CHEMISTRY
PAPER 1
(THEORY)

T7058164

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:

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 $= 6{\cdot}023 \times 10^{23}$

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Instruction to Supervising Examiner

1. Kindly read **aloud** the Instructions given on page 1 to all the candidates present in the examination hall.

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]

[+2, ethane, tetrahedral, square planar, zero, dry cell, nickel-cadmium cell, propane, Wolff-Kishner, Stephen, completely filled, incompletely filled, paramagnetic, diamagnetic]

(i) _____ is an example of a primary cell but _____ is an example of a secondary cell.

(ii) The complex compound $[Ni(CO)_4]$ is _____ in shape and nickel is in _____ oxidation state in this complex compound.

(iii) When acetaldehyde is treated with hydrazine and KOH in a high boiling solvent glycol, _____ is formed and the reaction is known as _____ reduction.

(iv) The transition metal ions having _____ d-orbitals are colourless and _____ in nature.

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

(i) Which one of the following can produce the foul smelling compound methyl isocyanide in presence of alcoholic KOH?

(a) Chloroform and aniline

(b) Chloroform and methanol

(c) Chloroform and dimethyl amine

(d) Chloroform and methyl amine

(ii) The osmotic pressure of a solution:

(P) increases with an increase in number of moles of solute.

(Q) decreases with an increase in number of moles of solute.

(R) increases at a higher temperature.

(S) is dependent on the nature of solute.

Which one of the following is correct?

(a) Only (P) and (Q) are correct

(b) Only (P) and (R) are correct

(c) Only (P) and (S) are correct

(d) Only (Q) and (S) are correct

(iii) Which one of the following alcohols is the strongest acid?

(a) Phenol

(b) Methanol

(c) Ethanol

(d) t-butyl alcohol

(iv) Which one of the following does **NOT** form a silver mirror on heating with Tollen's reagent?

(a) Glucose

(b) Fructose

(c) Sucrose

(d) Lactose

(v) The coordination number and the oxidation state of the central metal 'D' in the complex $[D(en)_2(H_2O)_2]Cl_3$ are:

(a) 6 and 2 respectively

(b) 4 and 2 respectively

(c) 3 and 6 respectively

(d) 6 and 3 respectively

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

Assertion: The process of halogenation of benzene takes place in the presence of anhydrous $FeCl_3$.

Reason: Anhydrous $FeCl_3$ prepares nucleophile to attack the benzene ring.

(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 Zr-Hf pair of elements has the same value of atomic radii though Zr and Hf are placed in different periods in the periodic table.

Reason: The lanthanoid contraction prevents the expected increase in atomic radii of Hf.

(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 passage carefully and answer the questions that follow. **[3×1]**

The rate of a reaction depends on the concentration of reactants. The rate law for a hypothetical reaction $aA + bB \longrightarrow cC + dD$ is rate = $k\,[A]^x[B]^y$ where x and y are calculated experimentally and known as *order of reaction*. In most cases, the mechanism of a reaction is not straight forward but broken down in simple elementary steps. These steps represent the progress of overall reaction at the molecular level.

(i) What will be the order of reaction if the unit of k is $mol^{-2}\ L^2\ s^{-1}$?

(ii) State *any one* difference between order of reaction and molecularity of reaction.

(iii) For the reaction $2A \longrightarrow B + C$, the rate law is rate = $k[A]^{3/2}$

What is the order and molecularity of the reaction?

SECTION B – 20 MARKS

Question 2 **[2]**

Calculate the number of coulombs required to electroplate 4·75 g of aluminium when electrode reaction is $Al^{3+} + 3e^- \longrightarrow Al$

(Given: Atomic weight of Al = 27 g mol^{-1}, 1 Faraday = 96,500 coulombs)

Question 3 **[2]**

An organic compound [A] has molecular formula $C_7H_6O_2$. When compound [A] is treated with $SOCl_2$, it yields compound [B]. On heating with NH_3, compound [B] forms compound [C]. Compound [C] forms compound [D] on reaction with Br_2/KOH. Compound [D] responds to carbylamine test.

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

Question 4 **[2]**

In the reaction $2NO + O_2 \longrightarrow 2NO_2$, the rate law is rate = $k[NO][O_2]^2$.

(i) How will the rate of reaction change if [NO] concentration is doubled and $[O_2]$ concentration is halved at the same time?

(ii) Write the order of reaction if [NO] concentration is in large excess.

Question 5 **[2]**

When an organic compound [A] having molecular formula C_4H_9Br is treated with aqueous KOH, the rate of reaction depends on concentration of compound [A] only. But when compound [B], with the same molecular formula, reacts with aqueous KOH, the rate of reaction depends on the concentration of compound [B] as well as of KOH. Compound [B] is a structural isomer of compound [A].

Identify compounds [A] and [B].

Question 6 [2]

Write a balanced chemical equation for each of the following:

(i) Ethyl cyanide is reduced with $LiAlH_4$.

(ii) Aniline is treated with bromine water.

Question 7 [2]

While conducting an experiment on coordination compounds, Shirin observed a white precipitate when $AgNO_3$ solution was added to the aqueous solution of the complex $[Co(NH_3)_3(en)SO_4]Cl$.

How can the ionisation isomer of this complex be detected by a chemical test? Write the structure and the IUPAC name of the ionisation isomer.

Question 8 [2]

(i) Arrange the following in the increasing order of their *Acidic strength*:

CH_3CH_2OH, CF_3CH_2OH, CCl_3CH_2OH

(ii) Arrange the following in the increasing order of their *Boiling points*:

CH_3CH_2OH, CH_2OH, CH_3CH_2Cl

CH_2OH

Question 9 [2]

(i) Identify the compounds [A], [B], [C] and [D] in the following reaction:

$$CH_3COOH + PCl_5 \rightarrow [A] \xrightarrow[\text{Boiling Xylene}]{H_2 \atop Pd/BaSO_4} [B] \xrightarrow[[O]]{K_2Cr_2O_7 + H_2SO_4} [C] \xrightarrow{Ca(OH)_2,\ \text{heat}} [D]$$

OR

(ii) Write chemical equations to convert the following:

(a) Benzaldehyde to benzene

(b) Benzoic acid to benzaldehyde

Question 10 [2]

Calculate the E^0_{cell} of the following if the cell potential (E_{cell}) is 0·59 V.

(Given: Ni / Ni^{2+}(0·1M)||Cu^{2+}(0·01M) / Cu)

Question 11 [2]

Write the chemical test to distinguish between each of the following pairs of compounds.

(i) Ethanol and propan-1-al

(ii) Phenol and benzoic acid

SECTION C – 21 MARKS

Question 12 **[3]**

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

(i) $C_2H_5Br \xrightarrow{KCN} [A] \xrightarrow[[4H]]{LiAlH_4} [B] \xrightarrow[0°-5°C]{HNO_2} [C]$

(ii) $C_2H_5CONH_2 \xrightarrow{Br_2 / KOH} [A] \xrightarrow{CHCl_3 + KOH} [B] \xrightarrow{Na/C_2H_5OH} [C]$

Question 13 **[3]**

The scientist van't Hoff introduced a factor (*i*) to account for the extent of association or dissociation of solutes. It is mathematically expressed as:

$$i = \frac{\text{normal molecular mass}}{\text{experimental molecular mass}}$$

In case of association, $i < 1$ and in case of dissociation $i > 1$.

(i) In the calculation of molecular mass of $K_4[Fe(CN)_6]$ by using a colligative property, what will be the value of van't Hoff factor if the solute is 25% dissociated?

(ii) Find the value of van't Hoff factor for a dilute aqueous solution of benzoic acid in water when it is completely associated to form a dimer.

Question 14 **[3]**

Write chemical equations to illustrate the following name reactions:

(i) Finkelstein reaction

(ii) Williamson's synthesis

(iii) Reimer-Tiemann reaction

Question 15 **[3]**

According to Crystal-Field Theory, the electronic configuration of complex compound [A] is $t_{2g}^4 e_g^2$ and that of complex compound [B] is $t_{2g}^6 e_g^0$.

(i) Which of the two complex compounds, [A] or [B], is a low spin complex?

(ii) Write the number of unpaired electrons in complex compounds [A] and [B].

(iii) Does complex [A] have strong field ligands or weak field ligands? Give a reason.

Question 16 **[3]**

(i) Answer the following questions.

(a) By referring to electrochemical series, how can anode and cathode half cells be identified in a galvanic cell?

(b) What is the role of salt bridge in a galvanic cell?

(c) Write an advantage and a disadvantage of a fuel cell.

OR

(ii) Answer the following questions.

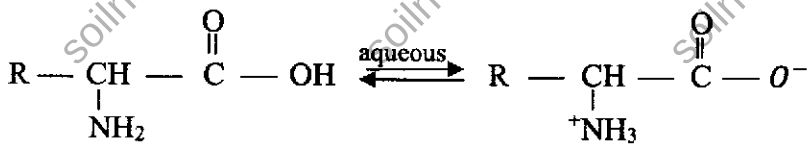
(a) Specific conductance of a solution decreases upon dilution. Why?

(b) The emf of a cell should be positive for a spontaneous reaction. Give a reason.

(c) Name the type of cell in which reaction occurs only in one direction and cannot be reversed by an external energy source. Write *any one* disadvantage of this type of cell.

Question 17 **[3]**

(i) The structure of amino acid exists in the following two forms:



The above structure is an example of _____. If the side chain R is replaced by hydrogen, the amino acid is known as _____.

(ii) Janice notices that her gums bleed while brushing and eating food. Name the water soluble vitamin which she should consume to prevent bleeding of gums.

(iii) Which linkage holds two units of monosaccharides in a disaccharide?

Question 18 **[3]**

The data given below is for the reaction between [NO] and [Cl_2] to form NOCl at 25°C.

S.No.	Conc. of [NO] mol L^{-1}	Conc. of [Cl_2] mol L^{-1}	Rate: mol L^{-1} sec^{-1}
1.	2·0	2·0	$2{\cdot}0 \times 10^{-3}$
2.	2·0	6·0	$6{\cdot}0 \times 10^{-3}$
3.	6·0	2·0	$1{\cdot}8 \times 10^{-2}$

Answer the following questions.

(i) What is the order of reaction with regard to NO and Cl_2 ?

(ii) Calculate the overall order of the reaction.

(iii) Find the value of rate constant (k).

SECTION D – 15 MARKS

Question 19 **[5]**

Phenol is an aromatic alcohol that is used to prepare many important compounds such as picric acid. Phenol is widely used in household and industrial settings as a cleaner and disinfectant. It is also used as a primary chemical to make plastics. Phenol is less soluble in water as compared to aliphatic alcohol. Some aliphatic alcohols are toxic and can be addictive.

(i) How is the acid mentioned above prepared from phenol? Write the chemical reaction involved in this preparation.

(ii) 'Phenol is less soluble in water as compared to aliphatic alcohol.' Explain.

(iii) Write the chemical equation for the preparation of phenol from chlorobenzene.

(iv) An organic compound [A] having molecular formula $C_4H_{10}O$ gives positive Lucas test within five minutes at room temperature. Compound [A] upon oxidation with $K_2Cr_2O_7$ / H_2SO_4 forms compound [B] which does not respond to Tollen's test.

Identify compounds [A] and [B].

(v) In the above reaction, compound [B] gets reduced with Zn/Hg and HCl and forms compound [C]. Identify compound [C] and write the balanced reaction for the conversion of compound [B] to compound [C].

Question 20 [5]

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

(a) Ti^{3+} salts are coloured whereas Ti^{4+} salts are colourless.

[Given: Atomic number of Ti = 22]

(b) Transition elements form alloys.

(c) The pink coloured $KMnO_4$ solution turns colourless when reacted with Mohr's salt (Fe^{2+}) in acidic medium.

(ii) Complete and balance the following reactions:

(a) $KMnO_4 + H_2SO_4 + H_2C_2O_4 \longrightarrow$ _____ + _____ + _____ + _____

(b) $K_2Cr_2O_7 + H_2SO_4 + H_2S \longrightarrow$ _____ + _____ + _____ + _____

Question 21 [5]

(i) Osmotic pressure is the external pressure which should be applied to stop the flow of solvent into the solution when the two are separated by a semipermeable membrane. The osmotic pressure is a colligative property. Two solutions having the same osmotic pressure are called *isotonic*. If there are two solutions and one of them is of lower osmotic pressure, it is called *hypotonic* while the other is called *hypertonic*.

Answer the questions given below.

(a) What will happen if red blood corpuscles are placed in a 5% NaCl solution which is a hypertonic solution?

(b) Show that osmotic pressure (π) is a colligative property.

(c) Calculate the amount of pressure required to stop osmosis of a solution when 40 g of Na_2SO_4 is added to 1 L of water at 298 K.

(Given: Na = 23, O = 16, S = 32 and R = 0·0821 L atm K^{-1} mol^{-1})

(d) Briefly discuss the process of *reverse osmosis* followed to desalinate sea water and convert it into drinking water.

OR

(ii) (a) An aqueous solution is made by dissolving 10 g of glucose ($C_6H_{12}O_6$) in 90 g of water at 300 K. If the vapour pressure of pure water at 300 K is 32·8 mm Hg, what would be the vapour pressure of the solution?

(Given: C = 12, H = 1 and O =16)

(b) A solution containing 12·5 g of a non-electrolyte solute in 175 g of water gave boiling point of 100·70°C. Calculate the molecular mass of the solute.

(Given: K_b for water = 0·52 K kg mol^{-1})

(c) Why are soda water bottles sealed under high pressure?