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 ___________.

(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.

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

Comments of Examiners

(a) (i) Some candidates wrote only ‘gram’ instead of ‘gram equivalent’; a few candidates also wrote ‘gram mole’ in the first blank. For the second blank, the correct answer was ‘volume’, but some candidates wrote ‘mass’.

(ii) Instead of ‘chloroform’, some candidates wrote ‘iodoform’ in the first blank. In the second blank in place of ‘haloform’, a few candidates wrote either ‘chloroform’ or ‘iodoform’.

(iii) Outer orbital complexes involve sp^3d^2 hybridisation, but a few candidates wrote d^2sp^3 hybridisation. They were high spin complexes, but some candidates wrote ‘low spin complexes’.

(iv) Some candidates interchanged the words coke and carbon monoxide.

(b) (i) Most of the candidates wrote the correct answer.

(ii) Maximum number of candidates chose incorrect option (3) primary alcohol or (1) secondary alcohol.

(iii) Instead of writing the correct answer (4) or KBr, some candidates wrote (3) or $K_4[Fe(CN)_6]$. The question asked for the least effective electrolyte, not for the most effective electrolyte.

(iv) Instead of writing (1) or alkyl isocyanide, some candidates wrote (4) or alkyl cyanide.

(c) Most candidates were able to attempt this part correctly.

(d) (i) The common name and the type of polymer was not written correctly by some candidates. Instead of ‘Nylon-6’ or perlon, some candidates wrote ‘Nylon-66’. In place of ‘*condensation polymer*’ a few candidates wrote ‘*addition polymer*’.

(ii) This subpart was not attempted correctly by some candidates.

(iii) The molar conductivity (λ_m^∞) for CH_3COOH at infinite dilution was calculated correctly

Suggestions for Teachers

- *Explain the term ‘conductance’ and ‘types of conductivity’, i.e. specific equivalent and molar conductivity clearly to the students.*
- *Clarify the formation of chloroform with ethanol and bleaching powder and the haloform reaction.*
- *Point out Octahedral complexes clearly to the students.*
- *Teach extraction of metals in detail.*
- *Describe the packing efficiency of the simple cubic, body centered cubic and face centered cubic crystals with calculations.*
- *Teach preparation of different types of monohydric alcohols i.e. primary, secondary and tertiary, with Grignard’s reagents.*
- *Spell out flocculation of the colloidal solution clearly.*
- *Explain the carbylamines reaction clearly to the students.*
- *Ensure students are aware of the types of semiconductors.*
- *Explain the concepts given under the head Match the following, clearly to the students.*
- *Explain the name of the polymer and their monomers, along with the type of polymerization.*
- *Point out the important properties of d-block elements such as, why some ions are coloured, and some ions are colourless.*
- *Give more practice in numerical problems of molar conductivity. Instruct students to write correct unit along with the answer.*
- *Give adequate practice in interconversion of organic compounds.*

by many candidates but the unit of molar conductivity was not written along with the answer, in many cases.

(iv) All the four compounds were not identified correctly by most candidates.

- *Explain Diazotization reaction clearly.*

MARKING SCHEME

Question 1

(a)	(i)	gram equivalent, volume	
	(ii)	chloroform, haloform	
	(iii)	sp^3d^2, high	
	(iv)	coke, carbon monoxide	
(b)	(i)	(3) OR 52·4%, 68% ,74%	
	(ii)	(2) OR Tertiary alcohol	
	(iii)	(4) OR KBr	
	(iv)	(1) OR Alkyl isocyanide	
(c)	(i)	Silicon and phosphorous	(c) n-type of semiconductors
	(ii)	Iodoform test	(a) Acetaldehyde
	(iii)	Arrhenius equation	(d) Frequency factor
	(iv)	Distorted octahedral structure	(b) Xenon hexafluoride
(d)	(i)	Nylon-6 or perlon Condensation polymer	
	(ii)	Zn^{2+} ions have completely filled d-orbitals ($3d^{10}$) and are colourless. Ni^{2+} ions and Cu^{2+} ions have incompletely filled d-orbitals ($3d^8$ and $3d^9$). These ions are coloured due to d-d-transition.	
	(iii)	$\lambda^0_{CH_3COOH} = \lambda^o_{CH_3COO^-} + \lambda^\circ_{H^+}$ *or* $= \lambda^o_{CH_3COONa} + \lambda^o_{HCl} - \lambda^o_{NaCl}$ $= 91\cdot0 + 426\cdot16 - 126\cdot45$ $\lambda^o_{CH_3COOH} = 390\cdot71\ ohm^{-1}\,\text{cm}^2\,\text{mol}^{-1}$	

	(iv)	A →C_6H_5COCl B →$C_6H_5CONH_2$ C →$C_6H_5NH_2$ D →$C_6H_5N_2Cl$ (Name or Formula)

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.

($N_A = 6{\cdot}023\times10^{23}$ 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.

($N_A = 6{\cdot}023\times10^{23}$ mol^{-1})

Comments of Examiners	Suggestions for Teachers
(a) The value of Z i.e. number of atoms was calculated correctly by the most candidates, but they did not write the type of unit cell. (b) Majority of the candidates calculated up to edge length of the cell correctly but determination of radius from edge length was either missing or incorrect.	▪ *Give adequate practice in numericals based on number of atoms per unit cell, density of unit cell, etc.* ▪ *Advise students to take the value of 'a' in cm.* ▪ *Train students to proceed systematically, while solving problems, identifying the values that are given, as well as the values that are to be calculated.*

MARKING SCHEME

Question 2

(a)	Given M = 93 g mol^{-1}, density (ρ)= 11·5 g cm^{-3}, a = 300 pm = 300×10^{-10} cm, $N_A = 6{\cdot}023\times10^{23}$ mol^{-1} Density (ρ) = $\frac{Z\times M}{a^3\times N_A}$ *or* Z = $\frac{\rho\times a^3\times N_A}{M}$

	$Z = \frac{11\cdot5\times\left(300\times10^{-10}\right)^3\times6\cdot023\times10^{23}}{93}$ $Z = 2$ Hence, the type of unit cell is body centered cubic (bcc). **OR**
(b)	Given: Atomic weight of Cu = $63\cdot55$ g mol^{-1}, Density (ρ)= $8\cdot93$ g cm^{-3} $N_A = 6\cdot023\times10^{23} mol^{-1}$, for fcc Z = 4 $a^3 = \frac{Z\times M}{\rho\times N_A}$ **OR** $a^3 = \frac{4\times63\cdot55}{8\cdot93\times6\cdot023\times10^{23}}$ $a^3 = 4\cdot726\times10^{-23}$ cm^3 **OR** $a^3 = 47\cdot26\times10^{-24}$ cm^3 $a = (47\cdot26\times10^{-24})^{⅓}$ cm Edge length (a) = $3\cdot6155\times10^{-8}$ cm $r = \frac{a}{2\sqrt{2}} = \frac{3\cdot6155\times10^{-8} cm}{2\sqrt{2}}$ **OR** $= 1\cdot2782\times10^{-8}$ cm

Question 3

[2]

Complete and balance the following chemical equations:

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

(ii) $Cu + \underset{dil.}{HNO_3} \rightarrow$ ________ + ___________ + ________

Comments of Examiners	Suggestions for Teachers
(i) Many candidates did not attempt this question. Those who did, wrote incorrect or unbalanced equation. (ii) Instead of NO, some candidates wrote NO_2.	▪ *Give more practice in writing complete and correct balanced chemical equations.*

MARKING SCHEME

Question 3

(i)	$P_4 + 3NaOH + 3H_2O \xrightarrow[Inert\ atm.]{heat} 3NaH_2PO_2 + PH_3$
(ii)	$3Cu + 8HNO_3 \xrightarrow{} 3Cu(NO_3)_2 + 2NO + 4H_2O$ dil.

Question 4

[2]

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

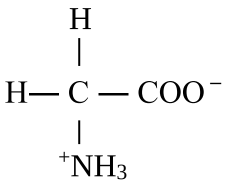
(ii) Write the zwitter ion structure of glycine.

Comments of Examiners	Suggestions for Teachers
(i) Many candidates did not write 'oxygen' in the equation. *Gluconic acid* was not mentioned by most of the candidates. In some cases, the equation was not written. (ii) The structure of glycine was written but the positive and negative charges were not shown by some of the candidates.	▪ *Train students to write a balanced chemical equation for any reaction asked in the question paper.* ▪ *Glycine is an amino acid and possess no charge, but zwitter ion of glycine possess both +ve and -ve charge on it. Explain this point clearly to the students.*

MARKING SCHEME

Question 4

(i)	$\begin{array}{l} CHO \\ \vert \\ (CHOH)_4 + [O] \\ \vert \\ CH_2OH \\ \text{Glucose} \end{array} \xrightarrow{Br_2\ water} \begin{array}{l} COOH \\ \vert \\ (CHOH)_4 \\ \vert \\ CH_2OH \\ \text{Gluconic acid} \end{array}$

(ii)	 $H-\overset{\overset{H}{\vert}}{\underset{\underset{{}^{+}NH_3}{\vert}}{C}}-COO^-$ 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.

Comments of Examiners	Suggestions for Teachers
(i) Most of the candidates wrote the difference between antiseptics and disinfectants correctly. (ii) Many candidates wrote ‘dettol’ / ‘savlon’, etc. for the substance that can be used as an antiseptic as well as a disinfectant.	▪ *Point out the difference between ‘antiseptic’ and ‘disinfectant’ to the students.* ▪ *Clarify that both phenol and hydrogen peroxide can be used as an antiseptic as well as a disinfectant.*

MARKING SCHEME

Question 5

(i)

Antiseptics	Disinfectants
The chemicals which prevent or kill the growth of microorganisms are called antiseptics. They can be applied to wounds, cuts, ulcers and diseased skin.	The chemicals which are capable of killing microorganism but are not safe to be applied to living tissues. They are applied to objects such as floors, instrument, etc. [

(ii) Phenol is used as an antiseptic (0·2% phenol) as well as disinfectant (1% phenol) or H_2O_2 (6%) H_2O_2(30%).

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?

Comments of Examiners	Suggestions for Teachers
Some of the candidates wrote only the formula of the given alloy without showing the calculation for the number of atoms at the corners and at the center.	▪ *Explain about the contribution of corner atoms, face centered atoms and body centered atom to the unit cell.*

MARKING SCHEME

Question 6

In fcc arrangement:

The number of gold (Au) atoms (corner atoms)

$$8 \text{ corners} \times \frac{1}{8} \text{ atoms per corner}$$

$$8 \times \frac{1}{8} = 1 \text{ atom}$$

The number of cadmium (Cd) atoms (face centred atoms)

$$6 \text{ face centres} \times \frac{1}{2} \text{ atoms per face centre}$$

$$6 \times \frac{1}{2} = 3 \text{ atoms}$$

Formula of the given alloy = $AuCd_3$ or Cd_3Au

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) $C_6H_5NH_2 + CH_3COCl \rightarrow$ ________ + ____________

(ii) $C_2H_5NH_2 + HNO_2 \rightarrow$ ________ + ____________ + ____________

Comments of Examiners	Suggestions for teachers
(a) (i) Many candidates did not mention the formation of H-bond and those who wrote about H-bond, did not compare it with aniline. (ii) In aliphatic amines the alkyl group shows +I effect. This was not mentioned by many candidates. For aromatic amines, the resonance effect was not mentioned by some candidates. (b) (i) Most of the candidates who attempted this question gave the correct equation. Some candidates wrote the formula of the product incorrectly. (ii) A few candidates wrote an incorrect skeleton equation. Some of them wrote incorrect by-products as well.	▪ *Explain to students that inter molecular H-bonding between ethylamine and water increases the solubility of ethylamine in water. Phenyl group is hydrophobic and does not form H-bond, hence, aniline is insoluble in water.* ▪ *Clarify the role of Inductive effect and Mesomeric effect on the strength of bases (weak / strong).* ▪ *Give adequate practice to students in writing balanced organic reactions.*

MARKING SCHEME

Question 7

(a)	(i)	Ethylamine is soluble in water because, ethylamine forms intermolecular hydrogen bonds with water. While, in aniline the aryl group possess steric hinderance and does not form hydrogen bond.
	(ii)	In Aliphatic amines, the lone pair is easily available for donation (due to +I effect). Hence, aliphatic amines are stronger bases. While, in aromatic amines the lone pair of electrons present on nitrogen takes part in resonance (M effect) and hence, not available for donation and are weaker bases. **OR**
(b)	(i)	$C_6H_5NH_2 + CH_3COCl \rightarrow CH_3\,CONHC_6\,H_5 + HCl$
	(ii)	$C_2H_5NH_2 + HNO_2 \rightarrow C_2H_5OH + N_2 + H_2O$

Question 8

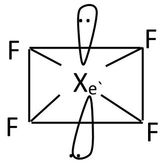
[2]

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

Comments of Examiners	Suggestions for Teachers
Majority of candidates did not mention two lone pairs of electrons in xenon. Many of them forgot to represent lone pairs in trans position to each other. Some candidates wrote tetrahedral geometry and sp^3 hybridisation in place of square planar and sp^3d^2 hybridisation.	▪ *Train students to draw the structures of xenon fluorides and oxides with lone-pair electrons.* ▪ *Explain clearly how lone pair electrons affect the hybridisation and geometry of the compound.*

MARKING SCHEME

Question 8



Hybridisation of the central atom = sp^3d^2

Geometry of the molecule = square planar geometry or Octahedral geometry.

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 = $8\cdot 314$ J K^{-1} mol^{-1})

OR

(b) Calculate the degree of dissociation ($\propto$) of acetic acid, if its molar conductivity (Λ_m) is $39\cdot 05$ 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})

Comments of Examiners	Suggestions for Teachers
(a) Some of the candidates did not write the Nernst equation correctly. Several candidates substituted the value of E^o instead of the value of E in the formula $\Delta G = -nFE$.	▪ *Give adequate practice in solving numerical problems based on Nernst equation. Tell students*

(b)	Molar conductivity at infinite dilution (λ_m^∞) for CH_3COOH was calculated correctly by many candidates but the degree of disassociation (α) was not calculated correctly, as several candidates used incorrect formulae.	*that the -ve sign must be shown while calculating the value of ΔG.* ▪ *Give more practice in solving numerical problems based on Kohlrausch's law and degree of dissociation of electrolytes.*

MARKING SCHEME

Question 9

(a) For the given cell at 298 K

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

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

$E^o_{cell} = E^o_{cathode} - E^o_{anode}$ Or

$= -0\cdot44 - (-0\cdot74\text{ V})$

$= 0\cdot30\text{ V}$

$$E_{cell} = E^o_{cell} - \frac{0\cdot 0591}{n}\log\frac{[Cr^{3+}]^2[Fe]^3}{[Fe^{2+}]^3(Cr]^2} \quad or$$

$$= 0\cdot 30 - \frac{0\cdot 0591}{6}\log\frac{(0\cdot 1)^2}{(0\cdot 01)^3}$$

$E_{cell} = 0\cdot 30 - 0\cdot 00985\log 10^4$

$= 0\cdot 30 - 0\cdot 00985 \times 4\log 10 \because (\log 10 = 1)$

$= 0\cdot30 - 0\cdot0394$

$E_{cell} = 0\cdot2606\text{ V}$

$\Delta G = -nFE$

$= - 6\times96500\times0\cdot2606\text{ J mol}^{-1}$

$= - 150887\cdot4\text{ J mol}^{-1}$

$= - 150\cdot887\text{ kJ mol}^{-1}$

OR

(b) Given $\Lambda_m = 39\cdot05\text{ S cm}^2\text{ mol}^{-1}$

$$\lambda^{o}_{(H^{+})} = 349\cdot6\,\mathrm{S\,cm^{2}mol^{-1}}$$

$$\lambda_{(CH_3COO^{-})} = 40\cdot95\,\mathrm{S\ cm^{2}\ mol^{-1}}$$

$$\Lambda^{o}_{m(CH_3COOH)} = \lambda^{o}_{(H^{+})} + \lambda_{(CH_3COO^{-})}\ \textbf{or}$$

$$= 349\cdot6 + 40\cdot95$$

$$= 390\cdot55\ \mathrm{S\ cm^{2}\ mol^{-1}}$$

Degree of dissociation $(\alpha) = \dfrac{\Lambda_m}{\Lambda^{o}_m} = \dfrac{39\cdot05\,S\,cm^{2}\,mol^{-1}}{390\cdot55\,S\,cm^{2}\,mol^{-1}}$

$$\alpha = 0.0999 \approx 0.1 \text{ or } 10\%$$

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.

Comments of Examiners	Suggestions for teachers
Many candidates wrote *bauxite*, *hematite*, etc. as the important ore of silver. Further, for the extraction process of silver from its sulphide ore, asked in the question, several candidates did not mention the *Froth Flotation process*. A large number of candidates wrote incorrect chemical equations / products / by products. Some did not mention the important step of *electro-refining*, which is necessary in the extraction of pure silver.	▪ *Advise students to prepare flow charts of extraction of each metal in terms of steps, reactions and conditions, according to scope of syllabus.* ▪ *Give emphasis on writing balanced chemical equations in each and every case.*

MARKING SCHEME

Question 10

Argentite (Ag_2S) OR Horn Silver ($AgCl$)

- Concentration by - Froth floatation process
- Treatment with sodium cyanide (Leaching)
- $Ag_2S + 4\,NaCN + 2O_2 \rightarrow 2Na\,[Ag\,(CN)_2] + Na_2SO_4$

  soluble
- Precipitation of Silver with zinc
- $2Na\,[Ag\,(CN)_2] + Zn \rightarrow Na_2\,[Zn(CN)_4] + 2Ag$
- Electrolytic refining

Question 11

[3]

How will you convert the following:

(i) Chlorobenzene to biphenyl.

(ii) Propene to 1- bromopropane.

(iii) Chlorobenzene to aniline.

Comments of Examiners	Suggestions for Teachers
(i) While most of the candidates attempted this part correctly, a few did not write the condition, i.e. *dry ether*, and *heat*. (ii) Most candidates did not mention the reagent, *peroxide* according to anti Markownikoff rule. (iii) A number of candidates were not able to write the complete balanced equation. The condition for the reaction was also not given in several cases.	▪ *Give regular practice to students on named organic reactions.* ▪ *Stress writing complete chemical reactions (balance) with required conditions.*

MARKING SCHEME

Question 11

(i)	$C_6H_5Cl + 2Na + ClC_6H_5 \xrightarrow[heat]{dry\ ether} C_6H_5 - C_6H_5 + 2NaCl$
(ii)	$CH_3CH = CH_2 + HBr \xrightarrow{peroxide} CH_3CH_2CH_2Br$
(iii)	$2C_6H_5Cl + 2NH_3 + Cu_2O \xrightarrow[60\ atm.]{475K} C_6H_5NH_2 + Cu_2Cl_2 + H_2O$ or $C_6H_5Cl + 2NH_3 \xrightarrow[475k\ high\ pr]{Cu_2O} C_6H_5NH_2 + NH_4Cl$

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).

Comments of Examiners	Suggestions for Teachers
(i) The observation given by most of the candidates was correct. *Tyndall effect* was not mentioned by a few candidates. (ii) Many candidates wrote "The migration of charged colloidal particle takes place towards the electrode" but the term *electrophoresis* was missed out by some candidates. (iii) A few candidates did not mention that coagulation/precipitation of negatively charged arsenious sulphide solution takes place.	▪ *Teach colloidal state and the properties of colloids thoroughly to the students. Also explain the movement of charged colloidal particles on passing electric current through colloidal solution.* ▪ *Explain the phenomenon of coagulation of colloidal solution by electrolyte ions clearly.*

MARKING SCHEME

Question 12

(i)	The path of beam is illuminated in all the directions. It is called Tyndall effect. This effect is due to scattering of light by the colloidal particles present in colloidal solution.
(ii)	The colloidal charged particles move towards the cathode or anode depending upon the charges on the colloidal particle (Electrophoresis/ coagulation/ precipitation).
(iii)	The colloidal solution of arsenious sulphide is negatively charged, when $AlCl_3$ is added the Al^{3+} ions (effective ion) coagulates the negatively charged arsenious sulphide sol. Or coagulation / precipitation takes place.

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

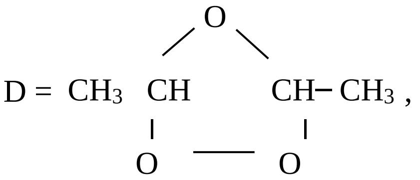
(b) A ketone A (C_4H_8O) which undergoes Iodoform reaction gives compound B on reduction. B on heating with conc.H_2SO_4 at 443 K gives a compound C which forms ozonide D. D on hydrolysis with Zn dust gives only E. Identify the compounds A to E. Write the Iodoform reaction with compound A.

Comments of Examiners	Suggestions for Teachers
(a) (i) Instead of using bimolecular hydrogen (H_2), some candidates used nascent hydrogen for the conversion of benzoyl chloride to benzaldehyde. The conditions for the reaction was also not correctly shown by some candidates. (ii) Most candidates answered this question correctly. Some used alternate methods for conversion of methyl chloride to acetic acid, which involved more steps. (iii) Many candidates were able to convert acetic acid to methane. Some did not mention the condition/s and the by-product. (b) Many candidates wrote 'A' as acetone instead of butanone though the molecular formula C_4H_8O was given in the question. Subsequently, the rest of the compounds were also identified incorrectly. Some candidates wrote that the ozonide product 'D' was ethylene ozonide or butylene ozonide in place of ozonide product of but-2-ene. A large number of candidates either forgot to write iodoform reaction of compound 'A' or mentioned incomplete iodoform reaction.	▪ *Explain the named organic reaction, i.e. Rosenmund's reaction with proper conditions.* ▪ *Give more emphasis on the conversion of organic compounds.* ▪ *Train students for identification of organic compounds by giving frequent practice in class.*

MARKING SCHEME

Question 13

(a)	(i)	$C_6H_5COCl + H_2 \xrightarrow[\text{boiling xylene}]{Pd/BaSO_4,\, S} C_6H_5CHO + HCl$
	(ii)	$CH_3Cl + KCN \longrightarrow CH_3CN \xrightarrow{H^+/H_2O} CH_3COOH$
	(iii)	$CH_3COOH + NaOH \longrightarrow CH_3COONa \xrightarrow[(CaO)]{+NaOH} CH_4 + Na_2CO_3$
OR		

(b)	$A = CH_3COCH_2CH_3$, $B = CH_3CHOHCH_2CH_3$, $C = CH_3CH = CH - CH_3$ D =  E = CH_3CHO (either name or formula) Iodoform reaction with compound A: $CH_3COCH_2CH_3 + 3I_2 + 4NaOH \longrightarrow CHI_3 + C_2H_5COONa + 3NaI + 3H_2O$

Question 14

[3]

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

Comments of Examiners	Suggestions for Teachers
A large number of candidates used incorrect formula for the rate of first order reaction. They used T_1 in place of T_2 or incorrectly substituted the values of k_1 and k_2. In logarithm formula many candidates did not use the constant value 2.303.	▪ *Give more practice in numerical problems based on Arrhenius equation and determination of rate constant of 1st order reaction.*

MARKING SCHEME

Question 14

Given: $T_1 = 300$ K, $T_2 = 320$ K, $R = 8{\cdot}314\ JK^{-1}\ mol^{-1}$

For first order reaction rate = $k = \frac{0{\cdot}693}{t}$

At 300 K; $k_1 = \frac{0{\cdot}693}{30} = 0{\cdot}0231\,\text{min}^{-1}$

At 320 K; $k_2 = \frac{0{\cdot}693}{10} = 0{\cdot}0693\,\text{min}^{-1}$

$$\log\frac{k_2}{k_1} = \frac{Ea}{2{\cdot}303R}\left(\frac{T_2 - T_1}{T_2 \times T_1}\right)$$

OR

$$\log\frac{0{\cdot}0693}{0{\cdot}0231} = \frac{Ea}{2{\cdot}303 \times 8{\cdot}314}\left(\frac{320 - 300}{320 \times 300}\right)$$

$E_a = 43{,}839 \cdot 29 \text{ J mol}^{-1}$ **OR**

$E_a = 43.839 \text{kJ mol}^{-1}$

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.

Comments of Examiners	Suggestions for teachers
(i) Some candidates did not mention that transition metal ions have vacant d-orbitals or partially filled d-orbitals. Hence, they are paramagnetic. (ii) Many candidates went wrong by using the word *Lanthanoid contraction*. Some candidates did not explain the cause of increase in density of elements from titanium to copper in the 3d series of transition elements. (iii) Most of the candidates did not use the words *nascent oxygen is liberated* or $K_2Cr_2O_7$ is *reduced to* $Cr_2(SO_4)_3$.	▪ *Teach the important properties of d-block elements in detail.* ▪ *Advise students to use key words while giving explanation.* ▪ *Give emphasis on the periodic properties of transition elements and how they vary in groups and periods.* ▪ *Point out the oxidising property of* $K_2Cr_2O_7$ *in acidic medium by giving suitable examples.*

MARKING SCHEME

Question 15

(i)	Transition metal ions have unpaired electrons in d-orbitals ($d^1 - d^9$). They exhibit paramagnetic behaviour.
(ii)	As we move from left to right along the 3d transition series (from Ti to Cu) the atomic radii decrease due to increase in nuclear charge. Therefore, atomic volume decreases with increase in atomic mass. Hence, density of transition metal increases from Ti to Cu.
(iii)	In acidic medium $K_2Cr_2O_7$ liberates nascent oxygen which oxidises the other substances hence, it acts as a strong oxidising agent.

	OR $K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3[O]$

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 ^oC. 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^{o}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 1·23 g of calcium nitrate in 10 g of water, boils at 100·975^{o}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})

Comments of Examiners	Suggestions for Teachers
(a) (i) Most of the candidates calculated the molecular weight (observed) only. They did not calculate the van't Hoff factor and did not state that acetic acid associates or dimerises in solution based on the value of van't Hoff factor. (ii) Majority of candidates did not use 'i' to calculate osmotic pressure. Many wrote van't-Hoff factor = '2' instead of '3' in spite of *complete dissociation of solute* being mentioned in the question. (b) (i) (1) The molality of solution was calculated correctly by most of the candidates.	▪ *Give sufficient practice in numerical problems based on molecular weights of non-volatile substances.* ▪ *Advise students to use the formula of van't Hoff factor during dissociation and association.* ▪ *Explain clearly to students that the boiling point of aqueous solution of non-volatile solute is always more than the boiling point of the solvent, i.e. water.*

(2) The elevation in boiling point i.e. ΔT_b was calculated correctly by most of the candidates. In some cases, to obtain the boiling point of solution, instead of adding the value of ΔT_b to the boiling point of solvent (373 K), candidates subtracted the value of ΔT_b and got the incorrect answer.

(3) The lowering of vapour pressure of water was not calculated correctly by most of the candidates. By using Raoult's Law, the value of $P_o - P_s$ or ΔP can be calculated. Some candidates neither used the correct formula nor the correct substitution.

(ii) Most of the candidates attempted this part well. A few calculated the value of van't Hoff factor, 'i' incorrectly.

- *Explain the Raoult's law and the formula, $(P_o-P_s)/P_o = n/N$ to the students. Give more numerical problems based on the above formula.*
- *Teach the correct formula to obtain the molecular mass (observed), when determined by elevation of boiling point method.*
- *Explain the steps for calculation of value 'i' when M(calculated) and M(observed) are known.*

MARKING SCHEME

Question 16

(a)	(i)	Given w = 0.30 g of acetic acid, W = 100 g of benzene $\Delta T_b = 0{\cdot}0633\text{K}$, $K_b = 2{\cdot}53$ K kg mol^{-1} (for benzene) Normal molecular weight of CH_3COOH = 60 $M = \dfrac{1000.K_b \times w}{\Delta T_b \times W}$ M (observed) = $\dfrac{1000 \times 2 \cdot 53 \times 0 \cdot 30}{0 \cdot 0633 \times 100} = 119 \cdot 9\, g\, mol^{-1}$ van't Hoff factor (i) = Normal molecular weight/Observed molecular weight $= \dfrac{60}{119 \cdot 9} = 0 \cdot 5004 \approx 0 \cdot 5$ Hence, acetic acid associates or dimerises in benzene.
	(ii)	Given: w = 0·025 g of K_2SO_4, Volume (V = 2 litres) T = 273 + 25 ^{o}C= 298 K, m = 174 g mol^{-1} R = 0·0821 Lit-atm K^{-1} mol^{-1} $\pi = ?$ $K_2SO_4 \longrightarrow 2K^+ + SO_4^{2-}$ i = 3

		$\pi \times V = i.\frac{w}{m}RT$ $\pi \times 2 = \frac{3 \times 0\cdot025 \times 0\cdot0821 \times 298}{174}$ **OR** $\pi = \frac{3 \times 0\cdot025 \times 0\cdot0821 \times 298}{2 \times 174}$ $\pi = \frac{1\cdot8349}{348} = 5\cdot27 \times 10^{-3} atm$	
(b)	(i)	(1)	The molality of solution: $\Delta T_f = K_f m$ $\Delta T_f = T_o - T_s$ $= 273\cdot0 - 272\cdot4$ $= 0\cdot6$ K $\therefore m = \frac{0\cdot6}{1\cdot86} = 0\cdot3225 m$
		(2)	Boiling point of solution: $\Delta T_b = K_b m$ $= 0\cdot512 \times 0\cdot3225$ $\Delta T_b = 0\cdot165 K$ $T_s = T_o + \Delta T_b$ $= 373 + 0\cdot165$ $= 373\cdot165$ K or $100\cdot165^{o}$C
		(3)	The lowering of vapour pressure of water at 298 K: $\frac{P_o - P_s}{P_o} = \frac{n}{N}$ **OR** $\frac{Po - Ps}{Po} = \frac{w}{m} \times \frac{M}{W}$ **OR** $\frac{P_o - P_s}{23\cdot756} = \frac{0\cdot3225}{1000} \times 18$ **OR** $\therefore P_o - P_s = \frac{0\cdot3225 \times 18}{1000} \times 23\cdot756$

			$(P_o - P_s)$ *or* $\Delta P = 0\cdot1379$ mm of Hg
	(ii)	Given: $w = 1\cdot23g$ $W = 10g$ $\Delta T_b = 100\cdot975 - 100 = 0\cdot975$ $K_b = 0\cdot52$ K kg mol^{-1} M(observed) = $\frac{1000K_b w}{W\Delta T_b}$ **OR** $= \frac{1000\times0\cdot52\times1\cdot23}{10\times0\cdot975}$ M(observed) = 65·6 Van't Hoff factor(i) = $\frac{M(calculated)}{M(observed)} = \frac{164}{65\cdot6}$ i = 2·5 alternate method $i = \frac{M(calculated)\times \Delta Tb \times W}{1000 \times Kb\times w}$ or $\frac{164\times0.975\times10}{1000\times0.52\times1.23}$ $\frac{1599}{639.6}$ = 2.5	

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)

Comments of Examiners	Suggestions for Teachers
(a) (i) (1) IUPAC name of $[Cu\ (NH_3)_4]SO_4$: Instead of writing tetraammine copper (II) sulphate, some candidates wrote *tetraamino*. A few candidates calculated incorrect oxidation state of the central metal atom. (2) IUPAC name of $[Co(en)_2Cl_2]$: Some candidates wrote *diethylenediamine*, which was incorrect. Correct alphabetical order of ligands was not used in several cases; i.e. first 'chlorido' then 'ethylenediamine'. The oxidation number of cobalt was not calculated correctly. Instead of oxidation number (II), some candidates wrote (III) or (IV). (3) IUPAC name of $K_3[Al(C_2O_4)_3]$: Instead of writing *potassium* trioxalatoaluminate (III), some candidates wrote '*trisoxalato*' and in place of *aluminate*, they wrote *aluminium*. The oxidation number of the central metal atom was however calculated correctly. (ii) (1) For $[Fe(H_2O)_6]^{2+}$, some of the candidates did not write *ion* with the IUPAC name. (2) The oxidation number of central metal atom was calculated correctly by most of the candidates. (3) The number of unpaired electrons were not reported correctly by some candidates. Instead of *four* unpaired electrons, some candidates wrote the number of unpaired electrons as *two*. (4) Most of the candidates wrote that the type of hybridization was sp^3d^2, but some candidates wrote 'd^2sp^3 hybridisation'.	▪ *Clarify general rules for the IUPAC nomenclature of coordination compound and give adequate practice in calculating the* oxidation number *of the central metal atom or ion.* ▪ *Tell students that when the IUPAC name of any coordination complex ion is written, at the end, the word ion must be written.* ▪ *Explain the valence bond theory in detail to students.* ▪ *Teach the structural isomerism of coordination compound in detail to the students.*

(b) (i) (1) Most of the candidates wrote *linkage isomerism* which was the correct answer.

(2) The correct answer was *hydrate isomerism* or *solvate isomerism*, but some candidates wrote *solvation isomerism*.

(3) The correct answer was *coordination isomerism*, but candidates wrote *coordinate isomerism*.

(ii) For the coordination compound [Ni $(CO)_4$], some of the candidates wrote the shape as *square planer* instead of *tetrahedral*. For magnetic behaviour, a number of candidates wrote *paramagnetic* instead of *diamagnetic*.

MARKING SCHEME

Question 17

(a)	(i)	(1)	tetraamminecopper(II) sulphate.
		(2)	dichloridobis (ethylenediamine) cobalt (II)
		(3)	Potassium trioxalatoaluminate(III)
	(ii)	(1)	hexaaquairon (II) ion
		(2)	+2
		(3)	Four unpaired electrons
		(4)	sp^3d^2 **OR**
(b)	(i)	(1)	Linkage isomerism
		(2)	Hydrate isomerism or Solvate Isomerism
		(3)	Coordination isomerism
	(ii)	[$Ni(CO)_4$] Shape – tetrahedral Hybridisation –sp^3 Magnetic behaviour – diamagnetic	

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:

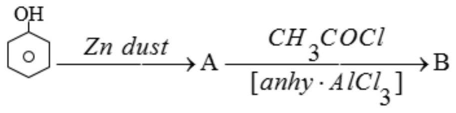
(1) Williamson's synthesis.

(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)


Comments of Examiners	Suggestions for Teachers
(a) (i) (1) Most of the candidates were able to write the correct product i.e. p-hydroxyazobenzene but the by-product, i.e. (HCl) was not written by many. (2) Most of the candidates were able to write the correct balanced chemical equation. (3) Most of the candidates were able to write the correct balanced chemical equation. A few candidates were not able to write the by-product, otherwise.	▪ *Stress upon writing correct balanced chemical equations. Give more emphasis on named organic reactions.* ▪ *Insist the students to write the by-product in all organic reactions.* ▪ *Perform the chemical test in laboratory for better understanding.*

(ii) (1) Some candidates mentioned only the name of the test, but the observation was not written. In several cases, incorrect obsession was given.

(2) Most of the candidates used Lucas test to distinguish between propan-1-ol and propan-2-ol, but in a few cases, the observation given was incorrect.

(b) (i) (1) For Williamson's synthesis, some candidates used C_2H_5OH instead of C_2H_5ONa. Ether was obtained as the main product, but the by-product was not mentioned in a few cases.

(2) For Esterification reactions, most of the candidates used carboxylic acid and alcohol to form ester and water which was correct, but conc. H_2SO_4 was not used by some of the candidates.

(3) For Reimer-Tiemann reaction, many candidates were not able to write the equation correctly - either the main product was incorrect or in some cases the by-product was missing. A few candidates were not able to give the balanced equation.

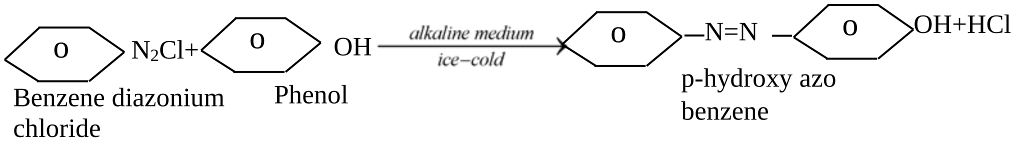
(ii) (1) Most of the candidates identified compound A i.e. CH_3CHO correctly. However, they went wrong by writing only 'aldol' as compound 'B', instead of writing $CH_3CHOHCH_2CHO$.

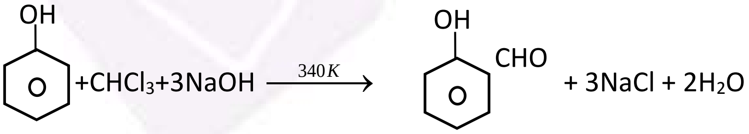
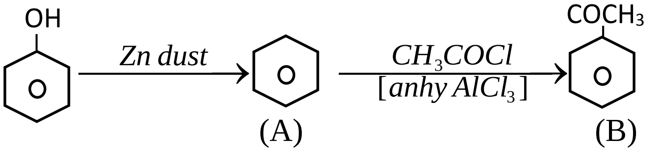
(2) Compound 'A' i.e. Benzene was identified correctly by most of the candidates. But compound 'B', i.e. $C_6H_5COCH_3$ was not identified correctly by many.

- *Insist that the students use the proper reagent and correct observation to distinguish between a pair of organic compounds.*
- *More practice should be given in identification of organic compounds.*

MARKING SCHEME

Question 18

(a)	(i)	(1)	
		(2)	$C_2H_5OC_2H_5 + PCl_5 \longrightarrow 2C_2H_5Cl + POCl_3$ diethyl ether phosphorus pentachloride Ethyl chloride

		(3)	$C_2H_5OH + SOCl_2 \longrightarrow C_2H_5Cl + SO_2\uparrow + HCl$ Ethyl alcohol Thionyl Chloride Ethyl chloride
	(ii)	(1)	Ethanol + I_2+ alkali $\xrightarrow{\Delta}$ gives yellow precipitate of Iodoform having characteristic odour. Dimethyl ether does not respond to this test. **Or** Ethanol + Acetic acid $\xrightarrow[H_2SO_4]{conc}$ Fruity smelling compound ester is formed. Dimethyl ether does not respond to this test. (*or any other relevant chemical test*)
		(2)	Propan-1-ol + Lucas reagent (conc. HCl and anhydrous zinc chloride) – shows no turbidity at room temperature. Propan-2-ol + Lucas reagent $\longrightarrow$ forms turbidity within five minutes at room temperature. (*or any other relevant chemical test*)
OR			
(b)	(i)	(1)	Williamson's synthesis $C_2H_5ONa + C_2H_5Cl \longrightarrow C_2H_5\text{-}O\text{-}C_2H_5 + NaCl$
		(2)	Esterification reaction $CH_3COOH + C_2H_5OH \xrightarrow{H2SO4(conc)} CH_3COOC_2H_5 + H_2O$
		(3)	Reimer-Tiemann reaction 
	(ii)	(1)	$C_2H_5OH \xrightarrow[\Delta]{Cu} CH_3CHO \xrightarrow{dil.NaOH} CH_3CHOHCH_2CHO$ (A) (B) (*either name or formula*)
		(2)	 (*either name or formula*)

NOTE: For questions having more than one correct answer/solution, alternate correct answers / solutions, apart from those given in the marking scheme, have also been accepted.

GENERAL COMMENTS

Topics found difficult/ confusing by candidates

- Numerical problems based on molar conductivity, Nernst equation, degree of association, calculation of activation energy, calculation of molality and lowering of vapour pressure.
- IUPAC nomenclature, isomerism, and hybridisation of coordination compounds.
- Reasoning questions of transition elements and colloidal state.
- Named organic reactions, conversion of organic compound.
- Extraction of silver.
- Outer orbital complex and its hybridisation.
- Antiseptics and disinfectants and their examples.
- Transition elements and their properties.
- Test to distinguish between organic compounds.
- Colloidal solutions and their properties.
- Nomenclature and isomerism of coordination compounds.
- Kohlrausch's law and its application.

Suggestions for Students

- Avoid selective study. Give equal importance to all the topics.
- Practice more numerical problems. While solving numerical problems follow proper steps i.e. formula, substitution, and correct answer with unit.
- Learn to write the complete balanced chemical equations along with the conditions in inorganic and organic chemistry.
- Learn distinguishing tests of various organic compounds with observations.
- Be very regular in studies.
- Learn to write the key words in the answer.
- Do not waste time in attempting extra questions given as internal choice.
- Keep enough time for rechecking and avoid careless mistakes.
- Utilise the additional reading time given to read the question paper.