Time allowed: 3 Hours

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SAMPLE PAPER (1

1

(Code: VSSPXII-E1)

CHEMISTRY PAPER 1 (THEORY)

Exam Guidelines

Tull Marks: 70



• This paper is segmented into four sections - A, B, C, and D. Ensure to attempt all questions.

Section-wise Breakdown:

- Section A: One question with sub-parts, each carrying one mark.
- Section B: Ten questions, each carrying two marks.
- Section C: Seven guestions, carrying three marks. (One internal choice)
- Section D: Three questions, carrying five marks each. (One internal choice)
- **Mork and Rough Work:** Do all working and rough work on the same sheet, next to your answers.
- Balanced Equations and Diagrams: Use balanced equations and diagrams for clarity if beneficial.
- Numerical Problem Solving: For numerical problems, showcase all essential working to ensure clarity.
- **Data Reference:** Utilize the following data when solving problems:
 - Gas constant (R): 1.987 cal deg ¬ mol ¬, 8.314 J K¬ mol ¬, 0.0821 dm³ atm K¬ mol ¬.
 - 1 L atm = 1 dm³ atm = 101.3 J.
 - 1 Faraday = 96500 coulombs.
 - Avogadro's number = 6.023 x 10²³.

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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: [1, alkoxide, -1, 2, S_N 2, -2, +3, 4, nitroalkane, 6, +2, alkyl nitrile, S_N i, alkyl ether, S_N 1] (i) In the decomposition of ozone, $2O_3 \rightarrow 3O_2$, order with respect to O_3 is and that with respect to O_2 is..... (ii) In the complex ion [Fe(EDTA)]²⁻, the coordination number and the oxidation number of the central metal ion are _____ and ____ respectively. (iii) Alkyl bromide on reaction with sodium cyanide gives _____ while on reaction with silver cyanide, it gives . (iv) Williamson's synthesis involves the reaction of an alkyl halide with an...... and it involves mechanism. (B) Select and write the correct alternative from the choices given below: (i) The standard reduction potential of four metals A, B, Cand D are -0.76 V, +0.34 V, -1.66 V and + 0.80 V respectively. Which of the following statements explain this correctly? P: Metal B and D are more reactive than A and C. Q: Metal A and Car e more reactive than B and D.
 - R: Metal A can displace metal B.
 - S: Metal D can displace metal B.
 - (a) Only P and R
 - (b) Only Q and S
 - (c) Only Q and R
 - (d) Only P and S
- (ii) Crystal field splitting energy (CFSE) for high spin d⁵ octahedral complex in the presence of a weak field ligand is:
 - (a) $-0.2 \Delta o$
 - **(b)** 0 Δο
 - (c) $-4.0 \Delta o$
 - (d) $-1.8 \Delta o$
- (iii) The catalytic activity of transition metals and their compounds can mainly be attributed to
 - (a) their unfilled d-orbitals
 - (b) their ability to adopt variable oxidation states
 - (c) their magnetic behaviour
 - (d) their chemical reactivity

- (iv) On heating an aliphatic primary amine with CHCl₃ and alcoholic KOH, the organic compound formed is an:
 - (a) Alkyl isocyanide
 - (b) Alkanol
 - (c) Alkanal
 - (d) Alkyl cyanide
- (v) K₂HgI₄ is 40% ionized in aqueous solution. The value of its van't Hoff factor is
 - (a) 1.6
 - **(b)** 1.8
 - **(c)** 2.0
 - (d) 2.2
- (vi) <u>Assertion</u>: On increasing dilution, the specific conductance keeps on increasing. <u>Reason</u>: On increasing dilution, degree of ionization of weak electrolyte increases and molality of ions also increases.
- (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: Aniline does not undergo Friedel Crafts reaction.

Reason: Friedel Crafts reaction is an electrophilic substitution reaction.

- (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.

Chintav went to Shillong to stay at his uncle's place during the winter vacations. One morning he found a thick-blanket of snow in front of his door. His uncle had two bottles containing Sodium chloride (NaCl) and Calcium chloride (CaCl₂). He sprinkled the salt on the ice slit in front of his door.

- (i) What is the purpose of sprinkling the salt on ice slit? What is the specific term used for this kind of salts?
- (ii) As a student of Chemistry can you calculate the amount of NaCl and CaCl₂, needed to be dissolved in 1 kg (1000 g) of water if you desire to decrease the freezing point by 10 °C? [K_f= 1.86, mol. wt. of NaCl=58.5, mol. wt. of CaCl₂, = 111, i = 2 for NaCl and i = 3 for CaCl₂]
- (iii) Which of the two salts will be preferred for sprinkling on ice slit based on the above calculation?

SECTION B – 20 MARKS

Question 2

Account for the following:

- (i) 1-chloro-2,2-dimethylpropane (*neo*-pentyl chloride) does not follow S_N2 mechanism.
- (ii) S_N1 reaction results in formation of racemized products while S_N2 does not.

Question 3

Give a reason for each of the following:

- (i) Cr is reducing reducing and Mn is oxidizing when both have d⁴ configurations.
- (ii) Although Zr belongs to 4d and Hf belongs to 5d transition series but it is quite difficult to separate them.

Question 4

Give one good chemical test to distinguish between the following pair of compounds:

- (i) Propan-1-ol and 2-methylpropan-2-ol
- (ii) Acetone and acetaldehyde

Question 5

Answer the following:

- (i) Cobalt (II) is stable in aqueous solution but in the presence of complexing reagents, it is easily oxidized. Why?
- (ii) The d¹ configuration is very unstable in ions. Why?

Question 6

Identify and specify the presence of a chiral center, if applicable, in the given molecules. Determine the number of stereoisomers for those molecules that contain a chiral center.

- (i) 1,2-dichloropropane
- (ii) 4-bromo-pent-1-ene

Question 7

- (i) What are the reactions occurring at the anode and cathode during the operation of a mercury cell?
- (ii) Why does the voltage of a mercury cell remain constant during its operation?

Question 8

What happens when (write chemical reactions only)

- (a) ethyl alcohol is treated with Cu at 573 K?
- (b) phenol is treated with CHCl3 in presence of NaOH followed by acid work-up?

Question 9

- (i) A 5% solution (by mass) of cane sugar in water has freezing point of 271 K. Calculate the freezing point of 5% glucose in water if freezing point of pure water is 273.15 K.
- (ii) Define cryoscopic constant.

Question 10

Give a reason for each of the following:

- (i) Higher carboxylic acids are practically insoluble in water.
- (ii) Di-*tert*-butyl ketone does not give a NaHSO₄ adduct but acetone does.

Question 11

- (i) Actinoid contraction is greater from element to element than lanthanoid contraction. Explain.
- (ii) Explain as to why the E^{Θ} value for the Mn^{3+}/Mn^{2+} couple is much more positive than that for Cr^{3+}/Cr^{2+} or Fe^{3+}/Fe^{2+} .

SECTION C - 21 MARKS

Question 12

For the reaction A + B \rightarrow -Product at 25 °C,

the initial rate of different reaction and initial concentration of reactants are given below:

S.	[A]	[B]	Initial reaction rate
No.	(mol/L)	(mol/L)	(mol/L/s)
1.	1.0	1.0	2.0 x10 ⁻³
2.	2.0	1.0	4.0 x10 ⁻³
3.	4.0	1.0	8.0 x10 ⁻³
4.	1.0	2.0	2.0 x10 ⁻³
5.	1.0	4.0	2.0 x10 ⁻³

Answer the following questions:

- (i) Write the overall order of reaction.
- (ii) Write the rate law expression.
- (iii) Calculate the rate constant.

Question 13

Arrange the following substances:

 $C_6H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$, $C_2H_5NH_2$

- (i) In an increasing order of basic strength in water
- (ii) In a decreasing order of basic strength in gas phase.

Question 14

- (i) Name the linkage connecting monosaccharide units in polysaccharides. What are the monosaccharide units present in the following molecules?
 - (a) Maltose
 - (b) Lactose
 - (c) Glycogen
- (ii) Isoelectric point of glycine is 6.1. What will be the nature of glycine in aqueous medium?

Question 15

- (i) The vapour pressure of water is 12.3 KPa at 300 K. Calculate the vapour pressure of 1 molal solution of non-volatile solute in it.
- (ii) Gases always tend to be less soluble in liquids as the temperature is raised. Explain.

Question 16

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

(i)
$$CH_3COOH \xrightarrow{NH_3} [A] \xrightarrow{Br_2/KOH (aq)} [B] \xrightarrow{CHCl_3/alc. KOH} [C]$$

(ii) $HC \equiv CH + H_2O \xrightarrow{Hg^{+2}/H_2SO_4} [A] \xrightarrow{Oxidation} [B] \xrightarrow{(i) Ca(OH)_2} [C]$

Question 17

- (i) How will the following be obtained? (Give chemical equations only)
 - (a) Benzene to *m*-bromophenol
 - (b) Benzoic acid to aniline
 - (c) An alkyl halide to a quaternary ammonium salt.

OR

(ii) Explain the mechanism of acid catalysed dehydration of ethanol to yield the corresponding alkene.

Question 18

- (i) During nuclear explosion, one of the products is 90 Sr with half-life of 28.1 years. If 1µg of 90 Sr was absorbed in the bones of a newly born baby instead of calcium. How much of it will remain after 60 years if it is not lost metabolically.
- (ii) Rate constant for the decomposition of hydrocarbons is 2.418×10^{-5} s⁻¹ at 546 K. If the energy of activation is 179.9 kJ/mol, then what will be value of pre-exponential factor?

SECTION D - 15 MARKS

Question 19

- (i) Give a reason for each of the following:
 - (a) Monochloroethanoic acid has a higher pKa value than dichloroethanoic acid.
 - **(b)** Carboxylic acids are higher boiling liquids than aldehydes, ketones and alcohols of comparable molecular masses.
- (ii) An organic compound (A) on treatment with acetic acid in the presence of sulphuric acid produces an ester (B). (A) on mild oxidation gives (C). (C) with 50% KOH followed by acidification with dilute HCl generates (A) and (D). (D) with PCl5 followed by reaction with ammonia gives (E). (E) on dehydration produces hydrocyanic acid. Identify the compounds A, B, C, D and E.

Question 20

- (i) Name the first naturally occurring organometallic compound. [1]
- (ii) Based on CFT, write the electronic configurations of d⁵ ion in octahedral field if:
 - a) $\Delta_{\rm o} < P$
 - **b)** $\Delta_0 > P$
- (iii) Write the optical isomers of $[Co(en)_2Cl_2]^+$
- (iv) Give the IUPAC name of the complex $[Co(NH_3)_6][Cr(CN)_6]$. [1]
- (v) Write the type of isomerism exhibited by the following complexes: [1]
 - a) $[Co(NH_3)_5Br]SO_4$
 - **b)** $[Co(ONO)(NH_3)_5]^{2+}$

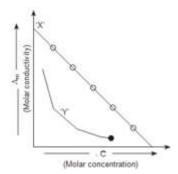
Question 21

(i) (a) For the cell reaction

 $Ni(s) \mid Ni^{2+}\left(aq\right) \parallel Ag^{+}\left(aq\right) \mid Ag(s)$

Calculate the equilibrium constant at 25 °C. How much maximum work would be obtained by operation of this cell ? [2]

(b) Observe the graph shown in figure between A_m (molar conductivity) Vs \sqrt{C} (Molar concentration) and answer the questions based on graph. [3]



- (a) What is intercept on Λ_m axis for 'X' equal to?
- **(b)** Give mathematical equation representing straight line.
- (c) What happens to molar conductivity on dilution in case of weak electrolyte and why?

OR

- (ii) (a) Conductivity of $2 \times 10^{-3} \, \text{M}$ methanoic acid is $8 \times 10^{-5} \, \text{S cm}^{-1}$. Calculate its molar conductivity and degree of dissociation if $\wedge_{\text{m}}{}^{\text{o}}$ for methanoic acid is $404 \, \text{S cm}^{2} \, \text{mol}^{-1}$. [2]
- (b) Calculate the ΔG^o and K_c for the given reaction at 298 K. [3] $Ni(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag(s)$ Given $E^o_{Ni}{}^{2+}_{/Ni} = -0.25V$ $E^o_{Ag^+/Ag} = +0.80V$, 1F = 96500 C

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