

CHEMISTRY

PAPER 1

(THEORY)

21004428

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, zero, second, Raoult's law, non-ideal, addition, substitution, Henry's law, ideal, +I, more, -I, less, dehydrohalogenation]

- (i) When a solution does not follow _____ over the entire range of concentration, it is called a / an _____ solution.
- (ii) For a particular reaction, the value of rate constant is 0.81s^{-1} . Hence, the reaction is of _____ order whereas in another reaction, the value of rate constant is $2.5\text{ mol L}^{-1}\text{s}^{-1}$. Thus, the order of this reaction is _____.
- (iii) The reaction of aqueous KOH with bromopropane is an example of _____ reaction while the reaction of alcoholic KOH with the same compound is evidence of _____ reaction.
- (iv) Amines are _____ basic than ammonia, as the alkyl groups present in amines provide _____ effect.

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

- (i) In the complexes, $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{Pt}(\text{en})(\text{H}_2\text{O})_2\text{Br}(\text{NO}_2)]^{2+}$, the respective oxidation numbers of central metal atoms are:

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

- (ii) Which one of the following properties of transition metals enables them to behave as catalysts?

- (a) Presence of vacant d-orbitals
(b) Formation of coloured ions
(c) High ionisation enthalpy
(d) High melting point

(iii) The reactivity orders of alkyl halides for dehydrohalogenation reaction are given below:

(P) $R-I > R-Br$

(Q) $R-Cl > R-F$

(R) $R-I < R-Br$

(S) $R-Cl < R-F$

Which one of the following combinations represents the correct order for dehydrohalogenation reaction?

(a) Only (P) and (Q)

(b) Only (P) and (S)

(c) Only (Q) and (R)

(d) Only (Q) and (S)

(iv) Samantha suffers from deformity of bones. The doctor has advised her to consume a particular vitamin.

Identify the vitamin that the doctor has prescribed to her.

(a) Vitamin A

(b) Vitamin D

(c) Vitamin C

(d) Vitamin B

(v) Identify the end product [B] in the following sequence of chemical reaction:



(a) Formaldehyde

(b) Acetaldehyde

(c) Acetic acid

(d) Acetone

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

Assertion: Primary, secondary and tertiary alcohols can be distinguished with the help of Lucas reagent.

Reason: Lucas reagent is an equimolar mixture of ZnCl_2 and concentrated NaOH solution.

- (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: Osmotic pressure of 0.5 molar KCl solution is more than that of 0.5 molar urea solution.

Reason: KCl solution has a greater number of particles than urea solution.

- (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]

In the year 1832, Michael Faraday performed many experiments on electrolysis. He established a relationship between the amount of products liberated at the electrodes and the quantity of electricity passed through the solution to carry out electrolysis. He formulated two laws of electrolysis that are known as Faraday's First Law and Second Law of Electrolysis.

Eva, a class XII student, studied these laws and tried to find a particular amount of charge in faraday to get 27g of aluminium in an experiment involving $\text{Al}^{3+} / \text{Al}$ cell.

- (i) State Faraday's First Law of Electrolysis.
- (ii) How much charge in faraday would Eva need to get a coating of 27g of aluminium at electrode, if she follows the following reaction?



(Atomic mass of $\text{Al} = 27 \text{ g mol}^{-1}$)

- (iii) How much mass of zinc in grams will be obtained if the amount of charge, calculated in subpart (ii), is passed through $\text{Zn}^{2+} / \text{Zn}$ cell for the same duration?



(Atomic mass of $\text{Zn} = 65 \text{ g mol}^{-1}$)

SECTION B - 20 MARKS

Question 2

[2]

Consider the mechanism given below derived from spectrochemical analysis of the reaction between NO and F_2 :



The overall reaction is:



- Write the rate law for this reaction.
- What is the overall order of this reaction?
- Calculate the number of times the rate of reaction will increase if the concentration of $[\text{NO}]$ is doubled and the concentration of $[\text{F}_2]$ is tripled.

Question 3

[2]

During an experiment, a scientist tried to determine the molecular mass of a protein by applying elevation of boiling point method but did not succeed. When she used osmotic pressure method, she found that 20g of protein in 2 litres solution had an osmotic pressure of 0.0171 atm at 25°C .

- Based on the findings of the scientist, calculate the molecular mass of protein.
($R = 0.0821 \text{ dm}^3\text{atm K}^{-1}\text{mol}^{-1}$)
- Why was the scientist unsuccessful in determining the molecular mass by using elevation of boiling point method?

Question 4

[2]

Calculate the value of ΔG° for the following cell at 298K



Given $E_{\text{Cr}^{3+}/\text{Cr}}^0 = -0.74\text{V}$; $E_{\text{Cd}^{2+}/\text{Cd}}^0 = -0.40\text{V}$

1 faraday = 96,500 coulombs

Question 5**[2]**

Carbon dating method is a useful tool to estimate the age of fossils. A radioactive carbon-14 isotope decays with a half-life of 5730 years. An ancient wooden artifact was found to have only 80% of its original C-14 content compared to a living plant.

Calculate the age of the wooden artifact.

Question 6**[2]**

Account for the following:

- (i) Co^{3+} readily loses one electron whereas Mn^{3+} readily gains one electron.
(Atomic numbers of Co = 27 and Mn = 25)
- (ii) The complex ion $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ is coloured.
(Atomic number of Ti = 22)

Question 7**[2]**

Using IUPAC nomenclature, write the formula for each of the following:

- (i) hexaaquairon(II)chloride
- (ii) potassium tetrachloridoplatinate(II)

Question 8**[2]**

Write the chemical equations to convert each of the following:

- (i) Chlorobenzene to benzoic acid
- (ii) 1-bromopropane to 2-bromopropane

Question 9**[2]**

- (i) Acetyl chloride is hydrogenated over palladium in presence of barium sulphate in boiling xylene. Write the balanced chemical equation and name the reaction that takes place.

OR

- (ii) Write chemical equations to convert each of the following:
 - (a) Toluene to benzaldehyde
 - (b) Acetic acid to acetamide

Question 10**[2]**

Write chemical tests to distinguish between the following pairs of compounds:

- (i) Phenol and acetic acid
- (ii) Ethanol and methanol

Question 11**[2]**

Write a chemical equation for each of the following named organic reactions:

- (i) Carbylamine reaction
- (ii) Mendius reaction

SECTION C - 21 MARKS**Question 12****[3]**

- (i) Complete and balance the following reactions:



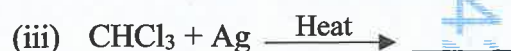
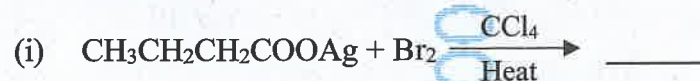
- (ii) Why are transition metals used to make alloys?

Question 13**[3]**

- (i) Mention *two* examples of fat-soluble vitamins.
- (ii) Name *two* pyrimidine bases present in RNA.
- (iii) What is a *zwitter ion*? Draw a structure of glycine in zwitter ion form.

Question 14**[3]**

Write the structural formula of the main organic compound formed in each of the following reactions:



Question 15**[3]**

Write chemical equations to convert each of the following:

- (i) Propan-1-ol to propyl cyanide
- (ii) Sodium methoxide to dimethylether
- (iii) Phenol to chlorobenzene

Question 16**[3]**

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

- (i)
$$\text{C}_6\text{H}_5\text{NO}_2 \xrightarrow[\text{Heat}]{\text{Sn / HCl}} [\text{A}] \xrightarrow[0 - 5^\circ\text{C}]{\text{HNO}_2 + \text{HCl}} [\text{B}] \xrightarrow{\text{CuCN / HCN}} [\text{C}]$$
- (ii)
$$\text{C}_2\text{H}_5\text{Cl} \xrightarrow{\text{alc. KCN}} [\text{A}] \xrightarrow{4[\text{H}]} [\text{B}] \xrightarrow[\text{heat}]{\text{CHCl}_3 + \text{alc. KOH}} [\text{C}]$$

Question 17**[3]**

- (i) How will the rate of reaction be affected by the presence of catalyst?
- (ii) The rate constant for a reaction is 0.05 s^{-1} at 300K and 0.5 s^{-1} at 310K . Calculate the activation energy for the reaction. ($R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$)

Question 18**[3]**

- (i) (a) (1) Calculate the charge required in coulombs to deposit 6.35 g of copper at cathode from CuSO_4 solution.
- (2) How much time is required for deposition of copper if an electric current of 3.5 ampere is passed through the electrolyte mentioned above?
(Atomic Mass of $\text{Cu} = 63.5 \text{ g mol}^{-1}$)
- (b) Can an aluminium vessel be used to store dil. HCl ? Give a reason for your answer by referring to the values given below.

$$E_{\text{Al}^{3+}/\text{Al}}^0 = -1.66\text{V}; E_{\text{H}^+/\frac{1}{2}\text{H}_2}^0 = 0.0\text{V}$$

OR

- (ii) (a) Ionic conductance at infinite dilution of Al^{3+} and SO_4^{2-} ions are $189 \text{ ohm}^{-1}\text{cm}^2\text{mol}^{-1}$ and $160 \text{ ohm}^{-1}\text{cm}^2\text{mol}^{-1}$ respectively.

Calculate the molar conductance of $\text{Al}_2(\text{SO}_4)_3$ at infinite dilution.

- (b) The resistance of 0.1N solution of an electrolyte in a conducting cell was found to be 15 ohm .

Calculate the following if the cell constant is 0.367 cm^{-1} .

- (1) Conductance (C)
- (2) Specific conductance (κ)
- (3) Equivalent conductance (Λ_{eq})

SECTION D - 15 MARKS

Question 19

[5]

- (i) What happens when (write chemical equations):
- (a) Benzaldehyde is heated with alcoholic KCN.
 - (b) Formaldehyde is heated with conc. NaOH solution.
 - (c) Acetone is treated with hydroxylamine.
- (ii) An aliphatic compound [A] with the molecular formula $\text{C}_2\text{H}_4\text{O}$ is reduced to compound [B]. Compound [B] reacts with PCl_5 and forms compound [C]. Compound [C] on treatment with alcoholic KOH forms compound [D] which is used to make a daily use plastic.

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

Question 20

[5]

- (i) An aqueous solution containing 1.25 g BaCl_2 (molecular mass $208.34 \text{ g mol}^{-1}$) in 100 g of water boils at 100.085°C .
Calculate the degree of dissociation of BaCl_2 .
(K_b for water = $0.52 \text{ K kg mol}^{-1}$)
- (ii) What happens when red blood cells are placed in pure water?
- (iii) What are *isotonic solutions*? Why does the phenomenon of osmosis not occur when two isotonic solutions are separated by a semi-permeable membrane?

Question 21**[5]**

- (i) (a) On the basis of Valence Bond Theory (VBT), state the following regarding $[\text{CoF}_6]^{3-}$ complex ion:

(Atomic Number of Co = 27)

- (1) Oxidation state of cobalt
- (2) Type of hybridisation of the central metal atom
- (3) Magnetic behaviour of the complex
- (4) IUPAC name of the complex

- (b) Consider the complex ions $[\text{Fe}(\text{CN})_6]^{3-}$ and $[\text{Fe}(\text{CN})_6]^{4-}$.

Which complex ion will be attracted towards applied magnetic field? Justify your answer with a reason.

(Atomic Number of Fe = 26)

- (c) What types of isomerism do the following pairs of compounds show?

- (1) $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$
- (2) $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$ and $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$

OR

- (ii) (a) $[\text{NiCl}_4]^{2-}$ is paramagnetic while $[\text{Ni}(\text{CO})_4]$ is diamagnetic though both are tetrahedral. Explain the statement by referring to the Valence Bond Theory (VBT).

(Atomic number of Ni = 28)

- (b) Write the IUPAC name of complex compound $[\text{PtBr}_2(\text{en})_2]\text{Cl}_2$.
- (c) Draw a diagram to show the splitting of d orbital in an octahedral crystal field for a complex having d^6 configuration in strong ligand field.

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