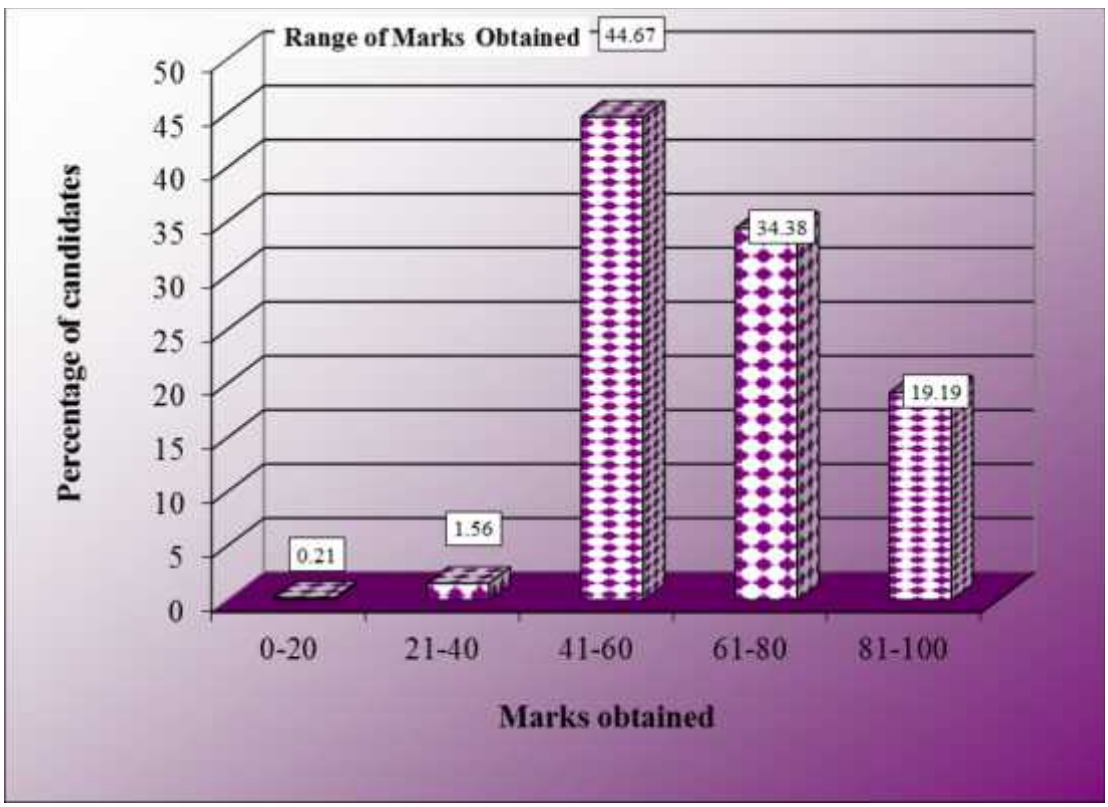
CHEMISTRY

A. STATISTICS AT A GLANCE

Total number of students taking the examination	35,095
Highest marks obtained	100
Lowest marks obtained	14
Mean marks obtained	65.06

Percentage of candidates according to marks obtained

	Mark Range				
	0-20	***21-40***	***41-60***	***61-80***	***81-100***
Number of candidates	72	549	15676	12065	6733
Percentage of candidates	0.21	1.56	44.67	34.38	19.19
Cumulative Number	72	621	16297	28362	35095
Cumulative Percentage	0.21	1.77	46.44	80.81	100



B. ANALYSIS OF PERFORMANCE

CHEMISTRY PAPER 1 (THEORY)

PART I (20 Marks)

*Answer **all** questions.*

Question 1

(a) Fill in the blanks by choosing the appropriate word/words from those given in the brackets: **[5]**

(increases, formic acid, decreases, less, zero, small, paired, atoms, unpaired, ions, pentagonal bipyramidal, electrical, more, ethylamine, molecules, propanoic acid, methylamine, chemical)

(i) An electrochemical cell converts _____ energy to _____ energy.

(ii) The crystal of graphite is made up of _____ while that of sodium chloride is made up of _____.

(iii) Ethyl isocyanide, on hydrolysis with dilute sulphuric acid, gives _____ and _____ .

(iv) The molar conductance of a solution _____ with dilution, while its specific conductance _____ with dilution.

(v) The Van't Hoff factor of acetic acid solution is _____than one and the value of normal colligative property is _____ than the observed colligative property of this solution.

(b) Complete the following statements by selecting the **correct alternative from** the choices given:- **[5]**

(i) Of the following terms used for denoting concentration of a solution, the one which does not get affected by temperature is:

(1) Molarity
(2) Molality
(3) Normality
(4) Formality

(ii) The solubility of calcium hydroxide is s mol litre^{-1}. The solubility product under the same condition will be:

(1) $4s^3$
(2) $2s^3$
(3) $2s^2$
(4) s^3

(iii) A current liberates 0·50g of hydrogen in 2 hours. The weight of copper (at.wt.= 63·5) deposited at the same time by the same current through copper sulphate solution is:

(1) 63·5 g

(2) 31·8 g

(3) 15·9 g

(4) 15·5 g

(iv) Natural rubber is a:

(1) Polyester

(2) Polyamide

(3) Polyisoprene

(4) Polysaccharide

(v) Among the following halogens, the one which does not form an oxyacid is:

(1) Fluorine

(2) Chlorine

(3) Bromine

(4) Iodine

(c) Answer the following questions: **[5]**

(i) What is the $[OH^-]$ concentration of an acid whose pH is 5 at 25^oC?

(ii) What happens when a nickel rod is dipped into a copper sulphate solution? Justify your answer.

$$\left[E^0_{Ni^{+2}/Ni} = -0 \cdot 25v \text{ and } E^0_{Cu^{+2}/Cu} = +0 \cdot 34v \right]$$

(iii) Write the equation for the preparation of acidanilide from aniline.

(iv) Define Raoult's law for the elevation of boiling point of a solution.

(v) An ionic compound is made up of A cations and B anions. If A cations are present at the alternate corners and B anion is present on the body of the diagonal, what is the formula of the ionic compound?

(d) Match the following: **[5]**

(i)	Molal depression constant	(a)	Infinite dilution
(ii)	Acetaldehyde	(b)	mol l^{-1} sec^{-1}
(iii)	Rate of reaction	(c)	Iodoform
(iv)	Optical activity	(d)	K Kg mol^{-1}
(v)	Kohlrausch's law	(e)	Lactic acid

Comments of Examiners

(a) (i) Some candidates wrote the answers in the reverse order. The correct answer was 'chemical' and 'electrical' respectively, but some candidates wrote 'electrical' and 'chemical' instead.

(ii) The crystal of graphite is made up of atoms. Some candidates wrote that the crystal of graphite is made up of molecules, which is not correct. Many candidates wrote that NaCl is made up of molecules instead of ions.

(iii) Some candidates wrote the formula instead of writing in words. Several candidates wrote 'propanoic acid' in place of 'formic acid' and 'methyl amine' in place of 'ethyl amine'.

(iv) Several candidates wrote the answer as 'decreases' and 'increases' while the correct answer was vice versa.

(v) Candidates were not clear whether Vant Hoff factor is less or more than one. Many candidates were confused whether acetic acid will associate or disassociate in solution.

(b) (i) Some candidates wrote 'molarity' instead of 'molality'.

(ii) The candidates were not very clear regarding the relationship between solubility (S) and solubility product (K_{sp}) for different kinds of weak electrolytes and hence wrote wrong answers.

(iii) Many candidates wrote 15.5 or 31.8 as answer whereas the correct answer was 15.9.

(iv) Some candidates gave the answers as 'polyamide' or 'polyester', whereas the correct answer was 'polyisoprene'.

(v) Most of the candidates were not able to write the correct option i.e. Fluorine.

Suggestions for teachers

- Explain the working of galvanic cell properly. The difference between electrolytic and electrochemical cell should be taught properly with the help of a diagram.
- In solid state, the type of crystals and their constituent particles must be clearly taught to students.
- Characteristics of different types of crystalline solids should be explained in tabular form.
- Tell students that the blanks must be filled with the options as given in brackets.
- The chemical properties of alkyl isocyanides should be taught in detail with specific examples.
- The relationship between specific conductance and molar conductance must be explained properly.
- The effect of dilution on specific and molar conductance should be explained to students.
- Students must be explained that only molality has weight term which is not affected by temperature whereas other options have volume term which depend on temperature.

(c) (i) Some candidates calculated pOH value instead of $[OH^-]$ concentration. Many candidates calculated the $[OH^-]$ concentration as 10^{-5} moles per litre instead of 10^{-9} moles/litre.

(ii) Some candidates wrote that Cu will displace Ni which was not correct. Some candidates did not mention that lower reduction potential of Nickel is responsible for displacing Copper from $CuSO_4$ solution when Ni rod is dipped into $CuSO_4$ solution.

(iii) A number of candidates were confused as they did not understand that acid anilide is also known as acetanilide. Some candidates wrote the reaction between aniline and acetic acid instead of aniline with acid chloride.

(iv) Most of the candidates defined Raoult's law directly as, "lowering of vapour pressure is directly proportional to molality" instead of "The elevation of boiling point is directly proportional to molality."

(v) Candidates were able to score marks in this part.

(d) Most of the candidates attempted this part correctly. Some candidates wrongly matched 'molal depression constant' with 'mol lit^{-1} sec^{-1}' and 'rate of reaction' with 'K kg $mole^{-1}$'.

- The relationship between solubility (S) and solubility product (K_{sp}) must be explained to candidates by taking different kinds of weak electrolytes.
- The relationship between Faraday and equivalent weight should be told properly to candidates.
- The calculation of $[H^+]$ concentration and $[OH^-]$ concentration and their relationship with pH value must be explained to students.
- Nomenclature of organic compounds should be taught in detail. Insist that students write complete and balanced equation.
- Definition of Raoult's law should be taught in different terms i.e. relative lowering of vapour pressure and elevation in boiling point.
- Calculation of number of atoms, cations and anions in different types of crystals must be taught properly.
- Explain the method for deriving units for the rate of reaction and molal depression constant.

MARKING SCHEME

Question 1.

(a)

(i) chemical, electrical

(ii) atoms, ions

(iii) formic acid, ethylamine (or vice versa)

(iv) increases, decreases

(v) less, more (or vice versa)

(b)

(i) (2) Molality

(ii) (1) $4s^3$

(iii) (3) 15·9

(iv) (3) Polyisoprene

(v) (1) Fluorine

(c)

(i) $[OH^-] = 10^{-9}$ moles/lit.

(ii) Ni displaces Cu from the solution due to its lower reduction potential.

(iii) $C_6H_5NH_2+CH_3COCl \rightarrow C_6H_5NHCOCH_3+HCl$ [Any Acid Chloride or any acid anhydride in place of CH_3COCl]

(iv) The elevation of b.p. is directly proportional to molality.

(v) AB_2

(d)

(i)	Molal depression constant	(d)	K kg mol^{-1}
(ii)	Acetaldehyde	(c)	Iodoform
(iii)	Rate of reaction	(b)	mol $l^{-1}sec^{-1}$
(iv)	Optical activity	(e)	lactic acid
(v)	Kohlraush's law	(a)	Infinite dilution

PART II (50 Marks)

Answer **six** *questions choosing* **two** *from* ***Section A****,* **two** *from* ***Section B*** *and* **two** *from* ***Section C****.*

SECTION A

Answer any **two** *questions.*

Question 2

(a) (i) What will be the vapour pressure of a solution containing 5 moles of sucrose ($C_{12}H_{22}O_{11}$) in 1 kg of water, if the vapour pressure of pure water is 4·57 mm of Hg? [C = 12, H = 1, O = 16] **[3]**

(ii) A 2 molal solution of sodium chloride in water causes an elevation in the boiling point of water by 1·88 K. What is the value of Van't Hoff factor? What does it signify? [K_b = 0·52 K kg mol^{-1}] **[2]**

(b) (i) Write the mathematical expression relating the variation of rate constant of a reaction with temperature. **[4]**

(ii) How can you graphically find the activation energy of the reaction from the above expression?

(iii) The slope of the line in the graph of log k (k = rate constant) versus $\frac{1}{T}$ is – 5841.

Calculate the activation energy of the reaction.

(c) Define Frenkel defect in solid crystal. **[1]**

Comments of Examiners

(a) (i) Instead of substituting the value of number of moles as '5' some candidates took the weight of sucrose as '5 grams'. Several candidates did wrong substitution and took approximate values, hence did not get the correct answer.

(ii) Most of the candidates calculated the correct value of Van't Hoff factor. However, a few could not write the importance or significance of this value.

(b) (i) Some candidates wrote incorrect mathematical expressions. Instead of writing $K = A_e^{-Ea/RT}$ candidates were confused with the base factor i.e. base 'e' or base '10'.

(ii) Many candidates did not plot the graph. Some candidates did not mention the axis of the graph. In some cases, the slope was not written with a negative sign.

(iii) A few candidates used a wrong formula E_a = - slope x R instead of using the correct formula E_a = - 2.303 x slope x R. Some candidates used a different numerical value of R (gas constant). Many candidate wrote the answer with a wrong unit.

(c) Some candidates wrote that anions leave their original site and move to an interstitial position which is incorrect.

Suggestions for teachers

- Enough practice should be given in numericals. Students must be told to solve the numerical step wise i.e. first the formula then substitution and finally the calculation. Answers should be given with the correct unit.
- The relationship between the value of Van't Hoff factor (i) and disassociation, or association of solute must be clearly explained to students. Mention the significance of (i) as = 1, i < 1, i > 1.
- Teach students to write all the correct mathematical expressions (i.e. all the forms of Arrhenius equation).
- Explain the calculation of activation energy (E_a) by graphical representation.
- The various imperfections found in crystal lattice should be properly explained to students.

MARKING SCHEME

Question 2.

(a) (i) $$\frac{P^o_{water} - P^o_{solution}}{P^o_{water}} = X_{sucrose}$$

$$\therefore X_{sucrose} = \frac{n_2}{n_1 + n_2} = \frac{5}{5 + \frac{1000}{18}} = \frac{5}{60 \cdot 5} = 0 \cdot 083$$

$$\therefore \frac{P^o - P}{P^o} = 0{\cdot}083$$

$P^o - P = 0{\cdot}083 \times P^o = 0{\cdot}083 \times 4{\cdot}57 = 0{\cdot}38$

$\therefore P = P^o - 0{\cdot}38 = 4{\cdot}57 - 0{\cdot}38 = 4{\cdot}19$ mm of Hg

(ii) $\Delta T_{b(expected)} = 0{\cdot}52 \times 2 = 1{\cdot}04$ K

$\Delta T_{b(observed)} = 1{\cdot}88$

$$i = \frac{\Delta T_{b(observed)}}{\Delta T_{b(expected)}} = \frac{1{\cdot}88}{1{\cdot}04} = 1{\cdot}80 \approx 2$$

$\therefore$ NaCl dissociates in two particles.

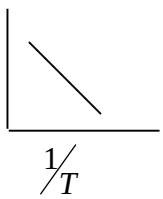
(b) (i) $k = Ae^{-E_a/RT}$

k = rate constant

A = collision factor

E_a = activation energy

(ii)



$$\text{Slope} = -\frac{E_a}{2{\cdot}303R}$$

(iii) $\therefore Ea = -2{\cdot}303 \times \text{slope} \times R$

$= -2{\cdot}303 \times -5841 \times 8{\cdot}314$

$= 111838{\cdot}4$ J mol^{-1}

$= 111{\cdot}8$ KJ mol^{-1}

(c) In a solid crystal lattice when a cation leaves its original site and moves to an interstitial position, the defect is known as Frenkel defect.

Question 3

(a) Explain giving reasons why: **[4]**

(i) Ionic solids conduct electricity in molten state, but not in solid state.

(ii) Solution of sodium chloride has no effect on litmus, but a solution of zinc chloride turns blue litmus red.

(b) In a crystal of diamond: **[2]**

(i) How many carbon atoms are present per unit cell?

(ii) What type of lattice does diamond crystallize in?

(iii) How many carbon atoms surround each carbon atom?

(iv) How are they arranged?

(c) (i) What is standard hydrogen electrode? **[1]**

(ii) 0·05 M NaOH solution offered a resistance of 31·6 ohm in a conductivity cell at 298 K. If the cell constant of the cell is 0·367 cm^{-1}, calculate the molar conductivity of the NaOH solution. **[3]**

Comments of Examiners

(a) (i) Most of the candidates failed to write that in solid state ions are held by strong electrostatic forces of attraction hence not free to conduct electricity whereas in molten state, ions are free to conduct electricity. Some candidates were confused between electrons and ions.

(ii) Many candidates failed to write that NaCl is a salt of strong acid and strong base and does not hydrolyse - hence the solution is neutral; zinc chloride is a salt of strong acid and weak base and undergoes cationic hydrolysis, hence the solution is acidic.

(b) (i) Most of the candidates answered this part correctly.

(ii) Some candidates gave the answer as, hexagonal closed packing or octahedral.

(iii) In this part, some candidates wrote eight or twelve instead of four.

(iv) Instead of writing that they are arranged in a tetrahedral manner, some candidates wrote sp3.

(c) (i) For standard hydrogen electrode, the conditions i.e. $[H^+]$ should be 1M, temp = 298 K, pressure 1 atm were missing from many of the answers given by candidates.

(ii) Most of the candidates wrote wrong unit of molar conductance.

Suggestions for teachers

- More emphasis should be laid on reasoning type of questions in chemical bonding.
- Teachers should explain the meaning of cation hydrolysis and anion hydrolysis and that a salt of strong acid and strong base does not undergo hydrolysis. The behaviour or limits to various type of solutions should be explained.
- Structure of diamond should be taught with the ball and stick model or with a 3-D diagram. The following points must be emphasized:
  - Type of lattice
  - No. of atoms per unit cell
  - Coordination number of each carbon atom
  - Hybridization
  - Arrangement of atoms
  - Properties
- Standard hydrogen electrode should be taught with diagram along with all relevant conditions.
- Derivation of unit with the help of formula should be clearly explained to students.

MARKING SCHEME

Question 3.

(a) (i) Ionic solids are bad conductors in the solid state because their constituent ions are held together in fixed positions by strong attractive forces. However, they conduct electricity in the molten state because of the presence of free ions.

(ii) $ZnCl_2$ is a salt of weak base and strong acid and undergoes cation hydrolysis. NaCl is a salt of strong acid and strong base and does not hydrolyse.

(b) Diamond crystallizes in

(i) Eight carbon atoms are present in a unit cell of diamond.

(ii) Face centred cubic (fcc) structure.

(iii) Four carbon atoms surround each carbon

(iv) They are arranged in a tetrahedral manner.

(c) (i) Standard Hydrogen Electrode (SHE)

Standard hydrogen electrode is set up by passing pure hydrogen gas at 1 atm pressure in a solution of H^+ (H_3O^+)ions of concentration of 1 mol L^{-1} in contact with a platinised platinum foil at 25°C. A standard hydrogen electrode can be represented as

$$Pt, H_2\ (g)\ (1\ atm)\ /\ H^+(1\ mol)\ at\ 25^oC$$

(ii) Conductance = 1 / R = 1 / 31.6 ohm^{-1}

Specific conductance , $\kappa = (1/31.6)\ ohm^{-1} \times (0.367\ cm^{-1})$

$$\text{Molar conductance} = \frac{© \times 1000}{C} = \frac{0.0116 \times 1000}{0.05} = \underline{232\ ohm^{-1}\ cm^2\ mol^{-1}}$$

Question 4

(a) (i) K_c for the reaction $SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons SO_{3(g)}$ is 61·7 at 60°C. What is its unit? Calculate K_p for the reaction and write its unit. **[3]**

(ii) What happens to the equilibrium in a reversible reaction if a catalyst is added to it? **[1]**

(b) State the effect of the following on the reaction $2SO_{2(g)}+O_{2(g)} \rightleftharpoons 2SO_{3(g)}+189{\cdot}4$ kJ at equilibrium: **[2]**

(i) Temperature is increased.

(ii) Concentration of SO_2 is increased.

(iii) Pressure is decreased.

(iv) Helium is added at constant pressure.

(c) (i) 0·3605 g of a metal is deposited on the electrode by passing 1·2 amperes of current for 15 minutes through its salt solution. The atomic weight of the metal is 96. What is the valency of the metal? **[3]**

(ii) Explain why phenolphthalein is used as an indicator in acid-base titration. **[1]**

Comments of Examiners

(a) (i) Some candidates wrote the unit of K_c and K_p incorrectly. The calculation of K_p was also not done correctly by a few candidates.

(ii) Many candidates wrote that equilibrium attains quickly but did not mention that equilibrium remains unaffected. They did not mention that the catalyst increases the rate of both forward and backward reaction.

(b) (i) Some candidates misunderstood that the reaction is endothermic, hence gave wrong answers.

(ii) The effect of increase in concentration of SO_2 was given correctly by most of the candidates.

(iii) A few candidates wrote that the equilibrium will shift towards right instead of writing that it will shift to the left or backward.

(iv) Some of the candidates gave the answer as 'no effect' instead of writing that the equilibrium will shift to the left or backward.

(c) (i) Some of the candidates wrote wrong formulas for the calculation of eq. wt. As the eq wt. was wrong the valency was also calculated incorrectly.

(ii) Most of the candidates were unable to give the pH range of 8.3 to 10. Several candidates were confused with the change in colour given by phenolphthalein in acidic and basic mediums.

Suggestions for teachers

- Derivation of unit with the help of formula should be taught and adequate practice should be given in solving numericals.
- The properties of catalysts should be explained with proper examples. The characteristics of chemical equilibrium must be taught.
- Le Chatelier's principle should be explained with proper examples. The following points need to be emphasized:
  - Change of concentration at equilibrium
  - Change of temperature
  - Change in pressure
  - Effect of catalyst
  - Addition of inert gas
- Explain the use of Faraday's laws of electrolysis, in calculation of eq. wt. and valency.
- Explain the pH range of phenolphthalein (8.3 to 10) and also $HPh \rightleftharpoons H^+ + Ph^-$
  colourless pink
  Due to CIE it remains colourless in acidic medium and gives pink colour in basic medium.

MARKING SCHEME

Question 4.

(a) (i) Unit = $[\text{mol/lit}]^{-1/2}$

$$\Delta n = 1 - 1\frac{1}{2} = -\frac{1}{2}$$

$K_p = K_c(RT)^{\Delta n}$

$K_p = 61{\cdot}7 \times [0{\cdot}0821 \times (60+273)]^{-\frac{1}{2}}$

$= 11.797 \text{ atm}^{-\frac{1}{2}}$

(ii) When a catalyst is added, the state of equilibrium is not distributed but equilibrium is attained quickly. This is because the catalyst increases the rate of forward and backward reaction to the same extent.

(b) (i) Temperature is increased – the equilibrium will shift to the backward direction as the increase in temperature will be compensated by absorbing heat.

(ii) Concentration of SO_2 is increased – the equilibrium will shift to the right so that additional SO_2 is used up to form SO_3.

(iii) Pressure is decreased – the equilibrium will shift to the left to produce more number of moles.

(iv) Helium is added at constant pressure – it will result in increase in volume. As a result, the number of molecules per unit volume will decrease. This stress is relieved by the formation of more molecules and the equilibrium will shift to the left.

(c) (i) $W = \frac{E_{g\,wt/i\times t}}{96500} \quad \therefore E_{gwt} = \frac{96500 \times 0{\cdot}3605}{1{\cdot}2 \times 15 \times 60} = 32.21$

$$\therefore Valency = \frac{96}{32{\cdot}18} = 2{\cdot}98 \approx 3$$

(ii) Phenolphthalein is a weak organic acid which changes its colour between pH value of 8.3 to 10. It gives pink colour in alkaline medium but is colourless in acidic medium due to common ion effect.

SECTION B

Answer any **two** *questions*

Question 5

(a) Write the formula of the following compounds: **[2]**

(i) Triamminetriaquachromium(III)chloride

(ii) Potassiumhexacyanoferrate(III)

(b) Name the types of isomerism shown by the following pairs of compounds: **[2]**

(i) $[CoCl(H_2O)(NH_3)_4]Cl_2$ and $[CoCl_2(NH_3)_4]Cl.H_2O$

(ii) $[Pt(NH_3)_4][PtCl_6]$ and $[Pt(NH_3)_4Cl_2][PtCl_4]$

(c) For the complex ion of $[Co(NH_3)_6]^{3+}$: **[1]**

(i) State the hybridisation of the complex.

(ii) State the magnetic nature of the complex.

Comments of Examiners

(a) Many candidates gave incorrect formula.
  (i) In place of $[Cr(NH_3)_3(H_2O)_3]Cl_3$ some candidates wrote $[Cr(NH_2)_3(H_2O)_3]Cl_3$.
  (ii) In place of $K_3[Fe(CN)_6]$ some candidates wrote $K_4[Fe(CN)_6]$.

(b) Many candidates gave incorrect answers.
  (i) Instead of 'hydrate isomerism' some wrote 'hydration isomerism'.
  (ii) Instead of 'coordination isomerism' they wrote 'coordinate isomerism'.

(c) Many candidates wrote $sp^3\ d^2$ hybridization in place of $d^2\ sp^3$ hybridization. For the magnetic nature of the complex, the word 'paramagnetic' was written in place of 'diamagnetic'.

Suggestions for teachers

- Explain the nomenclature of coordination compounds with examples.
- Give different examples of isomerism given in the scope of syllabus with correct name and spelling.
- Explain VBT for bonding of coordination compound. Inner orbital and outer orbital complexes should be taught properly.
- Also explain that presence of paired electrons represents diamagnetic character and that of unpaired electrons represent paramagnetic character.

MARKING SCHEME

Question 5.

(a) (i) $[Cr(NH_3)_3(H_2O)_3]\ Cl_3$

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

(b) (i) Hydrate isomerism [or solvate isomerism]

(ii) Coordination isomerism

(c) (i) d^2sp^3

(ii) diamagnetic

Question 6

(a) Write balanced chemical equations for the following reactions: **[3]**

(i) Ozone and lead sulphide.

(ii) Chlorine is passed through hot concentrated NaOH solution.

(iii) Sulphuric acid is treated with phosphorous.

(b) Give reasons for the following: **[2]**

(i) Zn^{+2} salts are white but Cu^{2+} salts are blue in colour.

(ii) Fluorine gives only one oxide but chlorine gives a series of oxides.

Comments of Examiners

(a) Many candidates gave unbalanced equations. Some candidates failed to write the correct products.

(b) (i) Many candidates failed to write about absorption of visible light for excitation of partly filled d – orbital electrons.

(ii) Most of the candidates wrote that fluorine gives only one oxide due to high electronegativity but did not mention that fluorine does not have d orbital whereas chlorine forms series of oxides due to vacant d orbital.

Suggestions for teachers

- Teach the chemical reactions of inorganic compounds in detail. Tell students that when equations are written, balancing is a must.
- Explain the variable covalency of chlorine due to the empty d subshell in chlorine whereas fluorine has no d orbital.

MARKING SCHEME

Question 6.

(a) (i) $PbS + 4\ O_3 \rightarrow PbSO_4 + 4\ O_2$

(ii) $3\ Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$

(iii) $5H_2SO_4+2P \rightarrow 2H_3PO_4+5SO_2+ 2H_2O$

Or

$P_4+10H_2SO_4 \rightarrow 2H_3PO_4+10SO_2+ 4H_2O$

(b) (i) Cu^{2+} salts are coloured because they absorb visible light for excitation of electrons to partly filled d-orbitals. Zn^{2+} salts are colourless because of the absence of partly filled d-orbitals to which the electrons can be oxidized.

(ii) Fluorine does not have d orbital. Chlorine has vacant 3d orbital. Electrons jumps from 3s and 3p orbitals to 3d orbitals.

Question 7

(a) How is potassium dichromate prepared from a sample of chromite ore? Give balanced equations for the chemical reactions involved. **[3]**

(b) For the molecule IF_7: **[2]**

(i) Draw the structure of the molecule.

(ii) State the hybridisation of the central atom.

(iii) State the geometry of the molecule.

Comments of Examiners

(a) Most of the candidates were not able to write all the three balanced equations correctly. Equations were either unbalanced or incomplete. Many candidates just described the preparation of potassium dichromate instead of giving balanced equations.

(b) Some of the candidates showed just seven bonds between iodine and fluorine but geometry (pentagonal bipyramid) was not shown correctly. A few candidates wrote sp^3d^2 hybridization instead of sp^3d^3 hybridization.

Suggestions for teachers

– Preparation of compounds should be taught in terms of reactants, products, conditions, balanced equations, etc.

– Explain the interhalogen compounds, their geometry, hybridization and structure in detail.

MARKING SCHEME

Question 7.

(a) Finely powdered Chromite ore is mixed with soda ash and quick lime. The mixture is then roasted in a reverberatory furnace in presence of excess of air, a yellow mass containing sodium chromate is obtained.

$$4\ FeCr_2O_4 + 8\ Na_2CO_3 + 7\ O_2 \rightarrow 2Fe_2O_3 + 8\ Na_2CrO_4 + 8CO_2$$

(Sodium chromate)

Conversion of sodium chromate to sodium dichromate

Sodium chromate is treated with concentrated sulphuric acid to form sodium chromate.

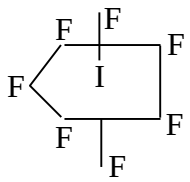
$$2\ Na_2CrO_4 + H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$$

Conversion of sodium dichromate to potassium dichromate

Sodium dichromate solution is heated to concentrate. Now add a calculated quantity of potassium chloride is added. On cooling, the least soluble potassium dichromate separate out as crystals.

$$Na_2Cr_2O_7 + 2\ KCl \rightarrow K_2Cr_2O_7 + 2\ NaCl$$

(b) (i)



(ii) sp^3d^3

(iii) Pentagonal bipyramid.

SECTION C

Answer any **two** *questions.*

Question 8

(a) How can the following conversions be brought about:

(i) Acetic acid to methyl cyanide. **[2]**

(ii) Acetaldehyde to formaldehyde. **[3]**

(iii) Nitrobenzene to 2, 4, 6 tribromoaniline. **[2]**

(b) Identify the reagents A, B, C, D, E and F required for the following conversion: **[3]**

$$C_6H_5NO_2 \xrightarrow{A} C_6H_5NH_2 \xrightarrow{B} C_6H_5N_2^+Cl^- \xrightarrow{C} C_6H_5Cl \xrightarrow{D} C_6H_5OH \xrightarrow{H_2SO_4} E + F$$

Comments of Examiners

(a) (i) Some candidates left the reaction in the middle and could not reach the end product. In some cases, for the conversion of CH_3COOH to CH_3CONH_2 heating was not shown. Similarly, for the conversion of CH_3CONH_2 to CH_3CN heating was not shown.

(ii) The correct reagents were not shown in many cases.

(iii) For the conversion of nitrobenzene to aniline, acidic medium was not used for reduction by several candidates. Instead of Br_2/H_2O, Br_2/CS_2 was used by several candidates.

(b) Many candidates were not able to identify all the reagents correctly. Mainly, the candidates were confused in the identification of E & F. In case of reagent D, only NaOH was written by some candidates in place of NaOH/HCl.

Suggestions for teachers

- Insist that students practice organic conversions stepwise with correct reagents and conditions.
- Stress upon studying organic reactions by writing the equations. Catalysts and conditions should be explained.

MARKING SCHEME

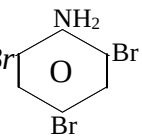
Question 8.

(a) (i) $CH_3COOH \xrightarrow[\Delta]{NH_3} CH_3CONH_2 + H_2O$

$CH_3CONH_2 \xrightarrow[\Delta]{P_2O5} CH_3CN + H_2O$

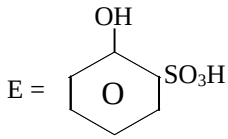
(ii) $CH_3CHO \xrightarrow[H^+]{K_2Cr_2O_7} CH_3COOH \xrightarrow[\Delta]{NH_3} CH_3CONH_2 \xrightarrow{Br_2 / KOH}$

$CH_3NH_2 \xrightarrow[NaNO_2 / HCl]{HONO} CH_3OH \xrightarrow[[O]]{Cu} HCHO$

(iii) $C_6H_5NO_2 \xrightarrow[^-H]{Sn / HCL} C_6H_5NH_2 \xrightarrow{Br_2 / H_2O}$ 

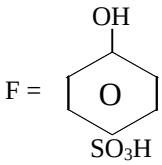
(b) $C_6H_5NO_2 \xrightarrow{A} C_6H_5NH_2 \xrightarrow{B} C_6H_5N_2^+Cl^- \xrightarrow{C} C_6H_5Cl \xrightarrow{D} C_6H_5OH \xrightarrow{H_2SO_4} E+F$

A = Sn / HCl

E = 

B = $NaNO_2$ + HCl & $0^oC - 5^oC$

C = CuCl / HCl

F = 

D = NaOH / HCl

Question 9

(a) The deficiency of which vitamin will cause the following diseases: **[2]**

(i) Scurvy

(ii) Haemorrhages

(b) Give one chemical test to distinguish between the following pairs of compounds: **[3]**

(i) Ethanol and 2 propanol.

(ii) Aniline and ethylamine.

(c) Write the structures of all enantiomers possible for lactic acid. **[1]**

(d) Give balanced equations for the following reactions: **[4]**

(i) Acetaldehyde is heated with hydroiodic acid in the presence of red phosphorous.

(ii) Calcium acetate is subjected to dry distillation.

(iii) Sodium ethoxide is treated with ethyl bromide.

(iv) Benzaldehyde is treated with sodium bisulphite.

Comments of Examiners

(a) Most of the candidates identified Vitamin C correctly but some were confused regarding the vitamin, the deficiency of which causes haemorrhages.

(b) Some candidates gave those chemical tests which are given by both the compounds hence the compounds could be distinguished. In several cases, only the name of the test was given, the reagents used and the observation were not written.

(c) Many candidates could not draw the correct optical isomers. A few candidates wrote wrong formula of lactic acid.

(d) A number of candidates were unable to write balanced equations; in some cases, by products were not mentioned.

Suggestions for teachers

- Explain the deficiency related diseases of different vitamins in detail to students.
- Students must be told to give correct chemical tests. If the test is positive with one reagent only then the negative test with other compound should be given.
- Explain optical isomerism in detail and also about enantiomers and diastereoisomers.
- Insist that students practice organic reactions with correct conditions and reagents.

MARKING SCHEME

Question 9.

(a) (i) Vitamin C

(ii) Vitamin K

(b) (i) Ethanol and propan-2-ol :

Lucas Test – With concentrated HCl + $ZnCl_2$ ethanol no turbidity is formed.

Turbidity appears within five minutes in propan-2-ol.

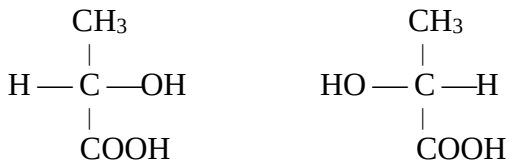
(or any other suitable test)

(ii) Aniline and ethylamine:

Azo dye Test – Dissolve the given amine in dil. HCl and cool it in ice-cold water. Now add ice-cold solution of $NaNO_2$ and HCl followed by an ice-cold β-naphthol solution. The appearance of brilliant orange-red indicates that the given amine is aniline.

Ethylamine does not form any dye and therefore does not show any colour when treated similarly. (or any other suitable test)

(c)



d(+) l(–)

(d) (i) $CH_3CHO + 4[H] \xrightarrow[\Delta]{Red\ P} C_2H_6 + H_2O + 2I_2$

(ii) $CH_3COO)_2Ca \xrightarrow{\Delta} (CH_3)_2CO + CaCO_3$

(iii) $C_2H_5ONa + C_2H_5Br \longrightarrow C_2H_5OC_2H_5 + NaBr$

(iv) $C_6H_5-CH(=O) + NaHSO_3 \longrightarrow C_6H_5-CH(SO_3Na)-OH$

Question 10

(a) An organic compound A with molecular formula C_7H_8 on oxidation by chromylchloride in the presence of CCl_4 gives a compound B which gives positive tollen's test. The compound B on treatment with NaOH followed by acid hydrolysis gives two products C and D. C on oxidation gives B which on further oxidation gives D. The compound D on distillation with sodalime gives a hydrocarbon E. Below 60°C, concentrated nitric acid reacts with E in the presence of concentrated sulphuric acid forming a compound F. Identify the compounds A, B, C, D, E and F. **[3]**

(b) Give balanced equations for the following name reactions: **[3]**

(i) Clemmensen's reduction.

(ii) Kolbe's electrolytic reaction.

(iii) Balz-Schiemann's reaction.

(c) (i) What do you observe when glucose is treated with bromine water? [2]

(ii) What is isoelectric point?

(d) Answer the following: **[2]**

(i) What is biuret test?

(ii) Write balanced equation for the formation of biuret.

Comments of Examiners

(a) Most of the candidates identified the compounds correctly. In some cases, in place of $C_6H_5CH_2OH$ (benzyl alcohol) C_6H_5OH (phenol) was reported.

(b) Many candidates failed to answer this question correctly especially parts (ii) and (iii). For Clemmensen's reduction, the correct condition for the reaction was not given by many candidates. For Kolbe's electrolytic reaction, many candidates wrote Kolbe Schmidt reaction. In part (iii), Balz-Schiemann's reaction, many candidates were confused and gave wrong answers.

(c) (i) Instead of giving the observations, some candidates wrote only balanced chemical reactions.

(ii) Some candidates wrote that isoelectric point is a point whereas it is the pH of solution at which migration of amino acid does not takes place to any electrode.

(d) (i) Several candidates forgot to mention heating of urea.

(ii) Balanced equation for the formation of biuret was not given by some candidates.

Suggestions for teachers

- Practice must be given in questions in which identification of compounds is based on different chemical reactions.
- Name reactions should be taught with correct examples. Candidates should be asked to practice balanced equations with proper reagents and conditions.
- Explain the difference between observation and chemical reaction.

MARKING SCHEME

Question 10.

(a) Identify the compounds from (A) to (F):

A = Toluene (or) $C_6H_5CH_3$

B = Benzaldehyde (or) C_6H_5CHO

C = Benzyl Alcohol (or) $C_6H_5CH_2OH$

D = Benzoic Acid (or) C_6H_5COOH

E = Benzene (or) C_6H_6

F = Nitrobenzene (or) $C_6H_5NO_2$

(b) (i) Clemmensen's reduction

$$CH_3CHO + 4(H) \xrightarrow[\text{Conc.HCl}]{\text{Zn / Hg}} CH_3\text{-}CH_3 + H_2O$$

(ACETALDEHYDE) (ETHANE)

(or)

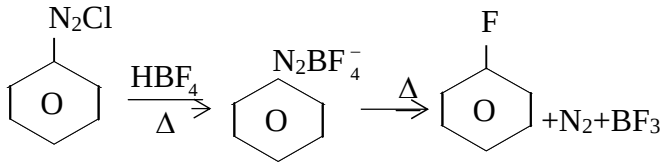
$$CH_3COCH_3 + 4(H) \xrightarrow[\text{Conc. HCl}]{\text{Zn / Hg}} CH_3CH_2CH_3 + H_2O$$

(PROPANE)

(ii) $2CH_3COOK \rightleftharpoons 2CH_3COO^- + 2K^+$ $\quad 2H_2O \rightleftharpoons 2H^+ + 2OH+$

at anode $2CH_3COO^- - 2e \longrightarrow C_2H_6 + CO_2$ at cathode $2H^+ + 2e \longrightarrow H_2$

(iii)



(c) (i) Decolourises bromine water.(Red colour of bromine water disappear)

OR

$$CH_2OH(CHOH)_4CHO \xrightarrow{Br_2 / H_2O} CH_2OH(CHOH)_4COOH$$

(glucose) (gluconic acid)

(ii) Isoelectric point – At a particular pH of a solution the amino acid molecule should not migrate to either electrode and should exist as a neutral dipolar ion. This pH is known as isoelectric point.

(d) (i) Urea on heating strongly (above 132°C) gives biuret, alkaline solution of biuret gives a violet colouration with dilute copper sulphate solution.

(ii) $$NH_2CONH_2 + NH_2CONH_2 \xrightarrow{\Delta} \underset{\text{biuret}}{NH_2CONHCONH_2} + NH_3$$

GENERAL COMMENTS:

(a) Topics found difficult by candidates in the Question Paper:

- Relative molecular mass and mole
- Chemical kinetics
- Chemical equilibrium
- Electrolyte conductance
- Coordination compounds
- Preparation of inorganic compounds
- Ionic equilibria
- Organic conversions and balanced equations
- Named organic reactions (Balz-Schiemann's reaction)

(b) Concepts in which candidates got confused:

- Van Hoff factor and colligative properties
- Raoult's Law and elevation of boiling point
- Calculation of activation by using slope of the graph
- Unit in numerical
- Le Chatelier's principle

- Isomerism and hybridization in coordination compounds
- Organic conversions
- Named reactions
- Biomolecules

(c) Suggestions for candidates:

- Numericals should be practiced regularly
- Practice organic conversions with correct conditions. Write the correct balanced chemical equations.
- Avoid selective study
- Read the question carefully and understand what is required before attempting the answers.
- Study chemical tests to distinguish between organic compounds.
- Write the formula then substitute the values and calculate the answers with correct units.
- Learn to write the keywords in the answer.