

CHEMISTRY

PAPER 1 (THEORY)

21006633

Maximum Marks: 70

Time Allotted: Three Hours

Reading Time: Additional Fifteen Minutes

Instructions to Candidates

1. You are allowed an **additional fifteen minutes** for **only** reading the question paper.
2. You must **NOT** start writing during the reading time.
3. This question paper has **11 printed pages and one blank page**.
4. It is divided into **four sections** and has **twenty one questions** in all.
5. Answer **all** questions.
6. **Section A** has **fourteen subparts**. Each question carries 1 mark.
7. While attempting **Multiple Choice Questions** in Section A, you are required to **write only ONE option as the answer**.
8. **Section B** has **ten questions**. Each question carries 2 marks.
9. **Section C** has **seven questions**. Each question carries 3 marks.
10. **Section D** has **three questions**. Each question carries 5 marks.
11. **Internal choices** have been provided in **one question each in Sections B, C and D**.
12. The intended marks for questions are given in brackets [].
13. All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.
14. Balanced equations must be given wherever possible and diagrams where they are helpful.
15. When solving numerical problems, all essential workings must be shown.
16. In working out problems, use the following data:

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

$$1 \text{ l atm} = 1 \text{ dm}^3 \text{ atm} = 101.3 \text{ J, } 1 \text{ faraday} = 96,500 \text{ coulombs}$$

$$\text{Avogadro's number} = 6.023 \times 10^{23}$$

Instruction to Supervising Examiner

1. Kindly read **aloud** the Instructions given on page 1 to all the candidates present in the examination hall.
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SECTION A – 14 MARKS

Question 1

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

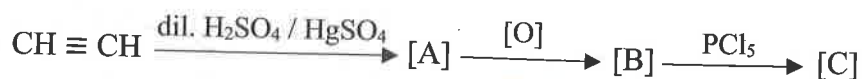
[first, alc. AgCN, primary, decrease, third, increase, zero, Lucas, alc. KCN, KOH, no change, two, Tollen's, AgOH, tertiary]

- (i) A mixture of anhydrous ZnCl_2 and conc. HCl is called _____ reagent which shows maximum reactivity with _____ alcohol.
- (ii) Methyl chloride on treatment with _____ forms methyl cyanide, whereas on treatment with _____ it forms methyl isocyanide.
- (iii) The hydrolysis of ethyl acetate in acidic medium is a pseudo _____ order reaction. However, the molecularity of the reaction is _____.
- (iv) Dissociation of solute particles leads to a / an _____ in the magnitude of a colligative property and a / an _____ in the value of the observed molecular mass.

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

- (i) Which one of the following is a tetrahedral complex as well as diamagnetic in nature?
- (a) $[\text{Ni}(\text{CN})_4]^{2-}$
- (b) $[\text{NiCl}_4]^{2-}$
- (c) $[\text{Cu}(\text{NH}_3)_4]^{2+}$
- (d) $[\text{Ni}(\text{CO})_4]$
- (ii) When H_2S gas is passed through acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution, the colour of the solution changes to:
- (a) green.
- (b) orange.
- (c) black.
- (d) red.

- (iii) Identify the end product [C] in the following sequence of chemical reaction:



- (a) Acetic anhydride
(b) Acetic acid
(c) Acetyl chloride
(d) Ethyl chloride
- (iv) Rohit is studying the iodoform reaction by using the following compounds:

- (P) CH_3OH
(Q) CH_3CHO
(R) CH_3COCH_3
(S) $\text{CH}_3\text{CH}_2\text{-CO-CH}_2\text{-CH}_3$

Which of the following combinations will give an iodoform test when the compounds are heated separately with iodine and aqueous NaOH?

- (a) Only (P) and (Q)
(b) Only (Q) and (R)
(c) Only (P) and (S)
(d) Only (Q) and (S)
- (v) Which one of the following nitrogen bases is absent in RNA?
- (a) Adenine
(b) Guanine
(c) Uracil
(d) Thymine

- (vi) Given below are two statements marked Assertion and Reason. Read the two statements carefully and select the correct option.

Assertion: Phenols are more acidic than aliphatic alcohols.

Reason: Phenoxide ion is stabilised by resonance but alkoxide ion is not stabilised by resonance.

- (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 and Reason is false.
(d) Both Assertion and Reason are false.
- (vii) Given below are two statements marked Assertion and Reason. Read the two statements carefully and select the correct option.

Assertion: The depression of freezing point of 0.1 molal aqueous solution of MgCl_2 is less than that of 0.1 molal aqueous solution of NaCl .

Reason: The number of particles furnished by 0.1 molal MgCl_2 is less than that of 0.1 molal NaCl .

- (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 and Reason is false.
(d) Both Assertion and Reason are false.

- (C) Read the information given below and answer the questions that follow.

[3×1]

Kohlrausch observed an interesting pattern between the values of molar conductance at infinite dilution (Λ^∞_m) for strong electrolytes. It was observed that different pairs of electrolytes having a common cation or anion had almost same difference of Λ^∞_m . On the basis of his observation, he postulated a law known as Kohlrausch's Law of Independent Migration of ions.

The values of molar conductivities at infinite dilution for some cations and anions are as follows:

Ion	$\lambda^\infty_m (\text{S cm}^2 \text{mol}^{-1})$
Ba^{2+}	127.2
Cl^-	76.3
Ca^{2+}	119.0
SO_4^{2-}	160.0

- (i) State the Kohlrausch's Law of Independent Migration of ions.
(ii) Calculate the molar conductance at infinite dilution Λ^∞_m for BaCl_2 .
(iii) Arrange the values of Λ^∞_m for CaSO_4 and BaCl_2 in increasing order.

SECTION B - 20 MARKS

Question 2

[2]

A reaction is of first order with respect to reactant [A] and second order with regard to reactant [B]. What is the effect on rate of reaction when:

- (i) concentration of only [B] is increased three times?
- (ii) concentration of both [A] and [B] is doubled?

Question 3

[2]

- (i) 0.680g of a compound is dissolved in 15.0g of benzene and the freezing point of solution is lowered by 1.44°C.

Calculate the experimental molecular mass of the compound.

(K_f for benzene = 5.12 K kg mol⁻¹)

- (ii) If the theoretical molecular mass of the compound referred to above is 80.5 g mol⁻¹, suggest whether it is undergoing association or dissociation.

Question 4

[2]

Write the IUPAC names of the following complex compounds:

- (i) [Pt(NH₃)₄Cl₂]SO₄
- (ii) K₂[Ni(CN)₄]

Question 5

[2]

Write chemical equations to convert each of the following:

- (i) Methyl magnesium bromide to propan-2-ol
- (ii) Phenol to benzene

Question 6

[2]

Calculate the value of ΔG° for the following cell at 25°C.



Given $E_{\text{Zn}^{2+}/\text{Zn}}^0 = -0.76\text{V}$, $E_{\text{Sn}^{2+}/\text{Sn}}^0 = -0.14\text{V}$

1 faraday = 96,500 coulombs

Question 7**[2]**

Write chemical reactions for the following named organic reactions:

- (i) Diazotisation reaction
- (ii) Sandmeyer's reaction

Question 8**[2]**

A first order reaction is 40% complete in 20 minutes. Calculate the time required for 90% completion of the same reaction.

Question 9**[2]**

- (i) Write chemical tests to distinguish between the following pairs of compounds:
 - (a) Acetaldehyde and acetone
 - (b) Acetic acid and benzaldehyde

OR

- (ii) An organic compound [A] having molecular formula C_3H_8O gives turbidity with Lucas reagent within five minutes of mixing. On heating compound [A] with Cu at 573K, compound [B] is formed. Compound [B] does not reduce Fehling's solution but when heated with iodine and sodium hydroxide, it gives a yellow precipitate of compound [C]. Identify the compounds [A], [B] and [C].

Write the chemical reaction for the conversion of compound [B] to compound [C].

Question 10**[2]**

- (i) Why is the first ionisation enthalpy of chromium less than that of zinc? (Atomic Number of Cr = 24 and Zn = 30)
- (ii) Why does pink colour of aqueous $KMnO_4$ solution disappear when warmed with oxalic acid solution in acidic medium?

Question 11**[2]**

Write chemical equations to convert each of the following:

- (i) Chlorobenzene to aniline
- (ii) Iodoform to acetylene

SECTION C - 21 MARKS

Question 12

[3]

Write chemical equations to convert each of the following:

- (i) Methanol to ethanol
- (ii) Benzene diazonium chloride to phenol
- (iii) Sodium ethoxide to ethoxyethane

Question 13

[3]

- (i) Complete and balance the following reactions:

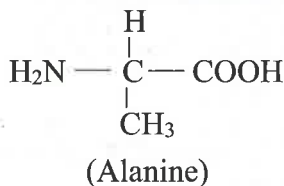
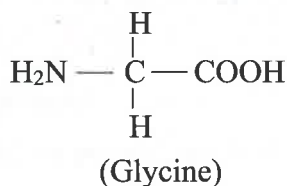


- (ii) Which ion, Co^{2+} or Zn^{2+} , is attracted to a magnetic field? Give reasons.
(Atomic Number of Co = 27 and Zn = 30)

Question 14

[3]

- (i) Give *one* example each of fibrous protein and globular protein.
- (ii) The structures of two amino acids, glycine and alanine, are given below. Draw the peptide linkage between these two amino acids.



- (iii) Justify that glucose is an aldose form of sugar, with the help of a chemical reaction.

Question 15

[3]

Write the chemical reactions when:

- (i) Chlorobenzene is heated with conc. HNO_3 in the presence of conc. H_2SO_4 .
- (ii) Ethyl alcohol is treated with SOCl_2 in the presence of pyridine.
- (iii) Chloroform is slowly oxidized with oxygen in the presence of sunlight.

Question 16**[3]**

- (i) The rate constant of a first order reaction increases five times when the temperature is raised from 350K to 500K. Calculate the activation energy of the reaction. ($R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$)
- (ii) The unit of rate constant of a reaction is same as that of its rate of reaction. What is the order of this reaction?

Question 17**[3]**

- (i) (a) The molar conductivity at infinite dilution for $\lambda_{\text{H}^+}^{\infty} = 348.65 \text{ Scm}^2\text{mol}^{-1}$ and for $\lambda_{\text{CH}_3\text{COO}^-}^{\infty} = 41.4 \text{ Scm}^2\text{mol}^{-1}$ respectively.

Calculate the degree of dissociation (α) of acetic acid if its molar conductivity (Λ_m^c) is $40.65 \text{ Scm}^2\text{mol}^{-1}$.

- (b) Compounds [A] and [B] are two electrolytes. Upon dilution, the molar conductivity of compound [A] increases 3 times while that of [B] increases 30 times. Which one of the two is a weak electrolyte? Why?
- (c) Can copper sulphate solution be stored in a zinc pot? Give a reason for your answer by referring to the values given below.

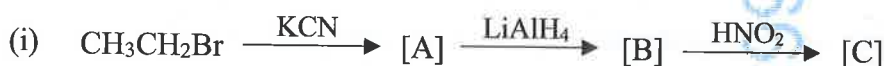
$$E_{\text{Zn}^{2+}/\text{Zn}}^0 = -0.76\text{V}, E_{\text{Cu}^{2+}/\text{Cu}}^0 = +0.34\text{V}$$

OR

- (ii) (a) When a current of 0.75 ampere is passed through a CuSO_4 solution for 25 minutes, 0.370 g of copper is deposited. Calculate the atomic weight of copper by using the given information.
- (b) Two metals A and B have standard reduction potential values, -0.76V and $+0.34\text{V}$ respectively.
Which of these metals will liberate H_2 gas from dil. H_2SO_4 ? Why?
- (c) Why does the specific conductivity (κ) of a solution decrease on dilution?

Question 18**[3]**

Identify the compounds [A], [B] and [C] in the following reactions:



SECTION D - 15 MARKS

Question 19

[5]

- (i) Calculate the mass of ascorbic acid (molecular mass = 176 g mol^{-1}) to be dissolved in 75 g of acetic acid to lower its freezing point by 1.5°C . Assume that the solute neither associates nor dissociates in solution.
(K_f for acetic acid = $3.9 \text{ K kg mol}^{-1}$)
- (ii) A solution of an organic compound was prepared by dissolving 6.8 g in 0.1 litre of water. Calculate the osmotic pressure of this solution at 25°C .
(Molecular mass of organic compound = $321.45 \text{ g mol}^{-1}$)
- (iii) Why are aquatic species more comfortable in cold water than warm water?

Question 20

[5]

- (i) What happens when (write chemical equations):
- Calcium acetate is subjected to dry distillation.
 - Acetaldehyde is reduced with hydrogen in the presence of Zn / Hg and conc. HCl.
 - Acetic acid is heated with ethyl alcohol in the presence of conc. H_2SO_4 .
- (ii) An organic compound [X] with molecular formula $\text{C}_2\text{H}_4\text{O}$ forms compound [Y] on oxidation. Compound [X] undergoes haloform reaction. On treatment with HCN, compound [X] forms a product [Z] which on hydrolysis gives 2-hydroxy propanoic acid.
- Write down the structures of compounds [X] and [Y].
 - Name the product formed when [X] reacts with dil. NaOH.

Question 21

[5]

- (i) (a) With reference to Valence Bond Theory (VBT), answer the following questions regarding the complex ion $[\text{Cr}(\text{NH}_3)_6]^{3+}$.
- What is the oxidation number of chromium in the complex?
 - State the magnetic behaviour of the complex.
 - How many unpaired electrons are there in the complex?
 - State the type of hybridisation of the central metal atom.

(b) The coordination complex $\text{CoNO}_2\text{Cl}\cdot 5\text{NH}_3$ exists in two isomeric forms 'P' and 'Q'. Isomer 'P' reacts with AgNO_3 solution to give white precipitate whereas 'Q' does not give any precipitate with AgNO_3 solution.

(1) Write the structural formula of isomers 'P' and 'Q'.

(2) Name the type of isomerism involved.

(c) Explain why an aqueous solution of potassium hexacyanidoferrate(II) does not give the test of ferrous ion.

OR

(ii) (a) Write the electronic configuration of the following:

(1) d^4 (high spin octahedral)

(2) d^6 (low spin octahedral)

(b) Based on the above configuration, calculate the value of Crystal Field Splitting Energy (CFSE). (Ignore pairing energy)

(c) Name the type of isomerism exhibited by the following pairs of coordination compounds.

(1) $[\text{Co}(\text{NH}_3)_5(\text{ONO})]\text{Cl}_2$ and $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$

(2) $[\text{PtCl}_2(\text{NH}_3)_4]\text{Br}_2$ and $[\text{PtBr}_2(\text{NH}_3)_4]\text{Cl}_2$

(d) Which of the following coordination complexes is an outer orbital complex? Explain.

$[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ or $[\text{Fe}(\text{CN})_6]^{4-}$