Analysis of Pupil Performance

Sciences & Mathematics

ISC Year 2017 Examination

CHEMISTRY

Year 2017

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This document of the Analysis of Pupils' Performance at the ISC Year 12 and ICSE Year 10 Examination is one of its kind. It has grown and evolved over the years to provide feedback to schools in terms of the strengths and weaknesses of the candidates in handling the examinations.

We commend the work of Mrs. Shilpi Gupta (Deputy Head) and the Research Development and Consultancy Division (RDCD) of the Council who have painstakingly prepared this analysis. We are grateful to the examiners who have contributed through their comments on the performance of the candidates under examination as well as for their suggestions to teachers and students for the effective transaction of the syllabus.

We hope the schools will find this document useful. We invite comments from schools on its utility and quality.

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Gerry Arathoon
Chief Executive & Secretary
</div>

November 2017

The Council has been involved in the preparation of the ICSE and ISC Analysis of Pupil Performance documents since the year 1994. Over these years, these documents have facilitated the teaching-learning process by providing subject/ paper wise feedback to teachers regarding performance of students at the ICSE and ISC Examinations. With the aim of ensuring wider accessibility to all stakeholders, from the year 2014, the ICSE and the ISC documents have been made available on the Council's website www.cisce.org.

The document includes a detailed qualitative analysis of the performance of students in different subjects which comprises of examiners' comments on common errors made by candidates, topics found difficult or confusing, marking scheme for each answer and suggestions for teachers/ candidates.

In addition to a detailed qualitative analysis, the Analysis of Pupil Performance documents for the Examination Year 2017 have a new component of a detailed quantitative analysis. For each subject dealt with in the document, both at the ICSE and the ISC levels, a detailed statistical analysis has been done, which has been presented in a simple user-friendly manner.

It is hoped that this document will not only enable teachers to understand how their students have performed with respect to other students who appeared for the ICSE/ISC Year 2017 Examinations, how they have performed within the Region or State, their performance as compared to other Regions or States, etc., it will also help develop a better understanding of the assessment/ evaluation process. This will help them in guiding their students more effectively and comprehensively so that students prepare for the ICSE/ ISC Examinations, with a better understanding of what is required from them.

The Analysis of Pupil Performance document for ICSE for the Examination Year 2017 covers the following subjects: English (English Language, Literature in English), Hindi, History, Civics and Geography (History & Civics, Geography), Mathematics, Science (Physics, Chemistry, Biology), Commercial Studies, Economics, Computer Applications, Economics Applications, Commercial Applications.

Subjects covered in the ISC Analysis of Pupil Performance document for the Year 2017 include English (English Language and Literature in English), Hindi, Elective English, Physics (Theory and Practical), Chemistry (Theory and Practical), Biology (Theory and Practical), Mathematics, Computer Science, History, Political Science, Geography, Sociology, Psychology, Economics, Commerce, Accounts and Business Studies.

I would like to acknowledge the contribution of all the ICSE and the ISC examiners who have been an integral part of this exercise, whose valuable inputs have helped put this document together.

I would also like to thank the RDCD team of Dr. Manika Sharma, Dr. M.K. Gandhi, Ms. Mansi Guleria and Mrs. Roshni George, who have done a commendable job in preparing this document. The statistical data pertaining to the ICSE and the ISC Year 2017 Examinations has been provided by the IT section of the Council for which I would like to thank Col. R. Sreejeth (Deputy Secretary - IT), Mr. M.R. Felix, Education Officer (IT) – ICSE and Mr. Samir Kumar, Education Officer (IT) - ISC.

Shilpi Gupta

November 2017   *Deputy Head - RDCD*

CONTENTS

INTRODUCTION

This document aims to provide a comprehensive picture of the performance of candidates in the subject. It comprises of two sections, which provide Quantitative and Qualitative analysis results in terms of performance of candidates in the subject for the ISC Year 2017 Examination. The details of the Quantitative and the Qualitative analysis are given below.

Quantitative Analysis

This section provides a detailed statistical analysis of the following:

- Overall Performance of candidates in the subject (Statistics at a Glance)
- State wise Performance of Candidates
- Gender wise comparison of Overall Performance
- Region wise comparison of Performance
- Comparison of Region wise performance on the basis of Gender
- Comparison of performance in different Mark Ranges and comparison on the basis of Gender for the top and bottom ranges
- Comparison of performance in different Grade categories and comparison on the basis of Gender for the top and bottom grades

The data has been presented in the form of means, frequencies and bar graphs.

Understanding the tables

Each of the comparison tables shows N (Number of candidates), Mean Marks obtained, Standard Errors and t-values with the level of significance. For t-test, mean values compared with their standard errors indicate whether an observed difference is likely to be a true difference or whether it has occurred by chance. The t-test has been applied using a confidence level of 95%, which means that if a difference is marked as 'statistically significant' (with * mark, refer to t-value column of the table), the probability of the difference occurring by chance is less than 5%. In other words, we are 95% confident that the difference between the two values is true.

t-test has been used to observe significant differences in the performance of boys and girls, gender wise differences within regions (North, East, South and West), gender wise differences within marks ranges (Top and bottom ranges) and gender wise differences within grades awarded (Grade 1 and Grade 9) at the ISC Year 2017 Examination.

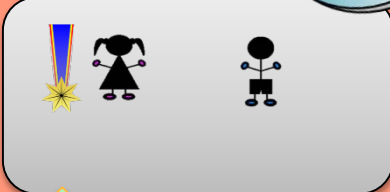The analysed data has been depicted in a simple and user-friendly manner.

Given below is an example showing the comparison tables used in this section and the manner in which they should be interpreted.

Comparison on the basis of Gender

Gender	N	Mean	SE	t-value
Girls	2,538	66.1	0.29	
Boys	1,051	60.1	0.42	

*Significant at 0.05 level

11.91*
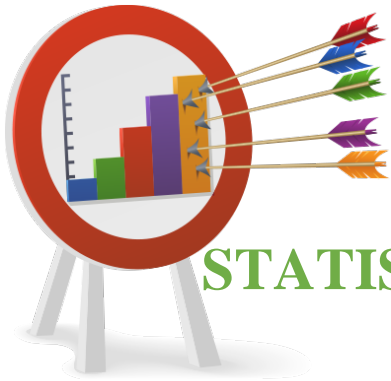
Girls performed significantly better than boys.

The results have also been depicted pictographically. In this case, the girls performed significantly better than the boys. This is depicted by the girl with a medal.

The table shows comparison between the performances of boys and girls in a particular subject. The t-value of 11.91 is significant at 0.05 level (mentioned below the table) with a mean of girls as 66.1 and that of boys as 60.1. It means that there is significant difference between the performance of boys and girls in the subject. The probability of this difference occurring by chance is less than 5%. The mean value of girls is higher than that of boys. It can be interpreted that girls are performing significantly better than boys.
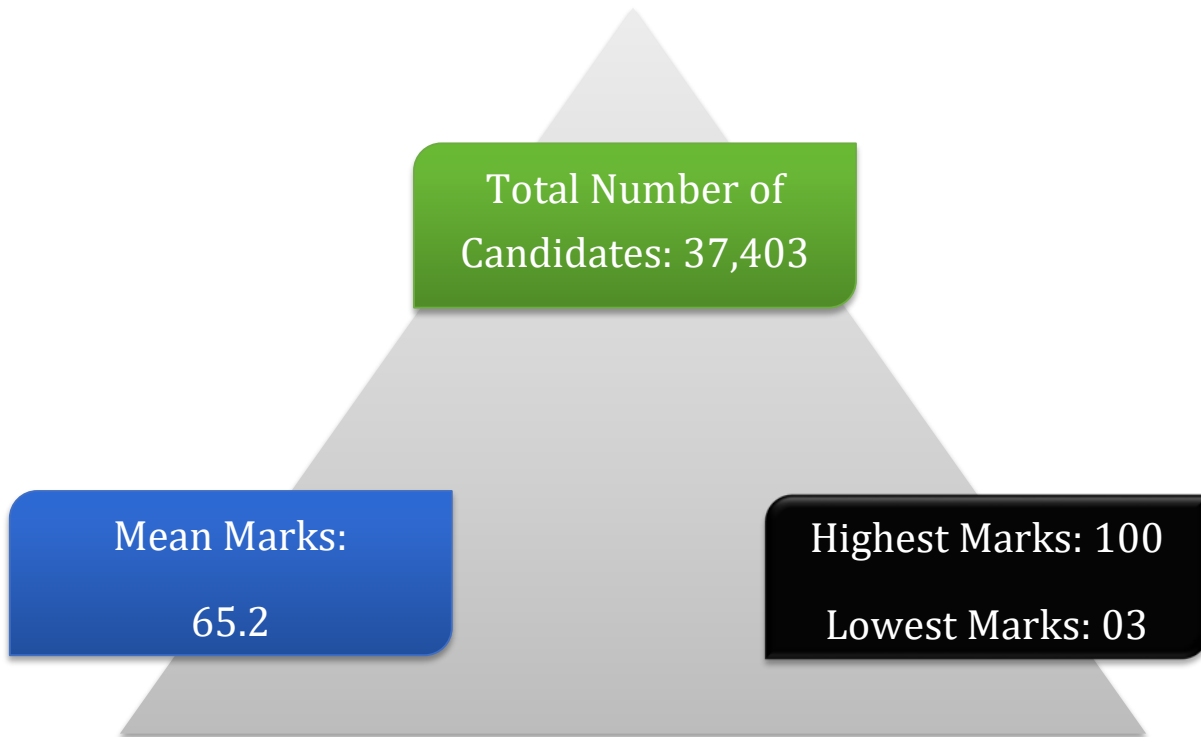
Qualitative Analysis

The purpose of the qualitative analysis is to provide insights into how candidates have performed in individual questions set in the question paper. This section is based on inputs provided by examiners from examination centres across the country. It comprises of question wise feedback on the performance of candidates in the form of *Comments of Examiners* on the common errors made by candidates along with *Suggestions for Teachers* to rectify/ reduce these errors. The *Marking Scheme* for each question has also been provided to help teachers understand the criteria used for marking. Topics in the question paper that were generally found to be difficult or confusing by candidates, have also been listed down, along with general suggestions for candidates on how to prepare for the examination/ perform better in the examination.
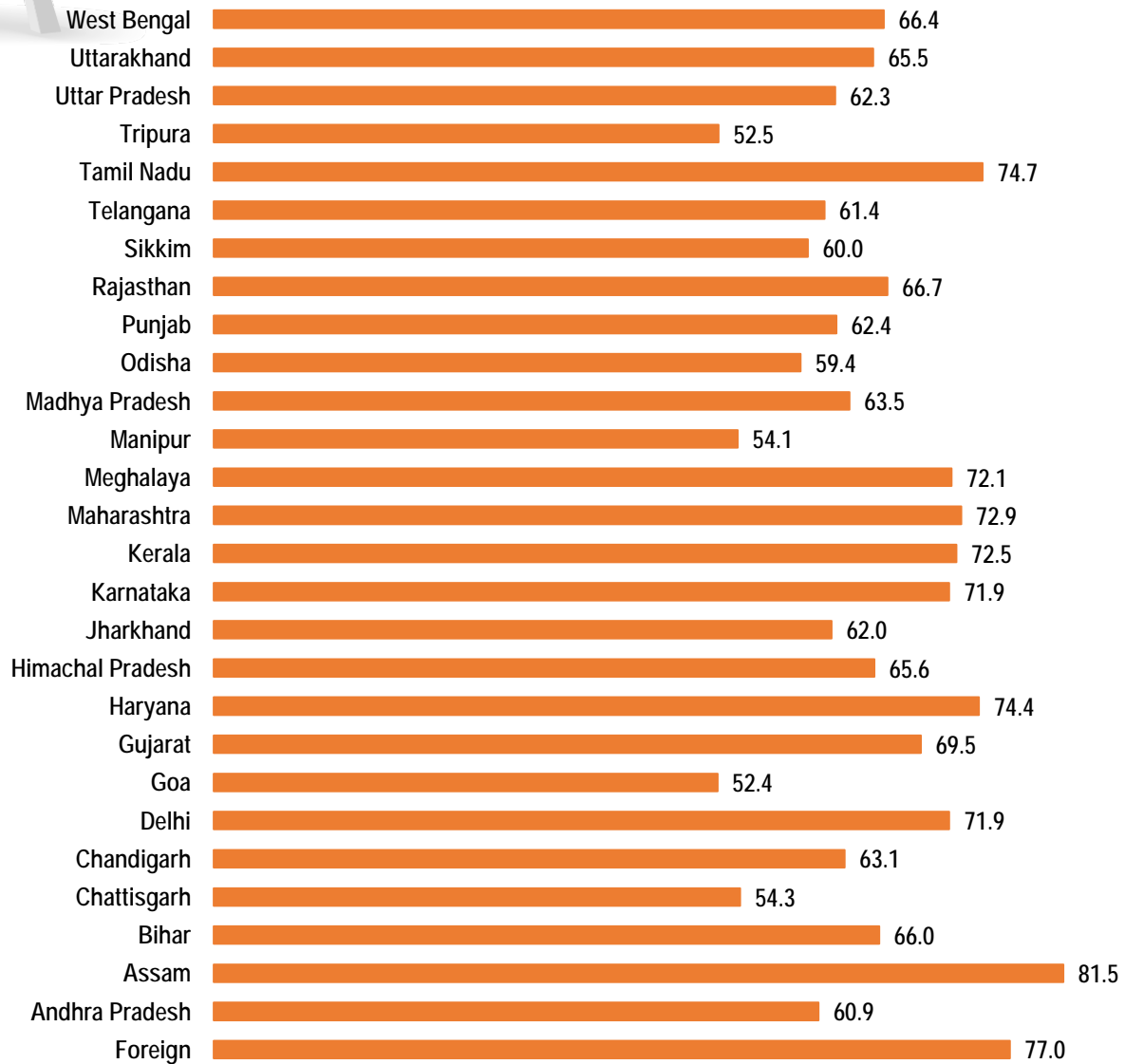
QUANTITATIVE ANALYSIS

STATISTICS AT A GLANCE

Total Number of Candidates: 37,403

Mean Marks: 65.2

Highest Marks: 100

Lowest Marks: 03

PERFORMANCE (STATE-WISE & FOREIGN)

State	Mean Marks
West Bengal	66.4
Uttarakhand	65.5
Uttar Pradesh	62.3
Tripura	52.5
Tamil Nadu	74.7
Telangana	61.4
Sikkim	60.0
Rajasthan	66.7
Punjab	62.4
Odisha	59.4
Madhya Pradesh	63.5
Manipur	54.1
Meghalaya	72.1
Maharashtra	72.9
Kerala	72.5
Karnataka	71.9
Jharkhand	62.0
Himachal Pradesh	65.6
Haryana	74.4
Gujarat	69.5
Goa	52.4
Delhi	71.9
Chandigarh	63.1
Chattisgarh	54.3
Bihar	66.0
Assam	81.5
Andhra Pradesh	60.9
Foreign	77.0

The States of Assam and Tamil Nadu secured highest mean marks. Mean marks secured by candidates studying in schools abroad were 77.
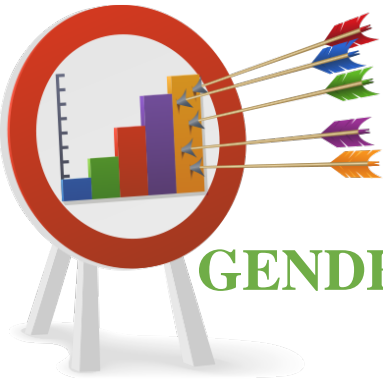
GENDER-WISE COMPARISON

GIRLS

Mean Marks: 66.6

Number of Candidates: 14,738

BOYS

Mean Marks: 64.4

Number of Candidates: 22,665

Comparison on the basis of Gender

Gender	N	Mean	SE	t-value
Girls	14,738	66.6	0.13	12.92*
Boys	22,665	64.4	0.11	

*Significant at 0.05 level
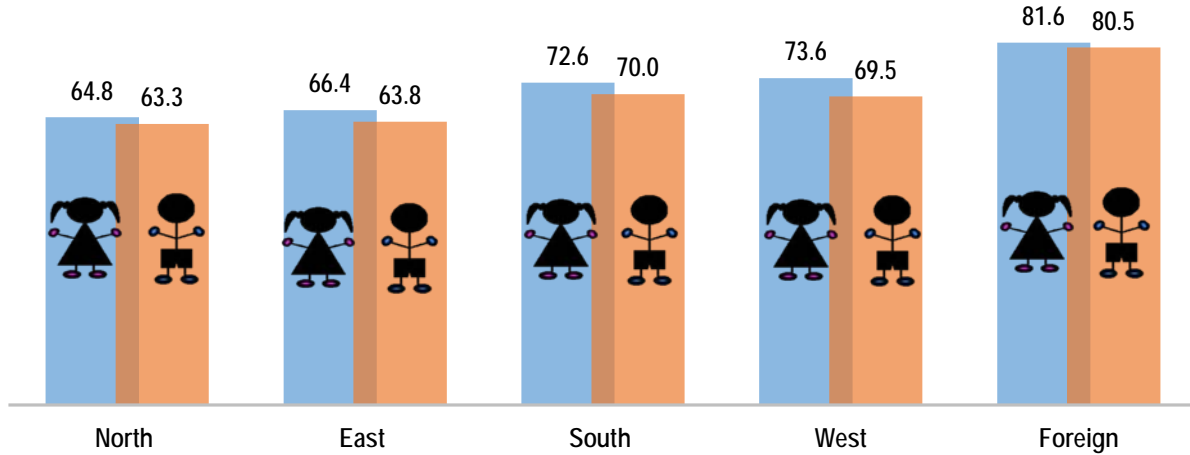
Girls performed significantly better than boys.

REGION-WISE COMPARISON

East

North

Mean Marks: 64.8

Number of Candidates: 11,295

Highest Marks: 100
Lowest Marks: 06

Mean Marks: 63.9

Number of Candidates: 20,795

Highest Marks: 100
Lowest Marks: 03

REGION

Mean Marks: 71.2

Number of Candidates: 3,332

Highest Marks: 100
Lowest Marks: 15

Mean Marks: 71.1

Number of Candidates: 1,836

Highest Marks: 100
Lowest Marks: 23

South

West

Mean Marks: 81.0

Number of Candidates: 145

Highest Marks: 100
Lowest Marks: 43

Foreign

Mean Marks obtained by Boys and Girls-Region wise

Comparison on the basis of Gender within Region					
Region	**Gender**	**N**	**Mean**	**SE**	**t-value**
North (N)	Girls	7,968	64.8	0.18	6.06*
	Boys	12,827	63.3	0.15	
East (E)	Girls	4,481	66.4	0.24	8.31*
	Boys	6,814	63.8	0.21	
South (S)	Girls	1,495	72.6	0.39	4.85*
	Boys	1,837	70.0	0.38	
West (W)	Girls	735	73.6	0.58	5.42*
	Boys	1,101	69.5	0.50	
Foreign (F)	Girls	59	81.6	1.45	0.52
	Boys	86	80.5	1.72	

*Significant at 0.05 level

The performance of girls was significantly better than that of boys in the northern, eastern, southern and western region. In foreign region no significant difference was observed.

REGION (N, E, S, W)
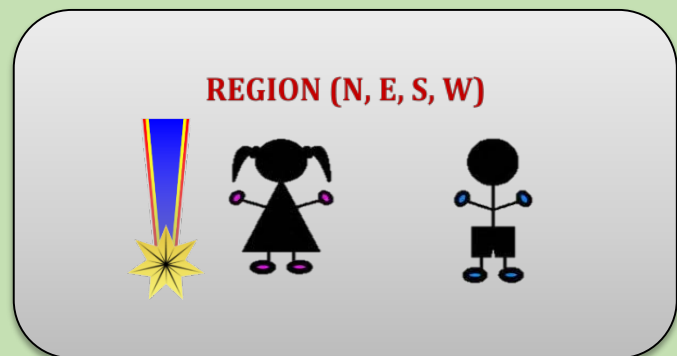
MARK RANGES : COMPARISON GENDER-WISE

Comparison on the basis of gender in top and bottom mark ranges

Marks Range	Gender	N	Mean	SE	t-value
Top Range (81-100)	Girls	3,428	88.2	0.09	-2.54*
	Boys	4,719	88.5	0.07	
Bottom Range (0-20)	Girls	19	16.8	0.96	0.23
	Boys	27	16.6	0.71	

*Significant at 0.05 level

Marks Range (81-100)

Performance of boys was significantly better than the performance of girls.

Marks Range (81-100)
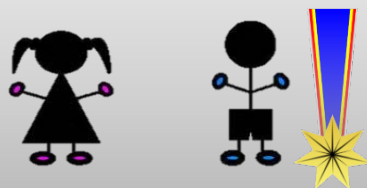
Marks Range (0 -20)

No significant difference was found in the performance of girls and boys in the bottom marks range.

■ Boys ■ Girls ■ All Candidates

Range	Boys	Girls	All Candidates
81 - 100	88.5	88.2	88.3
61 - 80	70.1	70.4	70.2
41 - 60	49.7	50.5	50.0
21 - 40	32.4	33.1	32.6
0 - 20	16.6	16.8	16.7
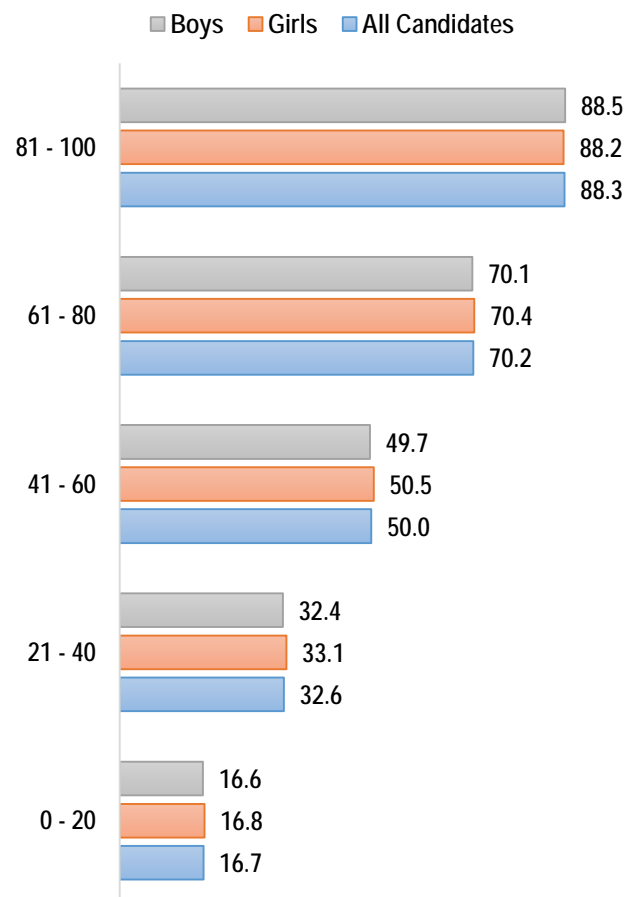
GRADES AWARDED : COMPARISON GENDER-WISE

Comparison on the basis of gender in Grade 1 and Grade 9

Grades	Gender	N	Mean	SE	t-value
Grade 1	Girls	1,272	93.8	2.63	0.02
	Boys	1,915	93.7	2.14	
Grade 9	Girls	172	25.7	1.97	0.06
	Boys	383	25.5	1.31	

In Grade 1 and Grade 9 no significant difference was observed between the average performance of girls and boys.

■ Boys ■ Girls ■ All Candidates

	Boys	Girls	All Candidates
1	93.7	93.8	93.8
2	84.3	84.3	84.3
3	74.3	74.5	74.3
4	64.5	64.6	64.5
5	57.0	57.0	57.0
6	52.0	52.1	52.1
7	47.1	47.0	47.1
8	42.5	42.5	42.5
9	25.5	25.7	25.6
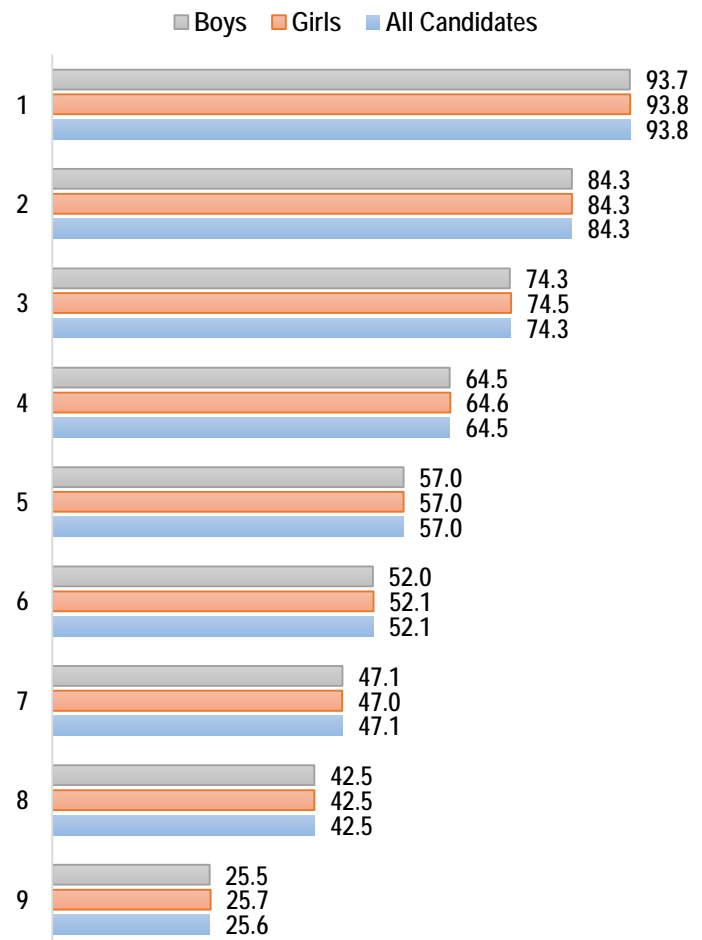
QUALITATIVE ANALYSIS
THEORY (PAPER-1)

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]**

(iodoform, acetaldehyde, positive, greater, acidic, acetone, disaccharide, negative, increases, glucose, decreases, chloroform, polysaccharide, lactose, lesser, basic, cationic hydrolysis, anionic hydrolysis)

(i) Calcium acetate on heating gives _____ which gives _____ on heating with iodine and sodium hydroxide solution.

(ii) On dilution of a solution, its specific conductance _____ while its equivalent conductance_____.

(iii) Sucrose is a _____ and yields upon hydrolysis, a mixture of _____ and fructose.

(iv) More _____ is the standard reduction potential of a substance, the _____ is its ability to displace hydrogen from acids.

(v) An aqueous solution of CH_3COONa is_____ due to _____.

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

(i) In a face centered cubic lattice, atom (A) occupies the corner positions and atom (B) occupies the face centre positions. If one atom of (B) is missing from one of the face centered points, the formula of the compound is:

(1) A_2B_5

(2) A_2B_3

(3) AB_2

(4) A_2B

(ii) The half-life period of a first order reaction is 20 minutes. The time required for the concentration of the reactant to change from 0·16 M to 0·02M is:

(1) 80 minutes

(2) 60 minutes

(3) 40 minutes

(4) 20 minutes

(iii) For a spontaneous reaction $\Delta G^o \ and \ E^o \ cell$ will be respectively:

(1)   -ve and +ve

(2)   +ve and -ve

(3)   +ve and +ve

(4)   -ve and -ve

(iv)   The conjugate acid of HPO_4^{2-} is:

(1) H_3PO_3

(2) H_3PO_4

(3) $H_2PO_4^-$

(4) PO_4^{3-}

(v)   The polymer formed by the condensation of hexamethylenediamine and adipic acid is:

(1)   Teflon

(2)   Bakelite

(3)   Dacron

(4)   Nylon-66

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

(i)   Why the freezing point depression (ΔT_f) of 0·4M NaCl solution is nearly twice than that of 0·4M glucose solution?

(ii)   Identify the order of reaction from each of the following units of rate constant (k):

(a)   mol L^{-1} sec^{-1}

(b) mol^{-1} L sec^{-1}

(iii) Specific conductivity of 0·20 M solution of KCl at 298 K is 0·025 S cm^{-1}. Calculate its molar conductivity.

(iv)   Name the order of reaction which proceeds with a uniform rate throughout?

(v)   What are the products formed when phenol and nitrobenzene are treated separately with a mixture of concentrated sulphuric acid and concentrated nitric acid?

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

(i)   Diazotisation   (a)   Bakelite
(ii)   Argentite   (b)   Nernst equation
(iii) Thermosetting plastics   (c)   Aniline
(iv)   Electrochemical cell   (d)   Ethylenediamine
(v)   Bidentate ligand   (e)   Froth floatation process

Comments of Examiners

(a) (i) Many candidates wrote 'acetaldehyde' instead of 'acetone' in the first blank. A few candidates wrote 'chloroform' instead of 'iodoform' in the second blank.

   (ii) Many candidates interchanged (reversed) the answer instead of 'decreases' and 'increases' they wrote 'increases' and 'decreases'.

   (iii) Instead of 'disaccharide' many candidates wrote 'polysaccharide' in the first blank. Few wrote 'lactose' in place of 'glucose' for the second blank.

   (iv) Some candidates wrote 'positive' instead of negative' in the first blank. For the second blank, instead of 'greater' a few candidates wrote 'more' which was not given in the list of words.

   (v) Some candidates wrote 'acidic' in place of 'basic' in the first blank. Instead of 'anionic hydrolysis' some candidates wrote 'cationic hydrolysis' in the second blank.

(b) (i) Some candidates wrote A_2B_3 or AB_2 instead of A_2B_5.

   (ii) Most of the candidates were able to calculate the answer correctly i.e. 60 minutes but some candidates wrote 40 minutes or 20 minutes also.

   (iii) The correct option was '-ve and +ve' but some candidates gave incorrect options also.

   (iv) Instead of $H_2PO_4^-$ some candidates wrote other options such as PO_4^{3-}, H_3PO_4 etc. which were not correct.

   (v) Instead of Nylon-66 which was the correct answer, some candidates wrote Dacron or Teflon which was not correct.

(c) (i) Many candidates wrote that NaCl is a strong electrolyte and glucose is a non-electrolyte. However, they were not able to explain that colligative property is directly proportional to number of moles in solutions. In a few cases, van't Hoff factor was not given.

   (ii) Instead of zero order and 2nd order reaction, some candidates wrote 1st order and zero order reaction.

   (iii) Most of the candidates calculated the value of molar conductivity correctly, but some candidates wrote the answer with incorrect unit.

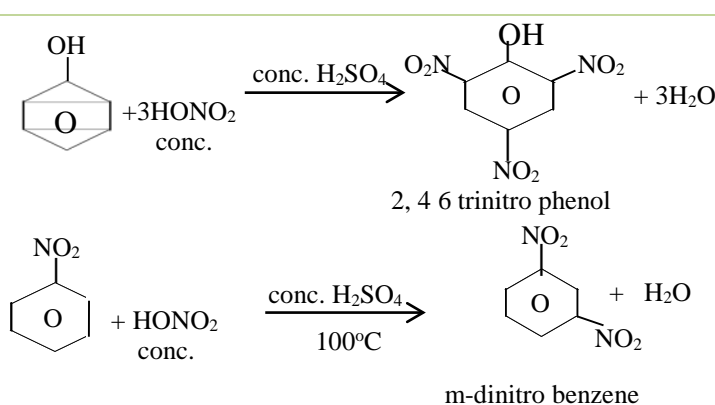   (iv) Instead of zero order reaction some candidates wrote first order and second order reactions.

(v) Most of the candidates failed to explain that OH group is ortho and para directing group. The concept of directive influence was not very clear to many candidates.

(d) Most of the candidates attempted this part correctly. A few candidates gave incorrect answers also, such as diazotization was matched with ethylenediamine and bidentate ligand was matched with aniline.

MARKING SCHEME

Question 1

(a)	(i)	acetone, iodoform
	(ii)	decreases, increases
	(iii)	disaccharide, glucose
	(iv)	negative, greater
	(v)	basic, anionic hydrolysis
(b)	(i)	(1) or A_2B_5
	(ii)	(2) or 60 minutes
	(iii)	(1) or -ve and +ve
	(iv)	(3) or $H_2PO_4^-$
	(v)	(4) or Nylon-66
(c)	(i)	$NaCl \rightarrow Na^+ + Cl^-$ (is an electrolyte) 0·4M 0·4M 0·4M Glucose $\rightarrow$ Glucose (non electrolyte) 0·4M 0·4M Number of moles increases (doubles) in NaCl solution. Hence, the depression in freezing point is nearly twice than that of glucose solution.
	(ii)	(a) Zero order reaction (b) 2nd order reaction
	(iii)	Molar conductivity $\Lambda_m = \dfrac{1000 \times K}{M}$ or $= \dfrac{1000 \times 0·025}{0·20}$ $= 125 \text{ S cm}^2 \text{ mol}^{-1}$
	(iv)	Zero order reaction.
	(v)	 2, 4 6 trinitro phenol m-dinitro benzene

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(d)	Match the following:				
	(i)	Diazotisation	(c)	Aniline
	(ii)	Argentite	(e)	Froth floatation process
	(iii)	Thermosetting plastics	(a)	Bakelite
	(iv)	Electrochemical cell	(b)	Nernst equation
	(v)	Bidentate ligand	(d)	Ethylenediamine

Part II (50 marks)

SECTION A
Answer any two questions.

Question 2

(a) (i) Determine the freezing point of a solution containing $0 \cdot 625$ g of glucose ($C_6H_{12}O_6$) dissolved in $102 \cdot 8$ g of water. **[2]**
(Freezing point of water = 273 K, K_f for water = $1 \cdot 87$K kg mol^{-1}, at. wt. C = 12, H = 1, O = 16)

(ii) A $0 \cdot 15$ M aqueous solution of KCl exerts an osmotic pressure of $6 \cdot 8$ atm at 310 K. Calculate the degree of dissociation of KCl. (R = $0 \cdot 0821$ Lit. atm K^{-1} mol^{-1}). **[2]**

(iii) A solution containing $8 \cdot 44$ g of sucrose in 100 g of water has a vapour pressure $4 \cdot 56$ mm of Hg at 273K. If the vapour pressure of pure water is $4 \cdot 58$ mm of Hg at the same temperature, calculate the molecular weight of sucrose. **[1]**

(b) (i) When ammonium chloride and ammonium hydroxide are added to a solution containing both Al^{3+} and Ca^{2+} ions, which ion is precipitated first and why? **[2]**

(ii) A solution of potassium chloride has no effect on litmus whereas, a solution of zinc chloride turns the blue litmus red. Give a reason. **[2]**

(c) How many sodium ions and chloride ions are present in a unit cell of sodium chloride crystal? **[1]**

Comments of Examiners

(a) (i) The value of ΔT_f was calculated correctly by most of the candidates but some candidates added the value of ΔT_f to 273 instead of subtracting this value from 273.

(ii) Many candidates calculated the value of van't Hoff factor (i) correctly but some candidates failed to calculate the value of degree of dissociation (α) for KCl.

(iii) Most of the candidates calculated the molecular weight of sucrose correctly but some candidates wrote the incorrect unit.

(b)(i) Many candidates wrote that Al^{3+} ions will be precipitated first. A few candidates wrote that Ca^{2+} ions will precipitate first. The concept of common ion effect and solubility product was not considered by many candidates.

(ii) Many candidates gave correct explanation for KCl but for $ZnCl_2$ some candidates wrote anionic hydrolysis instead of cationic hydrolysis.

(c) Some candidates wrote the coordination number 6:6 instead of 4 Na^+ and 4 Cl ions.

MARKING SCHEME

Question 2

(a)	(i)	$K_f = 1.87$ K kg mol^{-1}, $w = 0.625$g , $W = 102.8$ g, $m = 180$

$$\Delta T_f = \frac{1000 k_f \cdot w}{m\,W} = \frac{1000 \times 1.87 \times 0.625}{180 \times 102.8}$$

$$\Delta T_f = 0.06316\ K$$

Freezing point of solution = 273 - 0.06316

= 272.93684 K

	(ii)	$C = 0.15$M, $\pi = 6.8\ atm$, $T = 310\ K$, $R = 0.0821$ L atm K^{-1}mol^{-1}

$KCl \rightarrow K^+ + Cl^-$ (n = 2)

		$\pi = i\ CRT$ $6 \cdot 8 = i \times 0 \cdot 15 \times 0 \cdot 0821 \times 310$ $i = \frac{6 \cdot 8}{0 \cdot 15 \times 0 \cdot 0821 \times 310} = 1 \cdot 7812$ Degree of dissociation $(\alpha) = \frac{i-1}{n-1} = \frac{1 \cdot 7812 - 1}{2 - 1} = 0.7812$ or $= 78 \cdot 12\%$
	(iii)	$P^0 = 4 \cdot 58$ mm of Hg, P = $4 \cdot 56$ mm of Hg, w = $8 \cdot 44$g, W = 100 g, M = 18 g mol^{-1} $\Delta P = 4 \cdot 58 - 4 \cdot 56 = 0 \cdot 02$ mm of Hg. m $= \frac{P^0 \times w \times M}{\Delta P\ W} = \frac{4 \cdot 58 \times 8 \cdot 44 \times 18}{0 \cdot 02 \times 100} = 347 \cdot 90\ g\ mol^{-1}$
(b)	(i)	Al^{3+} ion will be precipitated first. The Ksp value of Al(OH)$_3$ is less as compared to Ca(OH)$_2$. Therefore, the ionic conc. product of [Al^{3+}] and [OH$^-$] ion will exceed the solubility product. The conc. of OH$^-$ ion is not sufficient (due to C.I.E) to exceed the solubility product of (Ca^{2+}) and [OH$^-$] due to high Ksp value.
	(ii)	KCl is a salt of strong acid and strong base hence do not hydrolyse with H$^+$ and OH$^-$ of water. Hence, the aq solution of KCl is neutral and has no effect on litmus ZnCl$_2$ is salt of strong acid and weak base hence undergo cationic hydrolysis, therefore, the number of H$^+$ ions increases in solution and turns blue litmus red.
(c)		Number of Na$^+$ = 4 Number of Cl$^-$ = 4

Question 3

(a) (i) Lead sulphide has face centered cubic crystal structure. If the edge length of the unit cell of lead sulphide is 495 pm, calculate the density of the crystal. (at. wt. Pb = 207, S = 32) **[1]**

(ii) For the reaction: $2H_2 + 2NO \rightleftharpoons 2H_2O + N_2$, the following rate data was obtained: **[3]**

S.No.	[NO] mol L^{-1}	[H$_2$] mol L^{-1}	Rate: mol L^{-1} sec^{-1}
1	0·40	0·40	4·6×10^{-3}
2	0·80	0·40	18·4×10^{-3}
3	0·40	0·80	9·2×10^{-3}

Calculate the following:

(1) The overall order of reaction.

(2) The rate law.

(3) The value of rate constant (k).

(b) (i) The following electrochemical cell is set up at 298 K: **[2]**

$Zn/Zn^{2+}\ (aq)(1M)//\ Cu^{2+}(aq)(1M)/Cu$

Given → E°Zn^{2+}/Zn = - 0·761V, E°Cu^{2+}/Cu = + 0·339 V

(1) Write the cell reaction.

(2) Calculate the emf and free energy change at 298 K.

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

    (1) What is the effect of temperature on ionic product of water (Kw)?

    (2) What happens to the ionic product of water (Kw) if some acid is added to it?

(c) Frenkel defect does not change the density of the ionic crystal whereas, Schottky defect lowers the density of ionic crystal. Give a reason. **[2]**

Comments of Examiners

(a)(i) Some candidates calculated the density without converting the unit of edge length from pm to cm. Some candidates took an incorrect value of Z. The unit of density was also incorrectly mentioned.

(ii) Several candidates calculated the overall order of reaction directly without showing the calculation. A few candidates were not able to calculate the value of rate constant (k).

(b) (i) Most of the candidates gave the cell reaction and emf of the cell correctly. Some candidates were not able to calculate the value of free energy change ($\Delta G°$) because they didn't know the correct equation. Many candidates did not write negative sign before the value of ($\Delta G°$).

(ii)(1) Many candidates wrote that the ionic product of water (k_w) remains the same instead of writing that the value of k_w increases with increase in temperature ($k_w \propto$ temperature).

(2) Instead of writing that the value of k_w remains constant on the addition of acid several candidates wrote the value of k_w increases.

(c) Cation was not specified by many candidates for Frenkel defect. Also for Schottky defect, many candidates wrote atoms instead of cations and anions.

Suggestions for teachers

- Stress upon that the value of Z changes with type of unit cells.
- Give more practice in solving numerical problems based on density, edge length, etc.
- More practice must be given on numerical problems based on order of reaction. Emphasize on step by step calculations.
- Insist that students must practice the numerical problems based on electrochemistry.
- Defects in crystals must be explained with the help of diagrams. How the density of the crystal changes due to these defects should also be explained.

	MARKING SCHEME		
	Question 3		
(a)	(i)	Density (d) = $\frac{Z \times M}{N_A \times a^3}$ or $\frac{4 \times 239}{6 \cdot 023 \times 10^{23} \times (495 \times 10^{-10})^3}$ $= 13 \cdot 087$ g/cm^3	

	(ii)	For reaction $2NO + 2H_2 \rightarrow 2H_2O + N_2$
		     Rate $= k\,[NO]^p\,(H_2)^q$
		     (i) $4 \cdot 6 \times 10^{-3} = k(0 \cdot 4)^P (0 \cdot 4)^q$
		     (ii) $18 \cdot 4 \times 10^{-3} = k(0 \cdot 8)^p (0 \cdot 4)^q$
		     (iii) $9 \cdot 2 \times 10^{-3} = k(0 \cdot 4)^p (0 \cdot 8)^q$
		 Dividing eq (ii) by eq (i)	

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$$\frac{18\cdot4\times10^{-3}}{4\cdot6\times10^{-3}} = \left(\frac{0\cdot8}{0\cdot4}\right)^p$$

$$4 = (2)^p$$

$$p = 2$$

Dividing eq (iii) by eq(i)

$$\frac{9\cdot2\times10^{-3}}{4\cdot6\times10^{-3}} = \left(\frac{0\cdot8}{0\cdot4}\right)^q$$

$$2 = (2)^q$$

$$q = 1$$

<table>
<tr><td>(i)</td><td>Over all order of reaction
Rate = k $[NO]^2 [H_2]^1$
Order of reaction = 2 + 1 = 3</td></tr>
<tr><td>(ii)</td><td>Rate law = rate = $k[NO]^2[H_2]^1$</td></tr>
<tr><td>(iii)</td><td>Rate constant (k) = $\frac{rate}{(A)^3} = \frac{4\cdot6\times10^{-3}}{(0\cdot4)^3}$
k = $0\cdot071875$ mol^{-2}L^{2}s^{-1}</td></tr>
</table>
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<tr>
<td>(b)</td>
<td>(i)</td>
<td>(1)</td>
<td>Cell reaction: $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2)</td>
<td>

E^0cell = E^0 (cathode) – E^0(anode)

      = $0\cdot339$ V – (- $0\cdot761$V)

      = $1\cdot10$ V

  ΔG^o = -nFE^0

     = -2×96500×$1\cdot10$

     = -212300 J

     = -$212\cdot3$ k.J
</td>
</tr>
<tr>
<td></td>
<td>(ii)</td>
<td>(1)</td>
<td>As the temperature is increased, the value of K_w will also increase
(K_w α temperature)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2)</td>
<td>When acid is added to water, the value of K_w remains constant.</td>
</tr>
<tr>
<td>(c)</td>
<td colspan="3">

- Frenkel defect arises due to presence of holes in the cationic lattice site and cation occupies an interstitial position. Hence, density remains the same.

- Schottky defect arises when same number of cations and anions are missing from their normal site and a pair of holes are formed hence density decreases.
</td>
</tr>
</table>

Question 4

(a) (i) Name the law or principle to which the following observations conform: **[3]**

(1) When water is added to a $1\cdot0$ M aqueous solution of acetic acid, the number of hydrogen ion (H^+) increases.

(2) When 9650 coulombs of electricity is passed through a solution of copper sulphate, $3\cdot175$ g of copper is deposited on the cathode (at.wt. of Cu = $63\cdot5$).

(3) When ammonium chloride is added to a solution of ammonium hydroxide, the concentration of hydroxyl ions decreases.

(ii) What is the difference between the order of a reaction and its molecularity?   **[2]**

(b)   (i)   Explain why high pressure is required in the manufacture of sulphur trioxide   **[2]**
by contact process. State the law or principle used.

  (ii)   Calculate the equilibrium constant (Kc) for the formation of NH_3 in the   **[1]**
following reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
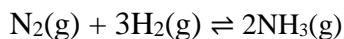
At equilibrium, the concentration of NH_3, H_2 and N_2 are 1.2×10^{-2}, 3.0×10^{-2} and 1.5×10^{-2} M respectively.

(c)   Explain the following: **[2]**

  (i)   Hydrolysis of ester (ethyl acetate) begins slowly but becomes fast after some time.

  (ii)   The pH value of acetic acid increases on addition of a few drops of sodium acetate.

Comments of Examiners

(a)(i) 1. Instead of 'Ostwald's dilution law' many candidates wrote 'common ion effect'.

2. Some candidates wrote only 'Faraday's Law' or 'Faraday's IInd Law' instead of 'Faraday's 1st Law of electrolysis'.

3. Instead of 'Common ion effect' some candidates wrote 'Le Chatelier's principle'.

  (ii) Some candidates were not able to write one pair of difference correctly. The concept of order of reaction and molecularity was not clear to many candidates.

(b)(i) Many candidates mentioned the name of the Law correctly but failed to give the requirement of high pressure in the manufacture of SO_3.

  (ii) Most of the candidates solved the numerical correctly. Some candidates did not substitute the correct values in the formula hence got incorrect value of Kc. The unit of Kc was also not mentioned correctly by many candidates.

(c)(i) A number of candidates did not write that acetic acid acts as an auto catalyst.

  (ii) A few candidates wrote only 'common ion effect' but failed to explain that H^+ ion concentration decreases as the dissociation of acetic acid is suppressed.

Suggestions for teachers

· Insist upon that students must learn the laws/principles and their applications after understanding thoroughly.

· Explain Molecularity and order of reaction to students with suitable examples.

· Le Chatelier's principle and its application in various chemical reactions at equilibrium must be clearly explained to students.

· Method to calculate equilibrium constants (k_c) for different reactions should be given more practice and the answer must be given along with the correct unit.

· Explain different types of catalysts to students.

· Explain the relationship of pH value with the concentration of [H^+] ion. Common ion effect should be explained clearly.

Question 4

(a)	(i)	(1)	Ostwald's dilution law.
		(2)	Faraday's 1st law of electrolysis
		(3)	Common ion effect

(ii)		Order of reaction		Molecularity
	1	Order of reaction is the sum of exponents in the rate law equation.	1	Molecularity is the total number of molecules of reactants taking part in a particular step of reaction
	2	Order of reaction may have fractional values or it may be zero.	2	There is always a whole number other than zero.

(b) **(i)** $2SO_2 + O_2 \rightleftharpoons 2SO_3$

Formation of SO_3 takes place with decrease in volume, when pressure is increased the equilibrium will shift in that direction where volume is less. Hence the forward reaction is favoured with high pressure.

Le Chatelier's principle: When a stress is applied on a system at equilibrium, the system behaves in such a way so as to counteract the stress.

(ii) $K_c = \dfrac{[NH_3]^2}{[N_2][H_2]^3} = \dfrac{(1\cdot2\times10^{-2})^2}{(1\cdot5\times10^{-2})(3\cdot0\times10^{-2})^3}$

$K_c = 3\cdot55 \times 10^2 \text{ mol}^{-2} \text{ L}^2$

(c) **(i)** $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$

auto catalyst

Acetic acid formed during the reaction acts as auto catalyst hence after some time, the rate of reaction increases.

(ii) Due to common ion effect, the dissociation of acetic acid decreases hence concentration of H^+ ion decreases. The pH value is inversely proportional to H^+ ion concentration. Therefore, the pH value of the solution increases.

SECTION B

Answer any two questions.

Question 5

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

(i) Potassium trioxalatoaluminate(III)

(ii) Hexaaquairon(II) sulphate.

(b) Name the types of isomerism shown by the following pairs of compounds: **[1]**

(i) $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$

(ii) $[Co(Pn)_2Cl_2]^+$ and $[Co(tn)_2Cl_2]^+$

(c) For the coordination complex ion $[Co(NH_3)_6]^{3+}$ **[2]**

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

  (ii) What is the oxidation number of cobalt in the complex ion?

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

  (iv) State the magnetic behaviour of the complex ion.

Comments of Examiners

(a) (i) Many candidates mentioned only 'K' in place of 'K$_3$' in the formula $K_3[Al(C_2O_4)_3]$. In some cases, the orders of central metal atom and ligand was reversed. The formula of ligand was also not written correctly by many candidates.

  (ii) Some candidates wrote Fe after H_2O in the formula of the compound e.g. $[H_2O)_6$ Fe]SO_4 instead of $[Fe (H_2O)_6]$ SO_4 which was incorrect.

(b)(i) A few candidates wrote 'coordinate isomerism' instead of 'coordination isomerism'. Some candidates also wrote linkage and ionisation isomerism which were not correct.

  (ii) A number of candidates were not able to identify the ligands in the formula hence, gave incorrect answers.

(c)(i) Many candidates wrote incorrect spelling in the IUPAC name of the complex ion. Instead of double 'aa' and double 'mm', a single 'a' and a single 'm' was written. Some did not write the word 'ion'.

  (ii) Most of the candidates wrote the correct oxidation number i.e. +3 but a few candidates wrote -3 which was not correct.

  (iii)Many candidates reported sp^3d^2 hybridisation instead of $d^2 sp^3$ hybridisation.

  (iv) A few candidates wrote the magnetic behaviour of given complex ion as 'paramagnetic' instead of 'diamagnetic'.

MARKING SCHEME		
Question 5		
(a)	(i)	$K_3[Al(C_2O_4)_3]$
	(ii)	$[Fe(H_2O)_6]SO_4$
(b)	(i)	Coordination isomerism.
	(ii)	Ligand isomerism.
(c)	(i)	hexaamminecobalt(III) ion.
	(ii)	+3
	(iii)	d^2sp^3 hybridisation
	(iv)	diamagnetic

Question 6

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

    (i)   Potassium permanganate is heated with concentrated hydrochloric acid.

    (ii)   Lead sulphide is heated with hydrogen peroxide.

    (iii)   Ozone is treated with potassium iodide solution.

(b)   Discuss the theory involved in the manufacture of sulphuric acid by contact process.   **[2]**

Comments of Examiners

(a)(i) Many candidates wrote either incorrect or incomplete chemical equation for potassium permanganate heated with concentrated hydrochloric acid. In some cases, the equations were unbalanced.

  (ii) A few candidates wrote unbalanced equation for the Lead sulphide heated with hydrogen peroxide.

  (iii) The chemical equation written for Ozone treated with potassium iodide solution was not balanced and the products written were also incorrect in several cases. In some equations, oxygen was missing.

(b)   'Heat' was not mentioned in the equation to obtain SO_3. The catalyst was not written. To prepare oleum ($H_2S_2O_7$), concentrated H_2SO_4 was not used.

> ### *Suggestions for teachers*
>
> - More practice should be given in writing complete and balanced equations.
> - Oxidising nature of H_2O_2 should be emphasized.
> - How ozone oxidises I^- to I_2 should be explained.
> - Emphasis should be given on writing complete and correct equations in the manufacture of sulphuric acid by contact process.

MARKING SCHEME	
Question 6	
(a) (i)	$2KMnO_4 + 16HCl \xrightarrow{\text{heat}} 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$
(ii)	$PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$
(iii)	$2KI + H_2O + O_3 \rightarrow 2KOH + I_2 + O_2$
(b)	Theory: $\quad S + O_2 \xrightarrow{\text{heat}} SO_2 \quad$ or $\quad 4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$ Catalytic oxidation of SO_2 $\quad 2SO_2 + O_2 \xrightarrow{Pt \ or \ V_2 \ 05} 2SO_3 \quad \Delta H = -heat$ $\quad SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ $\qquad$ Conc. $\qquad$ oleum $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

Question 7

(a) (i) What are the types of hybridisation of iodine in interhalogen compounds IF_3, **[3]** IF_5 and IF_7, respectively?

(ii) Draw the structure of xenon hexafluoride (X_eF_6) molecule and state the hybridisation of the central atom.

(b) Give the balanced equations for the conversion of argentite (Ag_2S) to metallic silver. **[2]**
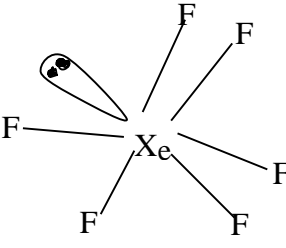
Comments of Examiners

(a)(i) Hybridisation of iodine in interhalogen compounds IF_3, IF_5 and IF_7 respectively was not correctly mentioned by some candidates. The candidates wrote dsp^3, d^2sp^3 and d^3sp^3 instead of sp^3d, sp^3d^2 and sp^3d^3.

(ii) Many candidates were able to draw six covalent bonds between XeF_6, but they did not show the lone pair. Some wrote sp^3d^2 hybridisation instead of sp^3d^3.

(b) Many candidates wrote either incorrect or incomplete equations for the conversion of argentite to metallic silver. Candidates did not mention reversible sign for reaction of Ag_2S with NaCN. Some candidates wrote incorrect formula of the complex compound.

> **Suggestions for teachers**
> - The concept of hybridization should be explained to students by taking various examples in class.
> - Explain the compounds of Xenon with fluorine, their geometry, hybridization and structure in detail.
> - Advise students to write proper balanced equations for extraction of metals.

	MARKING SCHEME	
	Question 7	
(a)	(i)	$IF_3 - Sp^3d$ $IF_5 - Sp^3d^2$ $IF_7 - Sp^3d^3$
	(ii)	 Sp^3d^3 hybridisation
(b)		$Ag_2S + 4NaCN \rightleftharpoons 2Na[Ag(CN)_2] + Na_2S$ $2Na[Ag(CN)_2] + Zn \rightarrow Na_2[Zn(CN)_4] + 2Ag$

Question 8

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

  (i) Acetaldehyde to propan-2-ol. **[1]**

  (ii) Nitrobenzene to p-aminoazobenzene. **[1]**

  (iii) Acetic acid to methylamine. **[2]**

  (iv) Aniline to benzene. **[1]**

(b) (i) How will you distinguish between primary, secondary and tertiary amines by Hinsberg's test? **[1]**

  (ii) Why do alcohols possess higher boiling points as compared to those of corresponding alkanes? **[1]**

(c) Identify the compounds A, B and C: **[3]**

  (i) $C_6H_5COOH \xrightarrow{Pcl_5} A \xrightarrow{H_2-Pd/BaSO_4} B \xrightarrow[\text{distil}]{\text{KCNalc}} C$

  (ii) $H-C\equiv C-H \xrightarrow[\text{dilH}_2SO_4+HgSO_4]{H_2O} A \xrightarrow[\text{[Ni]}]{H_2} B \xrightarrow[\text{conc H}_2SO_4]{140^oC} C$

Comments of Examiners

(a) (i) Most of the candidates wrote the conversion correctly, from acetaldehyde to propan-2-ol by using Grignard's reagent.

  (ii) Many candidates converted nitrobenzene to aniline but could not correctly complete the conversion upto p-amino azobenzene.

  (iii) Some candidates did not show heat after the formation of ammonium acetate to give acetamide.

  (iv) Aniline was directly converted to benzene by some candidates without the formation of benzene diazonium chloride.

(b) (i) Solubility of 1° amine in KOH and insolubility of 2° amine was missed by many candidates. For 3° amine, some candidates wrote 'clear solution', although it does not react.

  (ii) Many candidates were not able to write the correct reason.

(c) (i) Compounds A and B were identified correctly by most of the candidates but compound C i.e. benzoin was not identified correctly by several candidates.

Suggestions for teachers

· More practice should be given in conversion of organic compound s. Every step of conversion must be shown with proper reagent/conditions.

· Conversion of nitrobenzene to aniline and then C_6HsN_2Cl is an important aspect of many conversions hence must be practiced in class

· Insist that candidates give detailed explanation of the reaction by mentioning the solution, precipitate and the effect of addition of KOH

· How the extent of intermolecular hydrogen bonding affects the boiling point of alcohols should be explained to students.

· Insist that students must learn all the important name reactions. Stress upon writing the complete balanced equations with the correct conditions/reagents.

· More practice should be given in identification of organic compounds.

(ii) Many candidates identified compounds A and B i.e. CH$_3$CHO and C$_2$H$_5$OH correctly but some were not able to identify compound C.

MARKING SCHEME

Question 8

(a)	(i)	$CH_3MgBr + CH_3 - \underset{\underset{H}{\mid}}{C} = O \rightarrow CH_3 - \underset{\underset{H}{\mid}}{\overset{\overset{CH_3}{\mid}}{C}} - OMgBr \xrightarrow{HOH} CH_3 - \underset{\underset{H}{\mid}}{\overset{\overset{CH_3}{\mid}}{C}} - OH + Mg(OH)Br$
	(ii)	$C_6H_5NO_2 \xrightarrow[6[H]]{Sn/HCl} C_6H_5NH_2 \xrightarrow[0^o-5^oC]{NaNO_2+HCl} C_6H_5N_2Cl$ $C_6H_5N_2Cl + C_6H_5NH_2 \rightarrow C_6H_5\text{-}N = N\text{ - }C_6H_4NH_2 + HCl$ <center>(p-aminoazobenzene)</center>
	(iii)	$CH_3COOH \xrightarrow{+NH_3} CH_3COONH_4 \xrightarrow{\Delta} CH_3CONH_2 \xrightarrow{Br_2/KOH} CH_3NH_2$
	(iv)	$C_6H_5NH_2 \xrightarrow[0^o-5^oC]{NaNO_2+HCl} C_6H_5N_2Cl \xrightarrow[Cu+]{H_3PO_2,H_2O} C_6H_6$
(b)	(i)	1° amine $\xrightarrow[KOH]{C_6H_5SO_2Cl}$ *clear solution* $\xrightarrow{HCl}$ an insoluble substance 2° amine $\xrightarrow[KOH]{C_6H_5SO_2Cl}$ *An insoluble substance* $\xrightarrow{HCl}$ no change(insoluble) 3° amine $\xrightarrow[KOH]{C_6H_5SO_2Cl}$ *no reaction (insoluble)* $\xrightarrow{HCl}$ clear solution
	(ii)	In alcohols, inter molecular hydrogen bonding occurs due to which the boiling point of alcohols are higher than those of corresponding alkanes. Alkanes do not form hydrogen bond.
(c)	(i)	A = $\quad$ C$_6$H$_5$COCl B = $\quad$ C$_6$H$_5$CHO C = $\quad$ $C_6H_5-\underset{\underset{H}{\mid}}{\overset{\overset{OH}{\mid}}{C}} - \overset{\overset{O}{\parallel}}{C}-C_6H_5$
	(ii)	A - CH$_3$CHO B $\quad$ CH$_3$CH$_2$OH C $\quad$ CH$_3$CH$_2-$O CH$_2$CH$_3$

Question 9

(a) Give balanced equations for the following name reactions: **[3]**
   (i) Friedel-Crafts reaction (alkylation)

   (ii) Williamson's synthesis

   (iii) Aldol condensation

(b) Give chemical test to distinguish: **[3]**
   (i) Ethyl alcohol and sec-propyl alcohol

   (ii) Acetaldehyde and acetic acid

(c) (i) Deficiency of which vitamin causes the following diseases: **[4]**

(1) Scurvy

(2) Night blindness

(ii) Write two differences between globular and fibrous proteins.

Comments of Examiners

(a) (i) Some candidates wrote Friedel Crafts acylation instead of Friedel-Crafts alkylation. The catalyst use in the reaction was not mentioned in a few cases.

(ii) Williamson's synthesis reaction was well attempted by most of the candidates.

(iii) Many candidates did not mention the catalyst - dilute NaOH. Some wrote the catalyst as, 'concentrated NaOH;

(b) (i) Most of the candidates could give correct observations with Lucas test or with Victor Meyer's test. Some candidates wrote the iodoform test which cannot be used to distinguish ethyl alcohol and sec-propyl alcohol.

(ii) Tollens reagent test and Fehling's solution test were mentioned in many answers but the observations in several cases were not correct.

(c)(i) (1) This part was answered correctly by most of the candidates.

(2) Some candidates wrote vitamin D/ vitamin B instead of 'Vitamin A'.

(ii) Many candidates could not differentiate between globular protein and fibrous protein correctly. They wrote that globular proteins are globule like and fibrous proteins are fibre like. A few candidates gave examples only.

MARKING SCHEME
Question 9

(a)	Friedel – Crafts reaction (alkylation)	
	(i)	
	(ii)	Williamson's synthesis $CH_3CH_2Br + NaOCH_3 \rightarrow CH_3CH_2 - O - CH_3 + NaBr$

	(iii)	

$$CH_3-\overset{\overset{\text{O}}{\|}}{\underset{\underset{\text{H}}{|}}{C}} + HCH_2CHO \xrightarrow{\text{dil.NaOH}} CH_3-\overset{\overset{\text{OH}}{|}}{\underset{\underset{\text{H}}{|}}{C}}-CH_2CHO$$

aldol

(b)		Chemical test:
	(i)	Ethyl alcohol and sec-propyl alcohol

Victor Meyer's Test – Ethyl alcohol gives red colour solution

Sec-propyl alcohol gives blue colour solution

Lucas Test – Ethyl alcohol does not react with Lucas reagent at room temperature and does not produce turbidity.

Sec-propyl alcohol reacts with Lucas reagent and produce turbidity within 5 minutes.

(or any other suitable test)

	(ii)	Acetaldehyde and acetic acid:

Silver mirror test: Acetaldehyde gives silver mirror test with Tollen's reagent. Acetic acid does not give this test.

Fehling's solution test: Acetaldehyde gives red precipitate with Fehling's solution. Acetic Acid does not give this test.

$NaHCO_3$ Test: Acetic acid gives brisk effervescence of CO_2, Acetaldehyde does give this test.

$FeCl_3$ Test: On adding aq. $FeCl_3$ to acetic acid, blood red colouration is produced. Acetaldehyde does not give this test.

(or any other suitable test)

(c)	(i)	(1) Vitamin C
		(2) Vitamin A

	(ii)		Globular Protein	Fibrous protein
		1	These proteins are soluble in water	These proteins are insoluble in water
		2	They are very sensitive to changes in pH, temperature	They are stable to moderate changes in pH and temperature
		3	Possess folded spheroids structure	Possess thread like structures.

Question 10

(a) An aliphatic unsaturated hydrocarbon (A) when treated with H_gSO_4/H_2SO_4 yields a compound (B) having molecular formula C_3H_6O. (B) on oxidation with concentrated HNO_3 gives two compounds (C) and (D). Compound (C) when treated with PCl_5 gives compound (E). (E) when reacts with ethanol gives a sweet-smelling liquid (F). Compound (F) is also formed when (C) reacts with ethanol in the presence of concentrated H_2SO_4. **[4]**

   (i) Identify the compound A, B, C, D, E and F.

   (ii) Give the chemical equation for the reaction of (C) with chlorine in the presence of red phosphorous and name the reaction.

(b) Answer the following: **[3]**

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

    (ii) Name the two organic compounds which have the same molecular formula C_2H_6O. Will they react with PCl_5? If they react, what are the products formed?

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

    (i) Methyl magnesium bromide with ethyl alcohol.

    (ii) Acetic anhydride with phosphorous pentachloride.

    (iii) Acetaldehyde with hydroxylamine.

Comments of Examiners

(a)(i) Identification of compound 'A', an aliphatic unsaturated hydrocarbon was not done correctly by some candidates. Many candidates failed to identify compound 'D' also.

  (ii) HVZ reaction was identified correctly by most of the candidates. Some candidates wrote the reaction with higher homologue of CH_3COOH.

(b)(i) Many candidates identified the polymer correctly as Nylon 6, but the type of polymer was mentioned as 'addition' instead of 'condensation polymer'. A few candidates wrote 'Nylon 66'.

  (ii) Some candidates mentioned that dimethyl ether will not react with PCl_5.

(c)(i) Most of the candidates wrote C_2H_6 instead of CH_4.

  (ii) Chemical equations written by many candidates were not balanced. In some cases, the formula of acetic anhydride was incorrect.

  (iii) Some candidates failed to write the correct formula of hydroxylamine. Several candidates did not mention that water is formed in the reaction.

MARKING SCHEME		
Question 10		
(a)	(i)	A = $CH_3C{\equiv}CH$
		B = CH_3COCH_3
		C = CH_3COOH
		D = HCOOH
		E = CH_3COCl
		F = $CH_3COOC_2H_5$

	(ii)	$CH_3COOH + Cl_2 \xrightarrow{\text{Red P}} ClCH_2COOH + HCl$ HVZ reaction.
(b)	(i)	Nylon 6 Condensation polymer.
	(ii)	$CH_3CH_2OH + PCl_5 \rightarrow CH_3 CH_2 Cl + POCl_3 + HCl$ Ethyl alcohol $CH_3{-}O{-}CH_3 + PCl_5 \rightarrow 2CH_3Cl + POCl_3$ Dimethyl ether
(c)		Balanced equations for the asked reactions:
	(i)	$CH_3MgBr + C_2H_5OH \rightarrow CH_4 + Mg{<}^{Br}_{OC_2H_5}$
	(ii)	$CH_3CO.O.OCCH_3 + PCl_5 \rightarrow 2CH_3COCl + POCl_3$
	(iii)	$CH_3CHO + H_2NOH \rightarrow CH_3 CH = NOH + H_2O$

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 by candidates

- Relative molecular mass and mole: Numerical problems of freezing point, van't Hoff factor, degree of dissociation.
- Chemical kinetics: Calculation of order of reaction, unit of different order reaction, value of rate constant (k), difference between order of reaction and molecularity.
- Solid state: Calculation of density of unit cells, number of ions in the unit cell of NaCl.
- Ionic equilibria: Solubility product, salt hydrolysis, ionic product of water.
- Chemical equilibrium: Le Chatelier's principle
- Electrochemistry: Electrolytic conductance, calculation of emf and free energy change.
- Coordination compounds: Nomenclature, isomerism, hybridisation etc.
- Balanced chemical equations of inorganic compounds.
- Conversion of organic compound, named organic reactions, chemical test to distinguish between organic compounds.
  Biomolecules, deficiency of vitamins.

Concepts in which candidates got confused

- Depression in freezing point and the freezing point of solution.
- Abnormal molecular weights and degree of dissociation.
- Common ion effect and solubility product.
- Order of reaction and unit of rate constant (k) for different order reactions.
- Schottky defect, Frenkel defect and density of crystals.
- Coordination isomerism and Ligand isomerism.
- Specific conductance and equivalent conductance.
- Gibbs free energy and emf of cell in terms of spontaneity.
- Named organic reactions
- Polymers and monomers, addition and condensation polymers.
- Globular and fibrous proteins.

Suggestions for candidates

- Read the question properly and then answer accordingly
- Avoid selective study
- Practice numerical problems regularly, solve the numerical stepwise with correct formula and write the answer with correct unit.
- Practice writing balanced chemical equations with necessary conditions.
- Nomenclature should always be as per IUPAC norms.
- Learn proper tests to distinguish different organic compounds.
- Be neat in your work. Write the correct question numbers.
- Learn to write the key words in your answer.
- Time your paper, keep time for rechecking to avoid careless mistakes.
- Be very regular in your studies.

Attempt all questions

Question 1 [7]

You are provided with two solutions as follows:

- **C-10** is a solution containing $3 \cdot 2$ gms of potassium manganate (VII) ($KMnO_4$) per litre.

- **C-11** is a solution prepared by dissolving $6 \cdot 85$ gms of impure sample of oxalic acid crystals ($H_2C_2O_4 \cdot 2H_2O$) per litre.

PROCEDURE:

Rinse and fill the burette with potassium manganate(VII) solution **C-10** ($KMnO_4$).

Pipette out 20 ml or 25 ml of the oxalic acid solution **C-11** ($H_2C_2O_4.2H_2O$) in a clean conical flask. To this, add 20 ml of dilute sulphuric acid (H_2SO_4) **C-12**, specially provided for this purpose. Warm the contents of the flask to $60^oC – 70^oC$. The heating should be continued till the first bubble appears at the bottom of the flask.

Remove the conical flask from fire and titrate this solution by running solution **C-10** from the burette. Shake the solution constantly till a permanent pale pink colour is obtained. Ensure that the pink colour obtained does not disappear on shaking the contents of the conical flask.

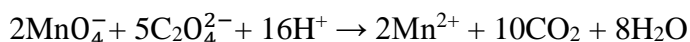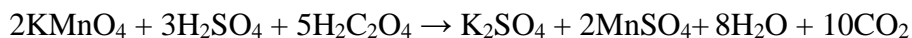Repeat the above procedure to get at least **two** concordant readings.
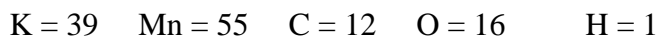
Tabulate your readings.

State:

(a) The capacity of the pipette used.

(b) The titre value you *intend* to use in your calculations.

   Show the titre value to the Visiting Examiner.

The equations for the above reactions are as follows:

$2KMnO_4 + 3H_2SO_4 + 5H_2C_2O_4 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2$

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

Relative atomic masses:

$K = 39$ $Mn = 55$ $C = 12$ $O = 16$ $H = 1$

Calculate the following:

(i) The **molarity** of potassium manganate (VII) solution **C-10.**

(ii)   The **molarity** of oxalic acid solution **C-11.**

(iii)   The **strength of** oxalic acid solution in gms per litre.

(iv)   The **percentage purity** of the sample of oxalic acid solution.

Note: Molarity must be calculated upto at least 4 decimal places.

Comments of Examiners

(i) A number of candidates did not seem to be aware of the significance of tabulating the readings. Some common errors observed were as follows:

- Initial and final readings were not written.

- Many candidates just gave one titre value; they did not have an understanding of 'concordant readings'.

- Some used average value with a difference between two readings of more than 0.2.

- Some candidates gave burette readings up to 2 decimal places, which was absurd.

- Some candidates did not read the question paper carefully and used incorrect solutions in the burette and pipette.

- Overwriting in the titre value was also observed.

- Candidates used incorrect formulae and incorrect atomic weights for calculating molecular weight of $KMnO_4$.

(ii) Many candidates used incorrect formulae to calculate molarity of hydrated oxalic acid i.e. grams per litre/ molecular weight instead of $M_1 V_1/M_2 V_2 = n_1/n_2 = 2/5$. Some candidates rounded off the value of molarity in questions (i) and (ii) and expressed only up to two places of decimal instead of four.

(iii) Some candidates reported molarity of C-10 and C-11 correctly upto 4 places of decimal but when they substituted the value of C-11 for the calculation of part (iii), they rounded off the value.

(iv) Some candidates used incorrect formula for calculating percentage purity of oxalic acid i.e. impure/pure into 100 instead of pure/ impure into 100.

MARKING SCHEME

Question 1

Calculations: Let the titre value be 24·3 mL

(i)	Molarity of the solution **C – 10** ($KMnO_4$)
	$\text{Molarity} = \dfrac{weight\ in\ grams\ per\ litre}{molecular\ weight} = \dfrac{3\cdot2}{158} = 0\cdot0202 \text{ M}$

(ii)	Molarity of the solution, **C - 11** (Oxalic Acid $H_2C_2O_4.2H_2O$)
	$\dfrac{M_1V_1}{M_2V_2} = \dfrac{n_1}{n_2}$ $\qquad\qquad$ M_1 – Molarity of C-10
	$\qquad\qquad\qquad\qquad\qquad\qquad V_1$ – Volume of C-10
	$\qquad\qquad\qquad\qquad\qquad\qquad n_1$ – Number of moles of C-10
	$\qquad\qquad\qquad\qquad\qquad\qquad M_2$ – Molarity of C-11
	$\qquad\qquad\qquad\qquad\qquad\qquad V_2$ – Volume of C-11
	$\qquad\qquad\qquad\qquad\qquad\qquad n_2$ – Number of moles of C-11
	$\dfrac{M_1V_1}{M_2V_2} = \dfrac{2}{5}$
	Let the titre value be 24·3 mL
	$\dfrac{\cdot0202\times24\cdot3}{M_2\times25} = \dfrac{2}{5}$
	$\qquad M_2 = 0\cdot0491 \text{M}$

(iii)	Strength in grams per litre of Oxalic acid
	$\qquad\qquad\qquad = \text{molarity} \times \text{molecular weight}$
	$\qquad\qquad\qquad = 0\cdot0491\times126 = 6\cdot1866 \text{ g / L}$

(iv)	% purity of Oxalic acid $= \dfrac{pure\ sample\,(gL^{-1})}{impure\ sample\ (gL^{-1})} = \dfrac{6\cdot1866}{6\cdot85}\times100$
	$\qquad\qquad = 90\cdot32\%$

Question 2 [4]

You are provided with two organic compounds, **C-13** and **C-14**.

Perform the experiments given below on each of the two compounds. Record the changes taking place at every step of the experiment.

Note the smell of the substance formed, if significant, the colour of the solution obtained, the colour of the precipitate produced and any other observations you may have. State the identity of each compound on the basis of the experiments and observational changes.

PROCEDURE:

(a) **Substance C - 13**

    (i)   Take 2 ml of saturated solution of sodium ($NaHSO_3$) in a test tube. To this, add a few drops of **C-13.** Shake well and gently warm the contents.

    (ii)   Take 1 ml of **C-13** in a test tube and add 1 ml of freshly prepared sodium nitroprusside solution, followed by 4 to 5 drops of dilute sodium hydroxide solution.

    (iii)   Take 2 ml of **C-13** in a test tube. To this, add a few crystals of iodine followed by a few drops of sodium hydroxide solution till the colour disappears. Warm the contents gently and cool.

(b) **Substance C-14**

Dissolve 2gm of the substance in 10 ml of hot water and perform the following tests:

    (i)   Take 2 ml of **C-14** in a test-tube and add a few drops of sodium bicarbonate solution.

    (ii)   Take 2 ml of **C-14** in a test-tube and add a few drops of concentrated sulphuric acid (H_2SO_4), followed by 5 ml of ethanol and heat the contents on water-bath.

    (iii)   Take 2 ml of **C-14** in a test-tube and add neutral ferric chloride ($FeCl_3$) solution.

Comments of Examiners

(a) C-13

Most candidates did not seem to have practical knowledge of reporting observations of organic compounds. They did not understand the significance of adding a particular reagent.

   (i) Some candidates reported evolution of a 'suffocating gas' instead of 'white precipitate' obtained.

   (ii) Many candidates reported 'red precipitate' instead of 'red /violet solution'. It seems that they did not know the difference between *solution* and *precipitate*.

   (iii) A number of candidates wrote "brown precipitate" or "yellow solution" or "yellow solution disappeared on adding sodium hydroxide" instead of "yellow precipitate of iodoform".

   (iv) C-13 was reported as ketone instead of acetone by several candidates.

(b) C – 14

   (i) 'White precipitate' was reported by many candidates instead of 'effervescence'.

   (ii) Some candidates reported formation of 'ethyl benzoate' instead of fruity smell of ester.

   (iii) Many candidates reported 'brown red precipitate' instead of 'buff coloured precipitate'.

MARKING SCHEME

Question 2

(Identification of organic compounds)

(a)	Substance **C-13**	
	(i)	**White crystalline precipitate** is obtained (residue/ solid/mass/ deposit).
	(ii)	A **violet / red / wine red** colouration is produced (solution/colour).
	(iii)	**Yellow precipitate** of iodoform having characteristic smell is obtained (residue/solid deposit/mass).
	(iv)	**C-13** is identified as **acetone.** *(based on any two correct tests.)*
(b)	**Substance C-14**:	
	Effervescences / gas evolved/ bubbles evolved.	
	Pleasant/ **fruity/ sweet/ smell** of Ester was obtained/ peppermint.	
	A **buff coloured precipitate** is formed. solid/ mass/ residue/ deposit	
	Deduction - C-14 is identified as **Benzoic acid**. *(based on any two correct tests.)*	

Question 3 [4]

Analyse qualitatively the substance **C-15** which contains *two* anions and *two* cations. Identify these ions.

(a)   While testing for **anions** you must mention:

    (i)   How the solution/soda extract was prepared.

    (ii)   How the gases were identified.

    (iii)   The confirmatory test for each anion.

Show the results as required to the Visiting Examiner.

(b)   While testing for **cations** you must mention:

    (i)   How the original solution for group analysis was prepared.

    (ii)   The formal group analysis with pertinent group reagents.

    (iii)   The confirmatory test for each cation.

Show the results as required to the Visiting Examiner.

Note: *Use of qualitative analysis booklet/table is not allowed.*

Comments of Examiners

(a) Wet tests for anions were performed by many candidates using either the aqueous solution or soda extract, instead of neutralized soda extract. Some other errors observed were as follows:

  (i) Sodium carbonate extract was incorrectly prepared with sodium bicarbonate instead of sodium carbonate.

  (ii) The confirmatory test for chloride was performed with salt mixture, concentrated sulphuric acid, manganese dioxide and heat instead of neutral sodium carbonate extract.

  (iii) The confirmatory test for chloride was left incomplete since the solubility of the precipitate in excess of ammonium hydroxide was not done.

  (iv) A few candidates reported Chromyl chloride test for chloride which is not acceptable.

  (v) Test for carbonate ion was done with original solution instead of salt mixture.

  (vi) Many candidates reported heat for carbonate ion which is not required.

  (vii) Some candidates added lime water to the test solution instead of passing the evolving gas through lime water.

(b) Many candidates prepared original solution for cation detection incorrectly. The salt mixture, or if residue of sodium carbonate extract was used, should have been dissolved in hot dilute HCl/ dilute HNO_3. Other errors observed were as follows:

  (i) Absence of groups I, II and III was not reported.

  (ii) H_2S was not boiled off before group III reagents were added.

  (iii) Most of the candidates did not add concentrated nitric acid in group III, boil and cool before adding group reagents.

  (iv) The order of preparing the buffer medium in group III was incorrect.

(v) The dirty white precipitate obtained in group IV was supposed to be used for confirmatory test of Zinc by dissolving in minimum quantity of dilute HCl and boiling, instead, candidates used the original solution.

(vi) In group zero several candidates used original solution instead of salt mixture and omitted heat in the test.

(vii) Many candidates performed the confirmatory test for ammonium ion incorrectly by adding Nessler's reagent to the test solution instead of passing the gas evolved into Nessler's reagent.

MARKING SCHEME

Question 3

Substance C-15

Mixture **C-15** contains **ammonium chloride** and **zinc carbonate** in the ratio (1:1) by mass.

	Carbonate ion
	Chloride ion
	Presence of Group Zero
	Confirmation of ammonium ion
	Presence of group IV
	Confirmation of zinc ion
	Preparation of sodium carbonate extract
	Preparation of original solution
	Details of tests: Test for carbonate: Sample/ **C-15** /Salt/ mixture + dil. Sulphuric acid – brisk **effervescence**. The gas when passed through lime water turns it **milky**/ turbid CO_3^{2-} ion present
	Preparation of sodium carbonate extract.
	1 part salt + 4 parts sodium carbonate + distilled water boil/warm/heat, cool and filter
	Test for chloride: To the Na_2CO_3 extract acidified with dil HNO_3 / acetic acid/ dil H_2SO_4
	Add silver nitrate solution. **Curdy white precipitate** is obtained which is soluble in excess of ammonium hydroxide, chloride ion is confirmed.
	Preparation of original solution in dilute HCl / dilute HNO_3.
	Group Zero: C_{15}/ Sample/ Salt /mixture when heated with sodium hydroxide, gives **pungent smelling** gas. Zero group present.
	Confirmatory test for NH_4^+ On placing a glass rod dipped in concentrated **HCl** near the mouth of the test tube gives **dense white fumes**. OR

Gas evolved in zero group is passed through **Nessler's reagent** which turns **brown**.
*Group IV: (This is accepted only if absence of group I, II and III is correctly shown). Passing H_2S gas through the third group solution gives **dirty white precipitate**. Group IV is present.
Confirmatory test for Zn^{2+}: Filter the above precipitate and **dissolve** it in dilute/ concentrated HCl with boiling. To the clear solution add NaOH solution drop by drop – **white precipitate appears** which dissolves in excess of NaOH. OR add **potassium ferrocyanide** solution – **bluish white** precipitate is obtained. (Zn^{2+} ion is confirmed).

Original solution + dilute HCl	No precipitate	Group I absent
*To the above solution of Group I pass H_2S gas OR If OS is made in HNO_3/ OS in dil HCl/ OS in HCl pass H_2S gas	No precipitate	Group II absent
*Boil off H_2S gas from the above solution (add concentrated HNO_3 and boil). Cool and add NH_4Cl solid and NH_4OH solution OR OS + NH_4Cl solid and NH_4OH solution only if 1 and 2 are correctly mentioned	No precipitate	Group III absent
*Pass H_2S gas through the above solution. OR OS + NH_4Cl solid and NH_4OH solution + Pass H_2S gas only if 1,2 and 3 are correctly done.	Dirty white precipitate	Group IV present

GENERAL COMMENTS

Topics found difficult by candidates

- Concepts of molarity based on (grams/litre)/ molecular weight for pure substances and morality based on titre value.
- Difference between precipitate and solution.
- Principles of formal group analysis.

Concepts in which candidates got confused

- Certain colours like buff precipitate.
- Solubility of mixture or preparation of original solution for group separation.
- Use of neutralized sodium carbonate extract for confirmatory test of anion.
- Identification of gases.
- Systematic analysis from group zero to IV and reporting absence and presence of groups.

Suggestions for candidates

- Learn thoroughly the basics of volumetric calculation before performing titrations.
- Titre value must be concordant and not average.
- Understand the chemistry involved in the precipitation of respective groups, and the importance of formal analysis.
- Learn formal group separation thoroughly with principles like buffer, common ion and solubility products.
- Do not forget the use of concentrated nitric acid in group III. Also understand why it is being used.
- Plan before writing formal group analysis.
- Listen to the teacher's instructions carefully, read the experiment thoroughly and then perform it.
- Develop a habit of observation and note them down correctly and to the point.
- Remember to tabulate your readings neatly, keeping in mind concordant readings not average and avoid overwriting in the tabular column.
- Do not round off molarity values, report to minimum four decimal places (check scope of syllabus).
- Follow the molecular formula given in the question paper, whether it is hydrated or anhydrous.
- Do not heat in the test of carbonate ion.
- Use of nitric acid and heating before adding reagents of group III and performing the confirmatory test for cation with group precipitate is a must.
- Remember to pass gas through a reagent and never add reagent to gas.