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.)*

All questions are compulsory

Question 1 is of 20 marks having four sub parts, all of which are compulsory.
*Question numbers 2 to 8 carry 2 marks each, with **two** questions having internal choice.*
*Question numbers 9 to 15 carry 3 marks each, with **two** questions having an internal choice.*

Question numbers 16 to 18 carry 5 marks each, with an internal choice.
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 = 1·987 cal deg^{-1} mol^{-1} = 8·314 JK^{-1} mol^{-1} = 0·0821 dm^3 atm $K^{-1}mol^{-1}$
1 l atm = 1 dm^3 atm = 101·3 J. 1 Faraday = 96500 coulombs.
Avogadro's number = 6·023 × 10^{23}.

Question 1

(a) Fill in the blanks by choosing the appropriate word/words from those given in the brackets: **[4×1]**

(iodoform, volume, mass, haloform, gram equivalent, chloroform, carbylamine, sp^3d^2, high, coke, d^2sp^3, low, gram mole, carbon monoxide)

(i) Equivalent conductivity is the conducting power of all the ions furnished by one _____ of an electrolyte present in a definite _____ of the solution.

(ii) Bleaching powder, on treatment with ethanol or acetone gives _____. This is an example of _____ reaction.

(iii) Outer orbital complexes involve _____ hybridization and are _____ spin complexes.

(iv) Zinc oxide is reduced by _____ at 1673K to form zinc and _____.

This Paper consists of 7 printed pages and 1 blank page.

(b) Select the correct alternative from the choices given: **[4×1]**

(i) The packing efficiency of simple cubic structure, body centered cubic structure and face centered cubic structure respectively is:

(1) 52·4%, 74%, 68%

(2) 74%, 68%, 52·4%

(3) 52·4%, 68%, 74%

(4) 68%, 74%, 52·4%

(ii) When acetone is treated with Grignard's reagent, followed by hydrolysis, the product formed is:

(1) Secondary alcohol

(2) Tertiary alcohol

(3) Primary alcohol

(4) Aldehyde

(iii) Which of the following electrolytes is least effective in causing flocculation of positively charged ferric hydroxide sol?

(1) $K_3[Fe(CN)_6]$

(2) K_2CrO_4

(3) $K_4[Fe(CN)_6]$

(4) KBr

(iv) On heating an aliphatic primary amine with chloroform and alcoholic potassium hydroxide, the organic compound formed is an:

(1) Alkyl isocyanide

(2) Alkanol

(3) Alkanal

(4) Alkyl cyanide

(c) Match the following: **[4×1]**

(i)	Silicon and phosphorous	(a)	Acetaldehyde
(ii)	Iodoform test	(b)	Xenon hexafluoride
(iii)	Arrhenius equation	(c)	n-type of semiconductors
(iv)	Distorted octahedral structure	(d)	Frequency factor

(d) Answer the following questions: **[4×2]**

(i) What is the common name of the polymer obtained by the polymerization of caprolactam? Is it addition polymer or condensation polymer?

(ii) Why Zn^{2+} ions are colourless while Ni^{2+} ions are green and Cu^{2+} ions are blue in colour?

(iii) The molar conductivity of NaCl, CH_3COONa and HCl at infinite dilution is 126·45, 91·0 and 426·16 $ohm^{-1}\ cm^2\ mol^{-1}$ respectively. Calculate the molar conductivity (λ_m^∞) for CH_3COOH at infinite dilution.

(iv) Identify the compounds A, B, C and D.

$$C_6H_5COOH \xrightarrow{SOCl_2} A \xrightarrow{NH_3} B \xrightarrow{Br_2/KOH} C \xrightarrow[0-5^\circ C]{NaNO_2+HCl} D$$

Question 2 **[2]**

(a) An element has atomic weight 93 g mol^{-1} and density 11·5 g cm^{-3}. If the edge length of its unit cell is 300 pm, identify the type of unit cell. ($N_A = 6·023\times10^{23}\ mol^{-1}$)

OR

(b) Calculate the radius of copper atom. The atomic weight of copper is 63·55 g mol^{-1}. It crystallises in face centered cubic lattice and has density of 8·93 g cm^{-3} at 298K. ($N_A = 6·023\times10^{23}\ mol^{-1}$)

Question 3 **[2]**

Complete and balance the following chemical equations:

(i) $P_4 + NaOH + H_2O \xrightarrow[Inert\ atm.]{heat}$ _____ + _____

(ii) $Cu + HNO_3$ (dil.) $\longrightarrow$ _____ + _____ + _____

Question 4 **[2]**

(i) Write the chemical equation for the reaction of glucose with bromine water.

(ii) Write the zwitter ion structure of glycine.

Question 5 **[2]**

(i) How do antiseptics differ from disinfectants?

(ii) Name a substance that can be used as an antiseptic as well as a disinfectant.

Question 6 [2]

An alloy of gold (Au) and cadmium (Cd) crystallises with a cubic structure in which gold atoms occupy the corners and cadmium atoms fit into the face centres. What is the formula of this alloy?

Question 7 [2]

(a) State reasons for the following:

(i) Ethylamine is soluble in water whereas aniline is insoluble in water.

(ii) Aliphatic amines are stronger bases than aromatic amines.

OR

(b) Complete and balance the following equations:

(i) $C_6H_5NH_2 + CH_3COCl \longrightarrow$ _____ + _____

(ii) $C_2H_5NH_2 + HNO_2 \longrightarrow$ _____ + _____ + _____

Question 8 [2]

Draw the structure of xenon tetrafluoride molecule. State the hybridisation of the central atom and the geometry of the molecule.

Question 9 [3]

(a) Calculate the emf and ΔG for the given cell at 25°C:

$Cr_{(s)}/Cr^{3+}(0{\cdot}1M)//Fe^{2+}(0{\cdot}01M)/Fe_{(s)}$

Given: $E^o_{Cr^{3+}/Cr} = -0{\cdot}74V$, $E^o_{Fe^{2+}/Fe} = -0{\cdot}44V$

(1F = 96500 C, R = 8·314 JK^{-1} mol^{-1})

OR

(b) Calculate the degree of dissociation ($\propto$) of acetic acid, if its molar conductivity (Λ_m) is 39·05 S cm^2 mol^{-1}

(Given $\lambda^o_{(H^+)} = 349{\cdot}6$ S cm^2 mol^{-1} and $\lambda^o_{(CH_3COO^-)} = 40{\cdot}95$ S cm^2 mol^{-1})

Question 10 [3]

Name an important ore of silver. How is silver extracted from its sulphide ore? Give balanced chemical equations involved in the extraction of pure silver.

Question 11 [3]

How will you convert the following:

(i) Chlorobenzene to biphenyl

(ii) Propene to 1- bromopropane

(iii) Chlorobenzene to aniline

Question 12 [3]

Explain what is observed when:

(i) A beam of light is passed through a colloidal solution.

(ii) An electric current is passed through a colloidal solution.

(iii) An electrolyte ($AlCl_3$) is added to a colloidal solution of arsenious sulphide (As_2S_3).

Question 13 [3]

(a) How will you convert the following: (Give balanced equation)

(i) Benzoyl chloride to benzaldehyde.

(ii) Methyl chloride to acetic acid.

(iii) Acetic acid to methane.

OR

(b) A ketone A (C_4H_8O) which undergoes Iodoform reaction gives compound B on reduction. B on heating with conc.H_2SO_4 at 443 K gives a compound C which forms ozonide D. D on hydrolysis with Zn dust gives only E. Identify the compounds A to E. Write the Iodoform reaction with compound A.

Question 14 [3]

A first order reaction is 50% completed in 30 minutes at 300 K and in 10 minutes at 320K. Calculate the activation energy of the reaction. ($R = 8{\cdot}314\ JK^{-1}\ mol^{-1}$).

Question 15 [3]

Explain the following:

(i) Transition metals and their compounds generally exhibit a paramagnetic behaviour.

(ii) There is an increase in density of elements from titanium (Z=22) to copper (Z = 29) in the 3d series of transition elements.

(iii) $K_2Cr_2O_7$ acts as a powerful oxidising agent in acidic medium.

Question 16 [5]

(a) (i) The elevation in boiling point when 0·30 g of acetic acid is dissolved in 100 g of benzene is 0·0633°C. Calculate the molecular weight of acetic acid from this data. What conclusion can you draw about the molecular state of the solute in the solution?

(Given K_b for benzene = 2·53 K kg mol^{-1}, at. wt. of C = 12, H = 1, O = 16)

(ii) Determine the osmotic pressure of a solution prepared by dissolving 0·025 g of K_2SO_4 in 2 litres of water at 25°C, assuming that K_2SO_4 is completely dissociated.

(R = 0·0821 Lit-atm K^{-1} mol^{-1}, mol. wt. of K_2SO_4 = 174 g mol^{-1})

OR

(b) (i) An aqueous solution of a non-volatile solute freezes at 272·4 K, while pure water freezes at 273·0 K. Determine the following:

(Given K_f = 1·86 K kg mol^{-1}, K_b = 0·512 K kg mol^{-1} and vapour pressure of water at 298 K = 23·756 mm of Hg)

(1) The molality of solution

(2) Boiling point of solution

(3) The lowering of vapour pressure of water at 298 K

(ii) A solution containing 1·23g of calcium nitrate in 10g of water, boils at 100·975°C at 760 mm of Hg. Calculate the van't Hoff factor for the salt at this concentration.

(K_b for water = 0·52 K kg mol^{-1}, mol. wt. of calcium nitrate = 164 g mol^{-1})

Question 17 [5]

(a) (i) Write the IUPAC names of the following complexes:

(1) $[Cu(NH_3)_4]SO_4$

(2) $[Co(en)_2Cl_2]$

(3) $K_3[Al(C_2O_4)_3]$

(ii) With reference to the coordination complex ion $[Fe(H_2O)_6]^{2+}$ answer the following: (at. no. of Fe = 26)

(1) Give the IUPAC name of the complex ion.

(2) What is the oxidation number of the central metal atom?

(3) How many unpaired electrons are there in the complex ion?

(4) State the type of hybridisation of the complex ion.

OR

(b) (i) Name of the type of isomerism exhibited by the following pairs of compounds:

(1) $[Co(ONO)(NH_3)_5]^{2+}$ and $[Co(NO_2)(NH_3)_5]^{2+}$

(2) $[Cr(H_2O)_4Cl_2]\ Cl.2H_2O$ and $[Cr(H_2O)_5Cl]Cl_2.H_2O$

(3) $[Co(NH_3)_6]\ [Cr(CN)_6]$ and $[Cr(NH_3)_6]\ [Co(CN)_6]$

(ii) Using the valence bond approach, predict the shape, hybridisation and magnetic behaviour of $[Ni(CO)_4]$. (at. no. of Ni = 28)

Question 18

[5]

(a) (i) Give balanced chemical equations for the following reactions:

(1) Phenol is treated with ice cold alkaline solution of benzene diazonium chloride.

(2) Diethyl ether is treated with phosphorous pentachloride.

(3) Ethyl alcohol is treated with thionyl chloride.

(ii) Give one chemical test each to distinguish between the following pairs of compounds:

(1) Ethanol and dimethyl ether

(2) Propan-1-ol and propan-2-ol

OR

(b) (i) Write chemical equations to illustrate the following name reactions:

(1) Williamson's synthesis

(2) Esterification reaction

(3) Reimer-Tiemann reaction

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

(1) $C_2H_5OH \xrightarrow[\Delta]{Cu} A \xrightarrow{dil.NaOH} B$

(2)