A] having molecular formula $C_4H_{10}O$ forms a compound [B] with molecular formula C_4H_8O on oxidation. Compound [B] gives a positive iodoform test. The reaction of compound [B] with CH_3MgBr followed by hydrolysis gives compound [C] with molecular formula $C_5H_{12}O$.

Identify the compounds [A], [B] and [C]. Write the reaction for the conversion of compound [A] to compound [B].

Question 9 **[2]**

If 200 cm^3 of an aqueous solution of a protein contains 1·26 g of protein, the osmotic pressure of the solution at 300K is found to be $2{\cdot}57 \times 10^{-3}$ atm.

Calculate the molar mass of protein.

($R = 0{\cdot}0821\ L\ atm\ K^{-1}\ mol^{-1}$)

Question 10 **[2]**

(i) Benzaldehyde is less reactive than propionaldehyde. Why?

(ii) In the preparation of ethanal by the oxidation of ethanol, ethanal should be removed immediately as it is formed. Why?

Question 11 **[2]**

(i) Why is Mn^{+2} ion more stable than Fe^{+2} ion?

(Atomic number of Mn = 25 and Fe = 26)

(ii) Trivalent Lanthanoid ions such as La^{3+} (Z = 57) and Lu^{3+} (Z = 71) do not show any colour in their solution. Give a reason.

SECTION C – 21 MARKS

Question 12 **[3]**

For the reaction $A + B \rightleftharpoons$ Product, following data was obtained:

Experiment number	Initial concentration of [A] (mol L^{-1})	Initial concentration of [B] (mol L^{-1})	Initial Rate (mol L^{-1} min^{-1})
1	0·15	0·15	$9 \cdot 6 \times 10^{-2}$
2	0·30	0·15	$3 \cdot 84 \times 10^{-1}$
3	0·15	0·30	$1 \cdot 92 \times 10^{-1}$
4	0·30	0·30	$7 \cdot 68 \times 10^{-1}$

Calculate the following:

(i) The overall order of the reaction

(ii) The rate law equation

(iii) The value of rate constant

Question 13 **[3]**

(i) Illustrate the following reactions by giving *one* suitable example in each case.

(a) Coupling reaction

(b) Acetylation of ethylamine

(ii) Aniline does not give Friedel – Crafts reaction. Give a reason.

Question 14 **[3]**

(i) Aradhana visits a physician as she is suffering from rickets and joint pain. Which fat-soluble vitamin should the physician prescribe to her?

(ii) Somesh put few drops of vinegar in milk. What change do you think he observed in the milk after some time? What is this phenomenon known as?

(iii) Name the product of hydrolysis of sucrose. Is it a reducing sugar or a non-reducing sugar?

Question 15 **[3]**

An aqueous solution containing 12·50 g of barium chloride in 1000g of water boils at 373·0834 K. Calculate the degree of dissociation of barium chloride.

Given K_b for H_2O = 0·52 K kg mol^{-1}; molecular mass of $BaCl_2$ = 208·34 g mol^{-1}

Question 16 **[3]**

An organic compound C_2H_4O gives red precipitate when heated with Fehling solution. It also undergoes aldol condensation in the presence of dilute NaOH.

(i) Identify the organic compound and write its IUPAC name.

(ii) Which compound will be formed when this organic compound reacts with hydroxylamine?

(iii) What is observed when the compound, referred to in subpart (i), is heated with ammonical silver nitrate?

Question 17 **[3]**

(i) Identify the compounds [A], [B] and [C] in each of the following reactions.

(a) $C_2H_5OH \xrightarrow{PCl_5} [A] \xrightarrow{KCN} [B] \xrightarrow{H_3O^+} C_2H_5COOH \xrightarrow[\triangle]{NH_3} [C]$

(b) $C_6H_5OH \xrightarrow{Zn/dust} [A] \xrightarrow[\text{anhy. } AlCl_3]{CH_3Cl} [B] \xrightarrow[K_2Cr_2O_7 + H_2SO_4]{[O]} [C]$

OR

(ii) Give a chemical test to distinguish between the following pairs of compounds.

(a) Ethanol and methanol

(b) Ethanol and Ethanal

(c) Propan-2-ol and 2-methyl propan-2-ol

Question 18 **[3]**

(i) The rate constant of a reaction at 500K and 700K are 0·02 sec^{-1} and 0·07 sec^{-1} respectively. Calculate the value of $E_{a.}$ (activation energy)

(ii) A radioactive substance which emits alpha particle follows first order reaction. The half-life period of this radioactive substance is 30 hours. Calculate the fraction in percent (%) of the radioactive substance which remains after 90 hours.

SECTION D – 15 MARKS

Question 19 **[5]**

(i) An organic compound [A], having a specific smell forms two compounds [B] and [C] by reacting with conc. sodium hydroxide. The molecular formula of compound [B] is C_7H_8O, which forms compound [A] again on oxidation. Compound [C] forms benzene on heating with soda lime.

Write the structures of compounds [A], [B] and [C]. Also, write the reactions involved.

(ii) Identify the compounds [A] and [B] in the reactions given below:

(a) $$C_6H_6 \xrightarrow[AlCl_3(anhy.)]{CH_3Cl} [A] \xrightarrow[K_2Cr_2O_7 + H_2SO_4]{[O]} [B]$$

(b) $$CH_3\text{-}CHOH\text{-}CH_3 \xrightarrow[K_2Cr_2O_7 + H_2SO_4]{[O]} [A] \xrightarrow{NH_2OH} [B]$$

Question 20 **[5]**

(i) A coordination compound has a formula $CoCl_3.4NH_3$. It precipitates silver ions as AgCl and its molar conductance corresponds to a total of two ions.

Based on this information, answer the following questions.

(a) Deduce structural formula of the complex compound.

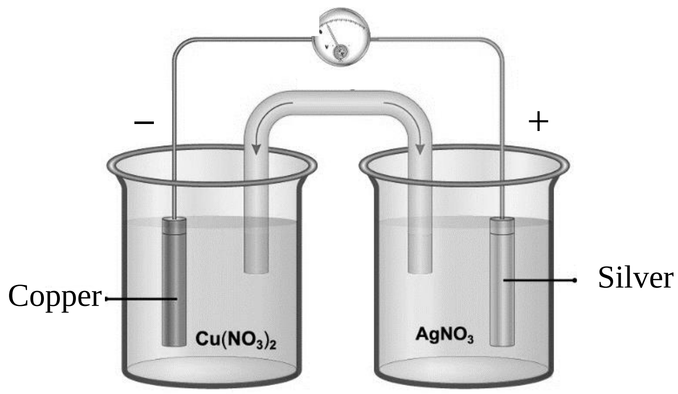
(b) Write the IUPAC name of the complex compound.

(c) Draw the geometrical isomers of the complex compound.

(ii) Give a chemical test to show that $[Co(NH_3)_5Cl]SO_4$ and $[Co(NH_3)_5SO_4]Cl$ are ionisation isomers.

Question 21 **[5]**

(i) (a) Study the diagram given below that represents Cu-Ag electrochemical cell and answer the questions that follow.



Given $E^0_{(Cu^{2+}/Cu)} = 0{\cdot}337$ V ; $E^0_{(Ag^+/Ag)} = 0{\cdot}799$ V

(1) Write the cell reaction for the above cell.

(2) Calculate the standard emf of the cell.

(3) If the concentration of $[Cu^{2+}]$ is 0·1 M and E_{cell} is 0·422 V, at 25^0 C, calculate the concentration of $[Ag^+]$.

(4) Calculate ΔG for the cell.

(b) Calculate $\wedge^0_m$ for $BaCl_2$ and $Al_2(SO_4)_3$ from the following data.

For $\wedge^0_m\ Ba^{2+} = 127{\cdot}2$ S cm^2 mol^{-1} , $\wedge^0_m\ Al^{3+} = 189$ S cm^2 mol^{-1}

$\wedge^0_m\ Cl^- = 76{\cdot}3$ S cm^2 mol^{-1} , $\wedge^0_m\ SO_4^{2-} = 160$ S cm^2 mol^{-1}

OR

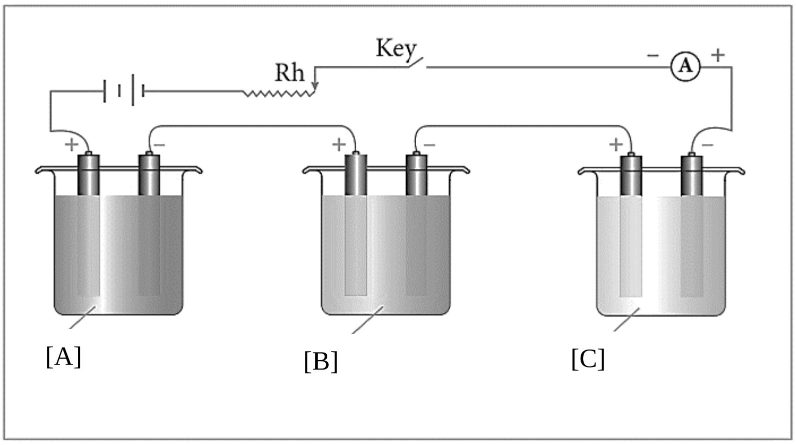
(ii) (a) A 0·05 M NH_4OH solution offers the resistance of 30·8 ohms to a conductivity cell at 298K. If the cell constant is 0·343 cm^{-1} and molar conductance of NH_4OH at infinite dilution is 471·4 S cm^{2}mol^{-1}, calculate the following:

(1) Specific conductance

(2) Molar conductance

(3) Degree of dissociation

(b) In the diagram of the electrolytic cell given below, A, B and C are connected in series having electrolytes of $ZnSO_4$, $AgNO_3$ and $CuSO_4$ respectively. A steady current of 1·5 A was passed until 1·45 g of Ag was deposited at the cathode of cell B.



(Atomic mass of Ag = 108, Cu = 63·5, Zn = 65·3)

Answer the following questions.

(1) How long did the current flow?

(2) What weight of Cu and Zn was deposited at cathode?