SECTION – I

Q.1. Answer any ONE of the following:

i. What is 'boiling point'?

Derive a relation between ΔH and ΔU for a chemical reaction.

Draw neat labelled diagram of calomel electrode.

Resistance and conductivity of a cell containing 0.001 M KCl solution at 298 K are 1500 Ω and 1.46×10^{-4} S. cm^{-1} respectively. What is the cell constant?

ii. Write molecularity of the following reaction:

$2NO_{(g)} + O_{2\,(g)} \longrightarrow 2NO_{2\,(g)}$

What is 'calcination'? How does it differ from 'roasting'?

Write resonating structures of ozone.

The decomposition of $N_2O_{5(g)}$ at 320 K according to the following equation follows first order reaction:

1

$N_2O_{5(g)} \rightarrow 2NO_{2(g)} + O_{2(g)}$

2

The initial concentration of $N_2O_{5(g)}$ is 1.24×10^{-2} mol. L^{-1} and after 60 minutes, 0.20×10^{-2} mol. L^{-1}. Calculate the rate constant of the reaction at 320 K.

Q.2. Answer any THREE of the following:

i. One mole of a gas expands by 3 L against a constant pressure of 3 atmosphere. Calculate the work done in:

a. L. atmosphere
b. Joules
c. Calories

ii. Calculate the amount of $CaCl_2$ (van't Hoff factor i = 2.47) dissolved in 2.5 L solution so that its osmotic pressure at 300 K is 0.75 atmosphere.
Given: Molar mass of $CaCl_2$ is 111 g. mol^{-1}.

$R = 0.082$ L. atm. K^{-1} mol^{-1}

iii. Describe anomalous behaviour of fluorine with the other elements of group 17 with reference to:

a. Hydrogen bonding
b. Oxidation state
c. Polyhalide ions

iv. Face centred cubic crystal lattice of copper has density of 8.966 g. cm^{-3}. Calculate the volume of the unit cell.
Given: Molar mass of copper is 63.5 g. mol^{-1} and Avogadro number N_A is 6.022×10^{23} mol^{-1}.

Q.3. Answer any SIX of the following:

i. What is the action of the following reagents on ammonia:
   a. Nessler's reagent
   b. Sodium metal

ii. State the first and second law of electrolysis.

iii. Draw neat and labelled diagram of Bessemer converter used in the extraction of copper.

iv. Derive the relation between half-life period and rate constant for first order reaction.

v. Derive the relation between ΔG° and equilibrium constant (K) for the reaction,
$aA + bB \quad cC + dD$.

vi. Explain brown ring test with the help of chemical equation.

vii. Explain, why do aquatic animals prefer to stay at lower level of water during summer?

viii. Distinguish between:
Crystalline solids and Amorphous solids.

Q.4. Select and write the most appropriate answer from the alternatives given below each sub-question:

i. To prepare n-type semiconductor, the impurity to be added to silicon should have the following number of valence electrons _____.
(A) 2 (B) 3
(C) 4 (D) 5

ii. Number of faradays of electricity required to liberate 12 g of hydrogen is _____.
(A) 1 (B) 8
(C) 12 (D) 16

iii. What is molecular formula of oleum?
(A) H_2SO_3 (B) H_2SO_4
(C) $H_2S_2O_7$ (D) $H_2S_2O_8$

iv. Purification of aluminium by electrolytic refining is carried out by _____.
(A) Hoope process (B) Hall Process
(C) Baeyer process (D) Serperck process

v. The rate of reaction for certain reaction is expressed as:

$$\frac{1}{3}\frac{d[A]}{dt} = -\frac{1}{2}\frac{d[B]}{dt} = -\frac{d[C]}{dt}$$

The reaction is _____.
(A) $3A \longrightarrow 2B + C$ (B) $2B \longrightarrow 3A + C$
(C) $2B + C \longrightarrow 3A$ (D) $3A + 2B \longrightarrow C$

vi. A system absorbs 640 J heat and does work of 260 J, the change in internal energy of the system will be _____.
(A) + 380 J (B) – 380 J
(C) + 900 J (D) – 900 J

vii. Which of the following is 'not' a colligative property?
(A) Vapour pressure (B) Depression in freezing point
(C) Elevation in boiling point (D) Osmotic pressure

SECTION – II

Q.5. Answer any ONE:

i. Write the structural formula and IUPAC names of all possible isomers of the compound with molecular formula C_3H_8O.
Write 'two' uses of phenol.
What happens when glucose is treated with:
a. Bromine water
b. Dilute nitric acid
c. Hydrogen cyanide (HCN)

ii. Write the molecular formula and structural formula of BHA and BHT.
What are thermoplastic polymers?
Write a note on aldol condensation.

Q.6. Answer any THREE:

i. What is the action of the following reagents on aniline?
a. Bromine water
b. Acetic anhydride
c. Hot and conc. sulphuric acid

ii. Discuss the optical activity of lactic acid.

iii. Write balanced chemical equations for action of potassium permanganate on:
a. Hydrogen
b. Warm conc. sulphuric acid
Explain why Mn^{2+} ion is more stable than Mn^{3+}?
(Given: Mn $\rightarrow$ Z = 25)

iv. What is effective atomic number (EAN)?
Calculate EAN of cobalt (Z = 27) in $[Co(NH_3)_6]^{+3}$ and of zinc (Z = 30) in $[Zn(NH_3)_4]SO_4$.

Q.7. Answer any SIX:

i. What is a 'soap'? How is it prepared?

ii. Identify the compounds 'A' and 'B' in the following equation:
$CH_3 - CH_3 + HNO_3 \xrightarrow{423-600\,K}$ 'A' $\xrightarrow{Sn/conc.HCl}$ 'B' + H_2O

iii. Write a note on self oxidation-reduction reaction of aldehyde with suitable example.

iv. Write names and chemical formulae of monomers used in preparing Buna–S.

v. Define complex lipids. Mention 'two' functions of lipids.

vi. Distinguish between S_N1 and S_N2 mechanisms.

vii. What are lanthanoids? What is the position of actinoids in periodic table?

viii. How is methoxyethane prepared from:
a. Methyl iodide
b. Diazomethane

Q.8. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. IUPAC name of $K_4[Fe(CN)_6]$ is _____.

(A) tetrapotassium ferrocyanide
(B) potassium ferricyanide
(C) potassium ferrocyanide
(D) potassium hexacyanoferrate

ii. Carbon atom in methyl carbocation contains how many pairs of electrons?

(A) 8
(B) 4
(C) 3
(D) 5

iii. How many moles of acetic anhydride will be required to form glucose pentaacetate from 2 M of glucose?

(A) 2
(B) 5
(C) 10
(D) 2.5

iv. Identify the weakest base amongst the following _____.

(A) p-methoxyaniline
(B) o-toluidine
(C) benzene-1,4-diamine
(D) 4-aminobenzoic acid

v. Bakelite is the polymer of _____.

(A) Benzaldehyde and phenol
(B) Acetaldehyde and phenol
(C) Formaldehyde and phenol
(D) Formaldehyde and benzyl alcohol

vi. Formalin is 40% aqueous solution of _____.

(A) Methanal
(B) Methanoic acid
(C) Methanol
(D) Methanamine

vii. Which among the following pairs of elements is 'not' an example of chemical twins?

(A) Zr and Hf
(B) Nb and Ta
(C) Mo and W
(D) Ta and Re

SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. The Arrhenius equation is _____.

(A) $K = Ae^{\frac{RT}{E_a}}$ (B) $A = Ke^{\frac{-E_a}{RT}}$

(C) $K = A \cdot e^{\frac{-RT}{E_a}}$ (D) $A = K \cdot e^{\frac{E_a}{RT}}$

ii. If the enthalpy of vaporisation of water at 100 °C is 186.5 J mol^{-1}, the entropy of vaporization will be _____.

(A) 4.0 J K^{-1} mol^{-1} (B) 3.0 J K^{-1} mol^{-1}

(C) 1.5 J K^{-1} mol^{-1} (D) 0. 5 J K^{-1} mol^{-1}

iii. The atomicity of sulphur in orthorhombic sulphur is _____.

(A) 8 (B) 6

(C) 4 (D) 2

iv. The major binding force in diamond is _____.

(A) covalent bond (B) ionic bond

(C) metallic bond (D) co-ordinate covalent bond

v. The boiling point of water at high altitude is low, because _____.

(A) the temperature is low

(B) the atmospheric pressure is low

(C) the temperature is high

(D) the atmospheric pressure is high

vi. The molar conductivity of cation and anion of salt BA are 180 and 220 mhos respectively. The molar conductivity of salt BA at infinite dilution is _____.

(A) 90 mhos cm^2 mol^{-1} (B) 110 mhos cm^2 mol^{-1}

(C) 200 mhos cm^2 mol^{-1} (D) 400 mhos cm^2 mol^{-1}

vii. What is the process in which concentrated ore is reduced to the corresponding metal by heating at high temperature with a reducing agent?

(A) Polling (B) Pyrometallurgy

(C) Hydrometallurgy (D) Calcination

Q.2. Answer any THREE of the following:

i. Describe anomalous behaviour of oxygen as compared with other elements of group 16 with reference to:
   a. magnetic property
   b. oxidation state
   c. hydrides

ii. What is the value of $\Delta S_{surr.}$ for the following reaction at 298 K?
$6CO_{2(g)} + 6H_2O_{(l)} \longrightarrow C_6H_{12}O_{6(s)} + 6O_{2(g)}$
Given that : $\Delta G° = 2879$ kJ mol^{-1}
$\Delta S = -210$ J K^{-1} mol^{-1}

iii. Sucrose decomposes in acid solution to give glucose and fructose according to the first order rate law. The half life of the reaction is 3 hours. Calculate fraction of sucrose which will remain after 8 hours.

iv. A solution containing 0.73 g of camphor (molar mass 152 g mol^{-1}) in 36.8 g of acetone (boiling point 56.3 °C) boils at 56.55 °C. A solution of 0.564 g of unknown compound in the same weight of acetone boils at 56.46 °C. Calculate the molar mass of the unknown compound.

Q.3. Answer any SIX of the following:

i. Describe triclinic crystal lattice with the help of a diagram.

ii. Write any four applications of electrochemical series.

iii. State and explain Hess's law of constant heat summation.

iv. Distinguish between:
Order and Molecularity of reaction.

v. With the help of the equation $\Delta G° = -nFE°_{cell}$ explain that cell potential is an intensive property.

vi. Describe the laboratory method of preparation of ammonia.

vii. Define van't Hoff factor. How is it related to the degree of dissociation?

viii. Write chemical formulae of the following ores:
   a. Calamine
   b. Haematite
   c. Magnetite
   d. Corundum

Q.4. Answer any ONE of the following:

i. Write the reactions involved in extraction of silver from its ore by leaching process.
Derive the equation : $W = -P_{ext} \cdot \Delta V$
A unit cell of iron crystal has edge length 288 pm and density 7.86 g cm^{-3}. Find the number of atoms per unit cell and type of the crystal lattice.
Given: Molar mass of iron = 56 g mol^{-1}
Avogadro's number $N_A = 6.022 \times 10^{23}$

ii. Define : Cryoscopic constant.
What is the action of hot/concentrated nitric acid on:
   a. Arsenic
   b. Antimony

Draw the structure of:

a. Orthophosphoric acid

b. Pyrophosphoric acid

How much electricity in terms of Faraday is required to produce:

a. 20 g of Ca from molten $CaCl_2$

b. 40 g of Al from molten Al_2O_3

(Given : Molar mass of calcium and aluminium are 40 g mol^{-1} and 27 g mol^{-1} respectively.)

SECTION – II

Q.5. Select and write the most appropriate answers from the given alternatives for each sub-question:

i. Which of the following is a trihydric alcohol?

(A) n-Propyl alcohol

(B) Glycerol

(C) Glycol

(D) Glycine

ii. Alkyl halides are _____.

(A) monohalogen derivatives of alkanes

(B) dihalogen derivatives of alkanes

(C) trihalogen derivatives of alkanes

(D) tetrahalogen derivatives of alkanes

iii. Mohr's salt is _____.

(A) ferrous ammonium sulphate (B) ferrous sulphate

(C) ammonium sulphate (D) ferric sulphate

iv. Which of the following is polyamide?

(A) Teflon (B) Nylon-6,6

(C) Terylene (D) Bakelite

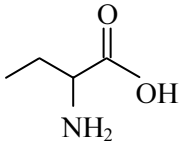
v. Vitamin 'C' belongs to the class of _____.

(A) vitamins of aliphatic series

(B) vitamins of alicyclic series

(C) vitamins of aromatic series

(D) vitamins of heterocyclic series

vi. What is the IUPAC name of 

(A) α-Aminobutanoic acid

(B) 2-Aminobutyric acid

(C) α-Aminobutyric acid

(D) 2-Aminobutanoic acid

vii. Which among the following molecular formulae represents urotropine?

(A) $C_6H_{12}N_4$

(B) $C_6H_{24}H_4$

(C) $C_6H_{12}N_4O_2$

(D) $C_6H_{24}N_4O_2$

Q.6. Answer any THREE of the following:

i. Write the structures of:
   a. 3-Chloro-3-ethylhex-1-ene
   b. 1-Iodo-2,3-dimethylbutane
   c. 1,3,5-Tribromobenzene

ii. What is the action of acidified potassium dichromate on:
   a. SO_2
   b. KI
   Draw structure of dichromate ion.

iii. Describe laboratory method for preparation of glucose.
   Write the reaction that indicates the presence of –CHO group in glucose.

iv. What will be the action of the mixture of sodium nitrite and dilute hydrochloric acid on:
   a. ethylamine
   b. aniline
   c. triethylamine

Q.7. Answer any SIX of the following:

i. What are chemical twins? Write 'two' examples.

ii. Explain the terms:
   a. Antiseptics
   b. Analgesics

iii. Draw the simple Fischer projection formulae of:
   D – (+) – glucose and D – (–) – fructose.

iv. Classify the following ligands into monodentate and polydentate:
   a. Ammonia
   b. Carbon monoxide
   c. Ethylene diamine
   d. Ethylene diamine tetra acetate ion

v. State and explain Markownikoff's rule with suitable example.

vi. How are propan-1-amine and propan-2-amine prepared from oxime?

vii. Identify 'A' and 'B' in the following reaction:

$$C_6H_5MgBr + CO_2 \xrightarrow[H^+/H_2O]{\text{Dry ether}} \text{'A'} \xrightarrow{PCl_5} \text{'B'}$$

viii. What is the action of the following reagents on phenol:
   a. Bromine in CS_2 at low temperature
   b. Conc. H_2SO_4 at room temperature

Q.8. Answer any ONE of the following:

i. Write the structure and IUPAC names of all the metamers represented by formula $C_4H_{10}O$.
   Write balanced chemical equations for action of ammonia on:
   a. formaldehyde
   b. acetaldehyde
   c. acetone

ii. Write four characteristics of co-ordinate complex ion.
   How is Nylon-6,6 prepared?
   Write any 'two' uses of terylene.
   Write four physical methods of preserving food materials.

SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. p-type semi-conductors are made by mixing silicon with impurities of _____.

(A) germanium (B) boron

(C) arsenic (D) antimony

ii. Amongst the following, identify the criterion for a process to be at equilibrium.

(A) $\Delta G < 0$ (B) $\Delta G > 0$

(C) $\Delta S_{total} = 0$ (D) $\Delta S < 0$

iii. Colligative property depends only on _____ in a solution.

(A) number of solute particles (B) number of solvent particles

(C) nature of solute particles (D) nature of solvent particles

iv. The charge of how many coulombs is required to deposit 1.0 g of sodium metal (molar mass 23.0 g mol^{-1}) from sodium ions?

(A) 2098 C (B) 96500 C

(C) 193000 C (D) 4196 C

v. What is the chemical composition of malachite?

(A) $CuO.CuCO_3$ (B) $Cu(OH)_2.CuCO_3$

(C) $CuO.Cu(OH)_2$ (D) $Cu_2O.Cu(OH)_2$

vi. The element that does NOT exhibit allotropy is _____.

(A) As (B) Sb

(C) Bi (D) N

vii. The integrated rate equation for first order reaction A $\rightarrow$ products is _____ .

(A) $k = 2.303\ t \log_{10} \frac{[A]_0}{[A]_t}$ (B) $k = -\frac{1}{t} \ln \frac{[A]_t}{[A]_0}$

(C) $k = \frac{2.303}{t} \log_{10} \frac{[A]_t}{[A]_0}$ (D) $k = \frac{1}{t} \ln \frac{[A]_t}{[A]_0}$

Q.2. Answer any SIX of the following:

i. Define the following terms:
   a. Enthalpy of fusion
   b. Enthalpy of atomization

ii. Derive van't Hoff general solution equation.

iii. Explain impurity defect in stainless steel with diagram.

iv. Derive the relation between half life and rate constant for a first order reaction.

v. Draw neat and labelled diagram of dry cell.

vi. Explain the structure of sulphur dioxide.

vii. What is calcination? Explain it with reactions.

viii. Arrange the following reducing agents in the order of increasing strength under standard state conditions. Justify the answer.

Element	$Al_{(s)}$	$Cu_{(s)}$	$Cl^-_{(aq)}$	$Ni_{(s)}$
E^o	–1.66 V	0.34 V	1.36 V	–0.26 V

Q.3. Answer any THREE of the following:

i. Determine whether the reactions with the following ΔH and ΔS values are spontaneous or non-spontaneous. State whether the reactions are exothermic or endothermic.
   a. $\Delta H = -110$ kJ, $\Delta S = +40$ J K^{-1} at 400 K
   b. $\Delta H = +40$ kJ, $\Delta S = -120$ J K^{-1} at 250 K

ii. 1.0×10^{-3} kg of urea when dissolved in 0.0985 kg of a solvent, decreases freezing point of the solvent by 0.211 K. 1.6×10^{-3} kg of another non-electrolyte solute when dissolved in 0.086 kg of the same solvent depresses the freezing point by 0.34 K. Calculate the molar mass of the another solute.
   (Given molar mass of urea = 60)

iii. Sucrose decomposes in acid solution into glucose and fructose according to the first order rate law with $t_{1/2} = 3$ hours. What fraction of the sample of sucrose remains after 8 hours?

iv. Explain how does nitrogen exhibit anomalous behaviour amongst group 15 elements.

Q.4. Answer any ONE of the following:

i. Niobium crystallises as body centred cube (BCC) and has density of 8.55 kg dm^{-3}. Calculate the atomic radius of niobium.
   (Given: Atomic mass of niobium = 93)
   Write one statement of first law of thermodynamics and its mathematical expression.
   Write the reactions involved in the zone of reduction in blast furnace during extraction of iron.

ii. Write molecular formulae and structures of the following compounds:
   a. Dithionic acid
   b. Peroxymonosulphuric acid
   c. Pyrosulphuric acid
   d. Dithionous acid

   Calculate E_{cell} and ΔG for the following at 28 °C:
   $Mg_{(s)} + Sn^{2+}$ (0.04 M) → Mg^{2+} (0.06 M) + $Sn_{(s)}$
   $E^o_{cell} = 2.23$ V
   Is the reaction spontaneous?

SECTION – II

Q. 5. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. Identify the product 'D' in the following sequence of reactions:

$H_3C - CH_2 - CH_2 - Cl \xrightarrow[\Delta]{Alc.KOH}$ 'B' $\xrightarrow{HBr}$ 'C' $\xrightarrow[Ether]{Na}$ 'D'

(A) 2,2-dimethylbutane (B) 2,3-dimethylbutane
(C) hexane (D) 2,4-dimethylpentane

ii. Which of the following complexes will give a white precipitate on treatment with a solution of barium nitrate?

(A) $[Cr(NH_3)_4SO_4]Cl$ (B) $[Co(NH_3)_4Cl_2]NO_2$
(C) $[Cr(NH_3)_4Cl_2]SO_4$ (D) $[CrCl_2(H_2O)_4]Cl$

iii. What is the geometry of chromate ion?

(A) Tetrahedral (B) Octahedral
(C) Trigonal planar (D) Linear

iv. Primary and secondary nitroalkanes containing α-H atom show property of _____.

(A) chain isomerism (B) tautomerism
(C) optical isomerism (D) geometrical isomerism

v. In phenol carbon atom attached to –OH group undergoes _____.

(A) sp^3 hybridisation (B) sp hybridisation
(C) sp^2 hybridisation (D) no hybridisation

vi. Identify the strongest acid amongst the following.

(A) Chloroacetic acid (B) Acetic acid
(C) Trichloroacetic acid (D) Dichloroacetic acid

vii. Which of the following vitamins is water soluble?

(A) A (B) D
(C) E (D) B

Q.6. Answer any SIX of the following :

i. Write a note on Friedel Craft's acylation.
ii. How is ethylamine prepared from methyl iodide?
iii. What are antibiotics? Give 'two' examples.
iv. Explain, why are boiling points of carboxylic acids higher than corresponding alcohols.
v. How are proteins classified on the basis of molecular shapes?
vi. What are interstitial compounds? Why do these compounds have higher melting points than corresponding pure metals?
vii. Write the structures and IUPAC names of the following compounds:
   a. Adipic acid
   b. α-methyl butyraldehyde
viii. Explain with examples, branched and linear polymers.

Q.7. Answer any THREE of the following:

i. On the basis of valence bond theory explain the nature of bonding in $[CoF_6]^{3-}$ ion.
Write the IUPAC name of $[Co(NO_2)_3(NH_3)_3]$.
ii. Define lanthanoid contraction. Explain its effects.
iii. Write mechanism of Aldol addition reaction.
iv. Define carbohydrates. What are reducing and non-reducing sugars?

Q.8. Answer any ONE of the following:

i. Write a note on Gabriel phthalimide synthesis.
What are biodegradable polymers and non-biodegradable polymers? Write 'one example' of each.
Explain cationic detergents.

ii. How is carbolic acid prepared from the following compounds:
a. Aniline
b. Chlorobenzene and steam at 698 K?
Draw structure of DDT. Write its environmental effects.
Mention 'two' physical properties of carbolic acid.

SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. The hybridisation of phosphorus in phosphorus pentachloride is _____.

(A) dsp^3 (B) sp^3d
(C) d^2sp^3 (D) sp^3d^2

ii. The rate constant for a first order reaction is 100 s^{-1}. The time required for completion of 50% of reaction is _____.
(A) 0.0693 milliseconds (B) 0.693 milliseconds
(C) 6.93 milliseconds (D) 69.3 milliseconds

iii. Silica is added to roasted copper ore during smelting process to remove _____.
(A) ferrous sulphide (B) ferrous oxide
(C) cuprous sulphide (D) cuprous oxide

iv. 96500 coulombs correspond to the charge on how many electrons?
(A) 1.6×10^{19} (B) 6.022×10^{20}
(C) 6.022×10^{23} (D) 6.022×10^{24}

v. For the reaction: $Cl_{2(g)} \longrightarrow 2Cl_{(g)}$, _____.
(A) ΔH is positive, ΔS is positive (B) ΔH is positive, ΔS is negative
(C) ΔH is negative, ΔS is negative (D) ΔH is negative, ΔS is positive

vi. The substance 'X', when dissolved in solvent water gave molar mass corresponding to the molecular formula 'X_3'. The van't Hoff factor (i) is _____.
(A) 3 (B) 0.33
(C) 1.3 (D) 1

vii. The relation $a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma \neq 90°$ represents which crystal system?
(A) Orthorhombic (B) Tetragonal
(C) Triclinic (D) Monoclinic

Q.2. Answer any SIX of the following:

i. Define ebullioscopic constant. Write its unit.
ii. State:
   a. Second law of thermodynamics in terms of entropy.
   b. Third law of thermodynamics.
iii. What is the hybridisation of carbon atom in diamond and graphite?
   0.1 mole of Buckminster fullerene contains how many kg of carbon?
   [Atomic mass of carbon = 12]

iv. Draw structures of:
   a. Chlorine trifluoride b. Chlorine pentafluoride

v. Derive an expression for maximum work in isothermal reversible expansion of two moles of an ideal gas.

vi. Can copper sulphate solution be stored in an iron vessel? Explain.

vii. Define:
   a. Average rate of reaction. b. Instantaneous rate of reaction.

viii. Define:
   a. Hydrometallurgy b. Electrometallurgy

Q.3. Answer any THREE of the following:

i. What is the action of dioxygen on:
   a. Calcium b. Iron c. Carbon disulphide?

ii. A solution of glucose in water is labelled as 10% (W/W).
   Calculate:
   a. Molality
   b. Molarity of the solution.
   [Given: Density of solution is 1.20 g mL^{-1} and molar mass of glucose is 180 g mol^{-1}]

iii. Resistance of conductivity cell filled with 0.1 M KCl solution is 100 ohms. If the resistance of the same cell when filled with 0.02 M KCl solution is 520 ohms, calculate the conductivity and molar conductivity of 0.02 M KCl solution. [Given: Conductivity of 0.1 M KCl solution is 1.29 S m^{-1}.]

iv. Ammonia and oxygen react at high temperature as:
   $4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(g)}$
   In an experiment, rate of formation of $NO_{(g)}$ is 3.6×10^{-3} mol L^{-1} s^{-1}.
   Calculate:
   a. Rate of disappearance of ammonia.
   b. Rate of formation of water.

Q.4. Answer any ONE of the following:

i. What is the effect of temperature on solubility of a gas in a liquid?
   Explain refining of nickel by Mond process.
   State Kohlrausch's law of independent migration of ions.
   Silver crystallises in F.C.C. (face-centred cubic crystal) structure. The edge length of the unit cell is found to be 408.7 pm. Calculate density of the unit cell.
   [Given: Molar mass of silver is 108 g mol^{-1}]

ii. Write 'four' uses of hydrochloric acid.
   Write chemical formula of the following oxoacids of chlorine:
   a. Hypochlorous acid b. Chlorous acid
   c. Chloric acid d. Perchloric acid
   The equilibrium constant K_p for the reaction,
   $H_{2(g)} + I_{2(g)} \quad 2HI_{(g)}$ is 130 at 510 K.
   Calculate $\Delta G°$ for the following reaction at the same temperature:
   $2HI_{(g)} \quad H_{2(g)} + I_{2(g)}$
   [Given: R = 8.314 J K^{-1} mol^{-1}]

SECTION – II

Q.5. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. Which among the following reducing agents is NOT used to reduce acetaldehyde to ethyl alcohol?

(A) Na-Hg and water (B) Zn-Hg and conc. HCl
(C) H_2-Raney Ni (D) $LiAlH_4/H^+$

ii. Acetaldehyde, when treated with which among the following reagents does NOT undergo addition reaction?

(A) Ammonia (B) Hydroxylamine
(C) Ammoniacal silver nitrate (D) Semicarbazide

iii. What is natural rubber?

(A) Cis-1,4-polyisoprene (B) Neoprene
(C) Trans-1,4-polyisoprene (D) Butyl rubber

iv. What is salvarsan?

(A) An antiseptic (B) An antibiotic
(C) An antifertility drug (D) An analgesic

v. Which among the following vitamins is also known as riboflavin?

(A) B_1 (B) B_2
(C) B_6 (D) B_{12}

vi. The amine which reacts with nitrous acid to give yellow oily compound is _____.

(A) ethylamine (B) isopropylamine
(C) secondary butylamine (D) dimethylamine

vii. What is the molecular formula of chromyl chloride?

(A) CrO_2Cl_2 (B) $CrOCl_2$
(C) $CrCl_3$ (D) Cr_2OCl_2

Q.6. Answer any SIX of the following:

i. Identify 'A' and 'B' in the following reaction :

$CH_3 - CH = CH_2 \xrightarrow{HBr}$ 'A' $\xrightarrow{alc.KOH}$ 'B'

ii. Distinguish between lanthanoids and actinoids.

iii. How are the following compounds prepared?

a. Benzyl alcohol from benzyl chloride.
b. Propan-1-ol from propanal

iv. What is the action of acetic anhydride on:

a. ethylamine?
b. diethylamine?

v. What are monosaccharides? Draw ring structure of α-D-(+)-glucopyranose.

vi. Explain the following terms:

a. Cationic detergents
b. Tranquilizers

vii. What is Stephen reaction?

viii. Explain Sidgwick's electronic theory with suitable example.

Q.7. Answer any THREE of the following:

i. What is the action of nitrous acid on:
   a. primary nitroalkane?
   b. secondary nitroalkane?
   c. tertiary nitroalkane?

ii. What is peptide linkage? How is tripeptide formed?

iii. Write the reactions involved in the preparation of:
   a. Teflon b. Orlon c. PVC

iv. What is the position of iron (Z = 26) in periodic table? Explain why is Fe^{3+} more stable than Fe^{2+}?

Q.8. Answer any ONE of the following:

i. Discuss the mechanism of alkaline hydrolysis of bromomethane.
   How is carbolic acid prepared from chlorobenzene?
   What is the action of bromine water on carbolic acid?
   Write chemical test to distinguish between carbolic acid and alcohol.

ii. Explain cationic complexes and anionic complexes of coordination compounds.
   Write the structure and IUPAC names of isomeric aldehydes having molecular formula $C_5H_{10}O$.
   Draw the structure of aspirin.

SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. Schottky defects are observed in which solid among the following?

(A) Brass (B) Cesium Chloride

(C) Zinc sulphide (D) Stainless steel

ii. 'No machine has an efficiency unity', is stated in _____ .

(A) first law of thermodynamics (B) second law of thermodynamics

(C) third law of thermodynamics (D) Hess's law of constant heat summation

iii. Which among the following reactions is an example of a zero order reaction?

(A) $H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)}$

(B) $2H_2O_{2(l)} \longrightarrow 2H_2O_{(l)} + O_{2(g)}$

(C) $C_{12}H_{22}O_{11(aq)} + H_2O_{(l)} \longrightarrow C_6H_{12}O_{6(aq)} + C_6H_{12}O_{6(aq)}$

(D) $2NH_{3(g)} \xrightarrow{Pt} N_{2(g)} + 3H_{2(g)}$

iv. Potential of saturated calomel electrode is _____ .

(A) 0.242 V (B) 1.1 V

(C) 0.337 V (D) 0.28 V

v. Which of the following compounds is used as a semipermeable membrane?

(A) Potassium ferrocyanide (B) Potassium argentocyanide

(C) Sodium meta aluminate (D) Copper ferrocyanide

vi. Which among the following minerals does NOT contain aluminium?

(A) Cryolite (B) Siderite

(C) China clay (D) Corundum

vii. The group 15 element having inner electronic configuration as of argon is _____ .

(A) Phosphorus (Z = 15) (B) Antimony (Z = 51)

(C) Arsenic (Z = 33) (D) Nitrogen (Z = 7)

Q.2. Answer any SIX of the following:

i. Write chemical reactions involved in Van Arkel method for refining titanium.

ii. Explain the relationship between Gibbs standard energy change of the reaction and equilibrium constant.

iii. A face centred cube (fcc) consists of how many atoms? Explain.

iv. Describe isolation method in determination of rate law and order of reaction.

v. Explain the following methods to protect metals from corrosion:

a. Galvanization

b. Passivation

vi. Write the Nernst equation and explain the terms involved.

vii. What happens when dilute sulphuric acid is treated with:

a. Fe? b. CaF_2?

viii. Define:

a. Osmosis b. Freezing point

Q.3. Answer any THREE of the following:

i. The rate constant of a first order reaction are 0.58 s^{-1} at 313 K and 0.045 s^{-1} at 293 K. What is the energy of activation for the reaction?

ii. Calculate the standard enthalpy of the reaction,

$2C(graphite) + 3H_{2(g)} \longrightarrow C_2H_{6(g)}$; $\Delta H° = ?$

from the following $\Delta H°$ values:

a. $C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}$; $\Delta H° = -1560$ kJ

b. $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$; $\Delta H° = -285.8$ kJ

c. $C(graphite) + O_{2(g)} \longrightarrow CO_{2(g)}$; $\Delta H° = -393.5$ kJ.

iii. 3.795 g of sulphur is dissolved in 100 g of CS_2. This solution boils at 319.81 K. What is molecular formula of sulphur in solution? The boiling point of CS_2 is 319.45 K.

(Given that K_b for CS_2 = 2.42 K kg mol^{-1} and atomic mass of S = 32.)

iv. Write the reactions involved in large scale preparation of nitric acid.

Q.4. Answer any ONE of the following:

i. State third law of thermodynamics. Write applications of standard molar entropy.

Draw neat labelled diagram of electrolytic refining of blister copper.

Determine the density of cesium chloride which crystallizes in bcc type structure with the edge length 412.1 pm. The atomic masses of Cs and Cl are 133 and 35.5 respectively.

Predict the coordination number of Cs^+ ion if r_{Cs^+} = 1.69 Å and r_{Cl^-} = 1.81 Å.

ii. What happens when thin copper leaves are thrown in jar containing chlorine?

H_2O is liquid while H_2S is gas at room temperature. Explain.

The conductivity of 0.02 M $AgNO_3$ at 25°C is 2.428×10^{-3} Ω^{-1} cm^{-1}. What is its molar conductivity? State Henry's law.

SECTION – II

Q.5. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. Sodium acetate reacts with ethanoyl chloride to form _____.

(A) acetic acid (B) acetone
(C) acetic anhydride (D) sodium formate

ii. Natalite is a mixture of _____.

(A) diethyl ether and methanol (B) diethyl ether and ethanol
(C) dimethyl ether and methanol (D) dimethyl ether and ethanol

iii. What is effective atomic number of Fe (Z = 26) in $[Fe(CN)_6]^{4-}$?

(A) 12 (B) 30
(C) 26 (D) 36

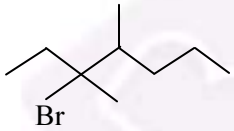
iv. Maltose is a _____ .

(A) polysaccharide (B) disaccharide
(C) trisaccharide (D) monosaccharide

v. Which one of the following oxidation state of manganese is unstable?

(A) +2 (B) +4
(C) +5 (D) +7

vi. IUPAC name of the following compound is _____ .



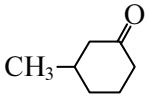
(A) 3-Bromo-3,4-dimethylheptane (B) 3,4-dimethyl-3-bromoheptane
(C) 5-Bromo-4,5-dimethylheptane (D) 4,5-dimethyl-5-bromoheptane

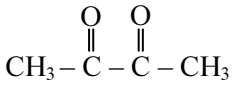
vii. Which of the following compounds is NOT prepared by the action of alcoholic NH_3 on alkyl halide?

(A) $CH_3 – NH_2$ (B) $CH_3 – CH_2 – NH_2$
(C) $CH_3 – CH_2 – CH_2 – NH_2$ (D) $(CH_3)_3C – NH_2$

Q.6. Answer any SIX of the following:

i. Write IUPAC names of the following compounds:

a. 

b. 

ii. What are the sources of Vitamin C and Vitamin K?

iii. Write four points of distinction between lanthanoids and actinoids.

iv. How is benzonitrile converted to benzophenone?

v. Write the formulae of the raw materials used for preparation of:

a. Buna-S

b. Dextron

vi. Write a note on Sandmeyer's reaction.

vii. What is the action of benzene diazonium chloride on:
   a. phenol in alkaline medium?
   b. aniline?

viii. Explain any two chemical methods of food preservation.

Q.7. Answer any THREE of the following:

i. What is the action of following reagents on glucose?
   a. Bromine water
   b. Dilute HNO_3
   c. Hydroxylamine

ii. Define ligand. Write four postulates of Werner's theory.

iii. Write reactions involved in preparation of potassium dichromate from chrome iron ore.

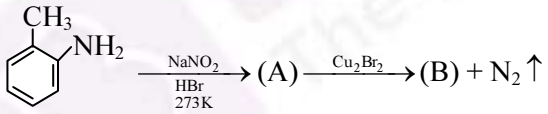
iv. What is metamerism?
Write the structure and IUPAC name of methyl-n-propylether.
What is the action of hot HI on it?

Q.8. Answer any ONE of the following:

i. a. How are the following polymers prepared?
   1. Orlon 2. Teflon

   b. Classify the following drugs into analgesics and antibiotics.
   1. Ofloxacin 2. Morphine
   3. Ampicillin 4. Chloramphenicol

   c. Identify 'A' and 'B' and rewrite the reactions.

1. 

2. $H_3C - CH_2 - \underset{\displaystyle Br}{\underset{|}{CH}} - CH_3 \xrightarrow[\Delta]{\text{Alcoholic KOH}} (A) + (B) + 2KBr + 2H_2O$

3. $C_2H_5 - \overset{+}{N}(CH_3)_3\,\bar{I} \xrightarrow[\Delta]{Ag_2O/H_2O} (A) \xrightarrow{\Delta} (B) + (CH_3)_3N + H_2O$

ii. How are the following conversions carried out?
   a. 2-methylbutan-l-ol into 2-methylbutanoic acid
   b. Phenylethene into benzoic acid
   c. Benzoic acid into meta-nitrobenzoic acid.

What is the action of benzene sulphonyl chloride on primary, secondary and tertiary amines?
Write two uses of formaldehyde.

SECTION – I

Q.1. Answer any SIX of the following:

i. What is ferromagnetism? Iron (Z = 26) is strongly ferromagnetic. Explain.

ii. Define boiling point. Write the formula to determine molar mass of a solute using freezing point depression method.

iii. Write mathematical equations of first law of thermodynamics for the following processes:
   a. Adiabatic process
   b. Isochoric process

iv. Explain graphical method to determine activation energy of a reaction.

v. Write the names and chemical formulae of any one ore of iron and zinc each.

vi. What is the action of
   a. Sodium on arsenic?
   b. Magnesium on bismuth?

vii. Define enthalpy of sublimation. How is it related to enthalpy of fusion and enthalpy of vaporization?

viii. What are Ellingham diagrams? Write any two features of it.

Q.2. Answer any THREE of the following:

i. Silver crystallises in fcc structure. If density of silver is 10.51 g cm^{-3}, calculate the volume of unit cell.
   [Atomic mass of silver (Ag) = 108 g mol^{-1}]

ii. The vapour pressure of pure benzene is 640 mm of Hg. 2.175×10^{-3} kg of non-volatile solute is added to 39 g of benzene, the vapour pressure of solution is 600 mm of Hg. Calculate molar mass of solute (C = 12, H = 1).

iii. Calculate C–Cl bond enthalpy from the following reaction:
   $CH_3Cl_{(g)} + Cl_{2(g)} \longrightarrow CH_2Cl_{2(g)} + HCl_{(g)}$; $\Delta H° = -104$ kJ
   If C–H, Cl–Cl and H–Cl bond enthalpies are 414, 243 and 431 kJ mol^{-1} respectively.

iv. Define cell constant. Draw a neat and well labelled diagram of primary reference electrode.

Q.3. Answer any ONE of the following:

i. Write four points of differences between properties of nitrogen and other elements of group 15.
   Explain the structure of ClF_3.
   Conductivity of a solution is 6.23×10^{-5} $\Omega^{-1}cm^{-1}$ and its resistance is 13710 Ω. If the electrodes are 0.7 cm apart, calculate the cross-sectional area of the electrode.
   Why is molality of a solution independent of the temperature?

ii. What are neutral oxides? Explain the nature of zinc oxide with the help of the reactions.
Define 'molar conductivity' and 'zero order reaction'.
In a first order reaction x → y, 40% of the given sample of compound remains unreacted in 45 minutes. Calculate rate constant of the reaction.

Q.4. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. The molecular formula $H_2S_2O_2$ represents which oxoacid among the following?
(A) Hydrosulphurous acid (B) Thiosulphurous acid
(C) Sulphuric acid (D) Pyrosulphurous acid

ii. Iodine exists as _____.
(A) polar molecular solid (B) ionic solid
(C) non-polar molecular solid (D) hydrogen bonded molecular solid

iii. Absolute entropies of solids, liquids and gases can be determined by _____.
(A) measuring heat capacity of substance at various temperatures
(B) subtracting standard entropy of reactants from products
(C) measuring vibrational motion of molecules
(D) using formula $\Delta S° = S^{\circ}_T - S^{\circ}_0$

iv. The determination of molar mass from elevation in boiling point is called as _____.
(A) cryoscopy (B) colorimetry
(C) ebullioscopy (D) spectroscopy

v. The process of leaching alumina, using sodium carbonate is called _____.
(A) Baeyer's process (B) decomposition
(C) cyanide process (D) Hall's process

vi. On calculating the strength of current in amperes if a charge of 840 C (coulomb) passes through an electrolyte in 7 minutes, it will be _____.
(A) 1 (B) 2
(C) 3 (D) 4

vii. A → B is a first order reaction with rate 6.6×10^{-5} M s^{-1}. When [A] is 0.6 M, rate constant of the reaction is _____.
(A) $1.1 \times 10^{-5}\ s^{-1}$ (B) $1.1 \times 10^{-4}\ s^{-1}$
(C) $9 \times 10^{-5}\ s^{-1}$ (D) $9 \times 10^{-4}\ s^{-1}$

SECTION – II

Q.5. Answer any SIX of the following:

i. Why is Sc^{3+} colourless while Ti^{3+} coloured? (Atomic number Sc = 21, Ti = 22)
ii. Illustrate with example, the difference between a double salt and a coordination compound.
iii. How is chlorobenzene prepared from aniline? How is chlorobenzene converted into diphenyl?
iv. What is metamerism? Explain metamerism with suitable examples of ethers.
v. What are ketones? How are ketones classified?
vi. How are
a. 1-nitropropane and b. 2-nitropropane
prepared from suitable oxime?
vii. Define antioxidants. Draw structure of BHT.
viii. What are carbohydrates? Write the reaction for the preparation of nylon-6.

Q.6. Answer any THREE of the following:

i. What are f-block elements? Distinguish between lanthanoids and actinoids.

ii. Explain the terms
   a. Optical activity
   b. Ligand
   c. Interstitial compounds

iii. Write the formula of Tetraamminedichloroplatinum(IV) chloride. How is propene converted into 1-bromopropane and 2-bromopropane?

iv. What are broad-spectrum antibiotics?
How are polythene and neoprene prepared?

Q.7. Answer any ONE of the following:

i. Explain the mechanism of esterification. Write the reactions involved in dehydration of 1°, 2° and 3° alcohols.

ii. What are vitamins? Name any two diseases caused by deficiency of vitamin A. Write the structures of:
   a. nucleoside b. nucleotide
How are 1-nitropropane, 2-nitropropane and 2-methyl-2-nitropropane are distinguished from each other using nitrous acid?

Q.8. Select and write the most appropriate answers from the given alternatives:

i. The preparation of alkyl fluoride from alkyl chloride, in presence of metallic fluorides is known as _____.
   (A) Williamson's reaction (B) Finkelstein reaction
   (C) Swarts reaction (D) Wurtz reaction

ii. Identify the weakest acidic compound amongst the following:
   (A) p-Nitrophenol (B) p-Chlorophenol
   (C) p-Cresol (D) p-Aminophenol

iii. On acid hydrolysis, propanenitrile gives _____.
   (A) propanal (B) acetic acid
   (C) propionamide (D) propanoic acid

iv. Which of the following amines yield foul smelling product with haloform and alcoholic KOH?
   (A) Ethylamine (B) Diethylamine
   (C) Triethylamine (D) Ethylmethylamine

v. Which of the following is NOT present in DNA?
   (A) Adenine (B) Guanine
   (C) Thymine (D) Uracil

vi. Amongst the following, identify a copolymer.
   (A) Orlon (B) PVC
   (C) PHBV (D) Teflon

vii. Phenelzine is used as an _____.
   (A) analgesic (B) antiseptic
   (C) antipyretic (D) antidepressant

SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. Which of the following is a basic oxide?

(A) SiO_2 (B) P_4O_{10}

(C) MgO (D) Al_2O_3

ii. In the representation of galvanic cell, the ions in the same phase are separated by a _____.

(A) single vertical line (B) comma

(C) double vertical line (D) semicolon

iii. An ionic crystal lattice has limiting value of radius ratio as 0.414 to 0.732; the co-ordination number of its cation is _____.

(A) 6 (B) 4

(C) 3 (D) 12

iv. The unit of rate constant for zero order reaction is _____.

(A) t^{-1} (B) $mol\ dm^{-3}\ t^{-1}$

(C) $mol^{-1}\ dm^3\ t^{-1}$ (D) $mol^{-2}\ dm^6\ t^{-1}$

v. Calcium carbonate used in the extraction of iron acts as _____.

(A) oxidising agent (B) reducing agent

(C) gangue (D) flux

vi. 10.0 grams of caustic soda when dissolved in 250 cm^3 of water, the resultant gram molarity of solution is _____.

(A) 0.25 M (B) 0.5 M

(C) 1.0 M (D) 0.1 M

vii. 55 L atm of work is obtained when 1.0 mole of an ideal gas is compressed isothermally from a volume of 28.5 L to 18.5 L, the constant external pressure is _____.

(A) 5.05 atm (B) 5.5 atm

(C) 0.05 atm (D) 0.55 atm

Q.2. Answer any SIX of the following:

i. State Henry's Law.

How does solubility of a gas in water varies with temperature?

ii. How is nitric acid prepared by Ostwald's process?

iii. Classify the following solids into different types:

a. Ammonium phosphate b. Brass

c. S_8 molecule d. Diamond

iv. Construct a labelled diagram for the following cell:

$Zn\left|Zn^{2+}(1M)\right|\left|H^{+}(1M)\right|H_{2(g,1atm)}\left|Pt\right.$

v. Explain with chemical reactions, why is zinc oxide amphoteric in nature?

vi. Write the names and chemical formulae of any 'two' minerals of aluminium.

vii. The rate law for the reaction

$2H_{2(g)} + 2NO_{(g)} \longrightarrow N_{2(g)} + 2H_2O_{(g)}$

is given by rate = $k[H_2][NO]^2$.

The reaction occurs in the following two steps:

a. $H_{2(g)} + 2NO_{(g)} \longrightarrow N_2O_{(g)} + H_2O_{(g)}$

b. $N_2O_{(g)} + H_{2(g)} \longrightarrow N_{2(g)} + H_2O_{(g)}$

What is the role of N_2O in the mechanism? What is the molecularity of each of the elementary steps?

viii. Write the mathematical expression of the First Law of Thermodynamics for the following processes:

a. Isothermal b. Adiabatic

c. Isochoric d. Isobaric

Q.3. Answer any THREE of the following:

i. From the following data for the liquid phase reaction A → B, determine the order of reaction and calculate its rate constant:

t/s	0	600	1200	1800
[A] / mol L^{-1}	0.624	0.446	0.318	0.226

ii. Calculate the standard enthalpy of combustion of $CH_3COOH_{(l)}$ from the following data:

$\Delta_fH°\ (CO_2) = -393.3$ kJ mol^{-1}

$\Delta_fH°\ (H_2O) = -285.8$ kJ mol^{-1}

$\Delta_fH°\ (CH_3COOH) = -483.2$ kJ mol^{-1}

iii. Write the cell representation and calculate equilibrium constant for the following redox reaction:

$Ni_{(s)} + 2\ Ag^{+}_{(aq)}\ (1M) \longrightarrow\ Ni^{2+}_{(aq)}\ (1M) + 2Ag_{(s)}$ at 25°C

$E^{\circ}_{Ni} = -0.25$ V and $E^{\circ}_{Ag} = 0.799$ V

iv. What is the action of concentrated sulphuric acid on the following:

a. phosphorous pentachloride

b. copper

c. potassium chlorate?

Q.4. Answer any ONE of the following:

i. Define:

a. Molality b. Osmotic pressure

Write any 'two' advantages of calomel electrode.

A metal crystallises into two cubic faces namely face centered (FCC) and body centered (BCC), whose unit cell edge lengths are 3.5 Å and 3.0 Å respectively. Find the ratio of the densities of FCC and BCC.

Arrange the following oxyacids of chlorine – $HClO$, $HClO_2$, $HClO_3$ and $HClO_4$ with respect to:

a. Increasing order of thermal stability.

b. Increasing order of oxidising power.

ii. An organic substance (M = 169 gram mol^{-1}) is dissolved in 2000 cm^3 of water. Its osmotic pressure at 12°C was found to be 0.54 atm. If R = 0.0821 L atm K^{-1} mol^{-1}, calculate the mass of the solute.

Calculate the number of atoms in a unit cell of a metal crystallising in face centered cubic structure.

Distinguish between isothermal process and adiabatic process.

Mention the names of various steps involved in the extraction of pure metals from their ores.

SECTION – II

Q.5. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. In the following

$$C_2H_5 - \underset{\displaystyle H}{\overset{|}{C}} = O + NH_2OH \longrightarrow A \xrightarrow[\Delta]{Na/C_2H_5OH} B$$

The compound 'B' is _____.

(A) Propan–1–amine (B) Propan–2–amine

(C) Isopropylamine (D) Dimethylamine

ii. The stability order for carbocation is _____.

(A) 2° > 3° > 1° (B) 3° > 2° > 1°

(C) 3° > 1° > 2° (D) 1° > 3° > 2°

iii. Effective atomic number rule is used to find _____.

(A) geometry of complex

(B) stability of complex

(C) number of isomers of complex

(D) number of possible ligands around metal ion in complex

iv. Which one of the following ions is coloured?

(A) Sc^{3+} (B) Zn^{2+}

(C) Ti^{4+} (D) V^{2+}

v. When phenol is heated with conc. HNO_3 in presence of conc. H_2SO_4 it yields _____.

(A) o-nitrophenol (B) p-nitrophenol

(C) 2,4,6-trinitrophenol (D) m-nitrophenol

vi. The secondary structure of protein is determined by _____.

(A) co-ordinate bond (B) ionic bond

(C) hydrogen bond (D) covalent bond

vii. Ethylidene dichloride when boiled with aqueous solution of NaOH yields _____.

(A) formaldehyde (B) acetaldehyde

(C) acetone (D) ethyl methyl ketone

Q.6. Answer any SIX of the following:

i. How is phenol prepared from cumene?

ii. Write a note on self oxidation-reduction reaction of aldehyde with suitable example.

iii. Explain basic nature of amines.

iv. What are antiseptics? Give any 'two' examples.

v. What happens when glucose is treated with

a. hydroxylamine? b. hydrogen cyanide?

vi. Draw the structures of chromate and dichromate ions.

vii. How is terylene prepared?

viii. Identify A and B in the following reaction:

$$CH_3 - Br + Mg \xrightarrow{\text{dry ether}} A + CO_2 \xrightarrow[H^+ / H_2O]{\text{dry ether}} B + Mg(Br)\,OH$$

Q.7. Answer any THREE of the following:

i. How ligands are classified? Explain with suitable examples.

ii. What is lanthanoid contraction?

Explain, why lanthanum (Z = 57) forms La^{3+} ion, while cerium (Z = 58) forms Ce^{4+} ion?

iii. What is the action of the following reagents on propanone?

a. Phenyl hydrazine

b. Zn – Hg / conc.HCl

c. Sodium bisulphite

iv. Define enzymes.

How is peptide linkage formed?

Q.8. Answer any ONE of the following:

i. How is nitroethane converted into:

a. ethylamine,

b. N-ethylhydroxylamine,

c. acetic acid?

Write names and chemical formulae of monomers used in preparing Buna-N.

What are soaps? How are they prepared?

ii. How will you prepare ethanol, propan-2-ol and 2-methylpropan-2-ol from Grignard's reagent?

Define optical activity.

Explain optical activity of lactic acid.

SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. An antifriction alloy made up of antimony with tin and copper, which is extensively used in machine bearings is called _____.

(A) Duralumin (B) Babbitt metal
(C) Spiegeleisen (D) Amalgam

ii. Which of the following pairs is an intensive property?

(A) Density, viscosity (B) Surface tension, mass
(C) Viscosity, internal energy (D) Heat capacity, volume

iii. Fe^{2+} ions react with nitric oxide formed from reduction of nitrate and yields a brown coloured complex _____.

(A) $[Fe(CO)_5NO]^{2+}$ (B) $[Fe(NH_3)_5NO]^{2+}$
(C) $[Fe(CH_3NH_2)_5NO]^{2+}$ (D) $[Fe(H_2O)_5NO]^{2+}$

iv. MnO_2 and $Ca_3(PO_4)_2$ present in iron ore get reduced to Mn and P in the zone of _____.

(A) combustion (B) reduction
(C) fusion (D) slag formation

v. An ionic compound crystallises in FCC type structure with 'A' ions at the centre of each face and 'B' ions occupying corners of the cube. The formula of compound is _____.

(A) AB_4 (B) A_3B
(C) AB (D) AB_3

vi. On passing 1.5 F charge, the number of moles of aluminium deposited at cathode are _____. [Molar mass of Al = 27 gram mol^{-1}]

(A) 1.0 (B) 13.5
(C) 0.50 (D) 0.75

vii. For a chemical reaction, A→ products, the rate of reaction doubles when the concentration of 'A' is increased by a factor of 4, the order of reaction is _____.

(A) 2 (B) 0.5
(C) 4 (D) 1

Q.2. Answer any SIX of the following:

i. What are 'fuel cells'? Write cathode and anode reaction in a fuel cell.

ii. Derive the relationship between half life and rate constant for first order reaction.

iii. Explain magnetic separation process of ores with the help of a neat, labelled diagram.

iv. Derive the relationship between relative lowering of vapour pressure and molar mass of solute.

v. Define the term 'enthalpy'.

What will happen to the internal energy if work is done by the system?

vi. Nitrogen does not form pentahalides. Give reason.

vii. Calculate the percentage efficiency of packing in case of simple cubic cell.

viii. Write the electronic configuration of the following elements:

a. Sulphur (Z = 16) b. Krypton (Z = 36)

Q.3. Answer any THREE of the following:

i. How is phosphine prepared using the following reagents?

a. HCl

b. H_2SO_4

c. Caustic soda

ii. 0.05 M NaOH solution offered a resistance of 31.6 Ω in a conductivity cell at 298 K. If the cell constant of the cell is 0.367 cm^{-1}, calculate the molar conductivity of NaOH solution.

iii. Calculate ΔH° for the reaction between ethene and water to form ethyl alcohol from the following data:

$\Delta_cH°\ C_2H_5OH_{(l)} = -1368$ kJ

$\Delta_cH°\ C_2H_{4(g)} = -1410$ kJ

Does the calculated ΔH° represent the enthalpy of formation of liquid ethanol?

iv. In the Arrhenius equation for a first order reaction, the values of 'A' of 'E_a' are 4×10^{13} sec^{-1} and 98.6 kJ mol^{-1} respectively. At what temperature will its half life period be 10 minutes?

[R = 8.314 J K^{-1} mol^{-1}]

Q.4. Answer any ONE of the following:

i. State Faraday's first law of electrolysis.

Write any 'two' uses of each of the following:

a. H_2SO_4 b. Chlorine

Distinguish between crystalline solids and amorphous solids.

A solution of a substance having mass 1.8×10^{-3} kg has the osmotic pressure of 0.52 atm at 280 K. Calculate the molar mass of the substance used.

[Volume = 1 dm^3, R = 8.314 J K^{-1} mol^{-1}]

ii. Define the following:

a. Leaching

b. Metallurgy

c. Anisotropy

Derive an expression for maximum work.

The boiling point of benzene is 353.23 K. When 1.80 gram of non-volatile solute was dissolved in 90 gram of benzene, the boiling point is raised to 354.11 K. Calculate the molar mass of solute.

[K_b for benzene = 2.53 K kg mol^{-1}]

SECTION – II

Q.5. Select and write the most appropriate answer from the given alternatives for each sub-question:

i. When primary amine reacts with $CHCl_3$ in alcoholic KOH, the product is _____.

(A) aldehyde (B) alcohol

(C) cyanide (D) an isocyanide

ii. $CH_3–CH_2–Br \xrightarrow[\Delta]{\text{Alcoholic KOH}} B \xrightarrow{HBr} C \xrightarrow{Na/\text{ether}} D$, the compound D is _____.

(A) ethane (B) propane

(C) n-butane (D) n-pentane

iii. Cisplatin compound is used in the treatment of _____.

(A) malaria (B) cancer

(C) AIDS (D) yellow fever

iv. A gas when passed through $K_2Cr_2O_7$ and dil. H_2SO_4 solution turns it green, the gas is _____.

(A) CO_2 (B) NH_3

(C) SO_2 (D) Cl_2

v. The alcohol used in thermometers is _____.

(A) methanol (B) ethanol

(C) propanol (D) butanol

vi. Which of the following vitamins is the vitamin of alicyclic series?

(A) Vitamin C (B) Vitamin K

(C) Vitamin B (D) Vitamin A

vii. Which of the following is the first oxidation product of secondary alcohol?

(A) Alkene (B) Aldehyde

(C) Ketone (D) Carboxylic acid

Q.6. Answer any SIX of the following:

i. How is diethyl ether prepared by continuous etherification process?
ii. Write a note on Hoffmann bromamide degradation.
iii. How is ethanoic acid prepared from dry ice?
iv. Write the molecular and structural formula of BHA and BHT.
v. Explain the preparation of glucose from cane sugar.
vi. Write the factors which are related to the colour of transition metal ions.
vii. Explain the following terms:
   a. Homopolymers b. Elastomers
viii. Define racemic mixture.

Give IUPAC name of $CH_3 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CHO$.

Q.7. Answer any THREE of the following:

i. What is 'effective atomic number' (EAN)?
Calculate the effective atomic number of the central metal atom in the following compounds:
   a. $K_4Fe(CN)_6$ b. $Cr(CO)_6$
   Fe (Z = 26) Cr (Z = 24)
ii. Write the different oxidation states of iron. Why +2 oxidation state of manganese is more stable? (Z of Mn = 25).
iii. Write a note on 'aldol condensation'.
iv. What are 'nucleic acids'?
Define complex lipids. Mention any 'two' functions of lipids.

Q.8. Answer any ONE of the following:

i. What is the action of mixture of $NaNO_2$ and dil. HCl on:
   a. Ethylamine b. Aniline c. Diethylamine
How is nylon 6,6 prepared?
What are 'antacids'?
Write any 'two' side effects of tranquilizers.

ii. Explain the mechanism of alkaline hydrolysis of tert-butyl bromide with energy profile diagram.
Define carbolic acid.
How carbolic acid is prepared from benzene sulphonic acid?