THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEM RESPONSE ANALYSIS REPORT ON THE DIPLOMA IN SECONDARY EDUCATION EXAMINATION (DSEE) 2021

CHEMISTRY

THE UNITED REPUBLIC OF TANZANIA

MNISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEM RESPONSE ANALYSIS REPORT ON THE DIPLOMA IN SECONDARY EDUCATION EXAMINATION (DSEE) 2021

732 CHEMISTRY

Published by:

The National Examinations Council of Tanzania,
P.O.Box 2624,
Dar es Salaam, Tanzania.

TABLE OF CONTENTS

FOREWORD

The National Examinations Council of Tanzania (NECTA) is pleased to issue this on Candidates' Items Response Analysis Report (CIRA) in the chemistry subject for Diploma in Secondary Education Examinations (DSEE) in the year 2021.

This report has been prepared to provide feedback to college tutors, teachers, parents, students, policy makers, school quality assurers and other education stakeholders on the candidates' performance this year. Basically, the candidates' responses to the examination questions show how the teaching and learning objectives were achieved in the classroom. It also shows the extent to which chemistry learning competencies were attained in the two-year DSEE.

The report highlights the factors behind the good performance of candidates on most of the topics. The factors which contributed to good performance of candidates include sufficient knowledge of the concepts assessed, having required skills for solving numerical problems, and understanding the principles of teaching and learning. For the few the few with weak performed, the candidates showed poor mastery of the assessed content and inability to interpret the demands of the questions.

The feedback provided in this report will enable educational stakeholders to identify proper measures to be taken in order to improve the teaching and learning of the chemistry subjects. Also, the given recommendations will be instrumental for enhancing the candidates' performance in future examinations particularly those administered by the Council.

Finally, the Council would like to thank all individuals who participated in processing and analyzing the data used in this report.

Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report on the analysis of candidates' performance aims at providing feedback on the performance of the Diploma in Secondary Education Examination candidates in the chemistry subject. The examination consisted of two papers, namely 732/1 Chemistry 1 (Theory paper) and 732/2 Chemistry 2 (Practical paper). The theory paper consisted of 16 questions in three sections, namely A, B and C. The practical paper consisted three questions.

The examination assessed the candidates' competences in using knowledge and skills gained in chemistry to solve daily life challenges, use and manage a chemistry laboratory, and assess learners' achievement objectively as stipulated in the syllabus.

The examination results show that the candidates who sat were 687, and all of them (100%) passed. This performance is better by 0.2 per cent compared to 2020 in which the percentage of the candidates who passed was 99.8. The analysis of the candidates' performance in 2020 and 2021 in grades is presented in Table 1.

Table of Candidates' performance of in the chemistry Examination

Year	Sat	Number of Candidates and Percentage					
		Passed	Grades				
			A	B	C	D	F
2020	872	870	1	94	612	163	2
		99.8%	0.1%	10.7%	69.6%	18.6%	0.2%
2021	687	687	9	148	444	78	0
		100	0.1%	21.5%	64.6%	11.4%	0%

Table 1, shows that all (100%) candidates passed in DSEE 2021, whereas 99.8 per cent of the candidates passed in 2020.

The performance statistics indicate that the performance in grades in higher in 2021 where 86.2 per cent got A to C, compared to the performance in 2020 in which the candidates who passed in the same grades is 80.4 per cent.

The candidates' performance in each question is categorized as good, average, or weak, based on the scores. These categories are in the ranges of 70 – 100; 40 – 69 and 0 – 39 respectively. Apart from the percentage ranges, different colours: green, yellow and red were used to represent these categories.

The report is presented into four sections, namely introduction, analysis of the candidates' performance in each question, followed by an analysis of performance in each topic and ends with conclusions and recommendations. In addition, summaries of performance by topics, and the comparative performance between 2020 and 2021papers are attaches as Appendices I and II.

2.0 ANALYSIS OF THE CANDIDATES' RESPONSES IN EACH QUESTION

This part analyses both performance statistics and candidates' responses on each question. The statistics in each question is presented with the aid of figures, while the descriptions of the responses are supported with extracts. The extracts are used as samples to portray the reality of good or weak responses which the candidates wrote in the examination.

2.1 732/1 Chemistry 1: Theory Paper

The Chemistry theory paper comprised three sections, A, B and C. Section A consisted of ten short answer questions. Each question weighed 4 marks. Section B had three structured questions from academic content. Each question weighed 15 marks. Section C had three essay questions from the pedagogic content. Each question had the weight of 15 marks. The candidates were required to answer all the questions in section A and two questions from each of section B and C.

2.1.1 Question 1: Chemistry Curriculum Materials

The question required the candidates to explain the importance of the chemistry syllabus in four points.

The general performance was good as 648 (94.2%) candidates passed by scoring from 2 to 4 marks, while 40 (5.8%) failed. The performance statistics are shown in Figure 1.

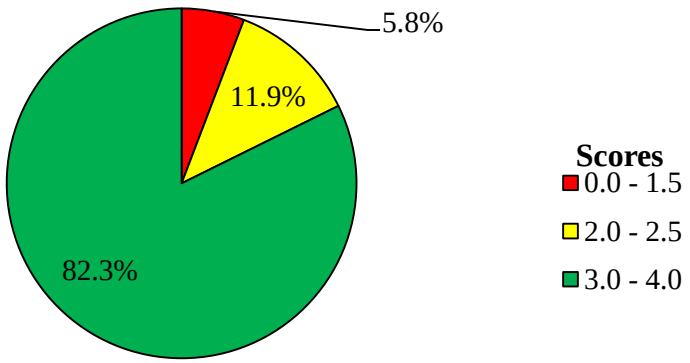
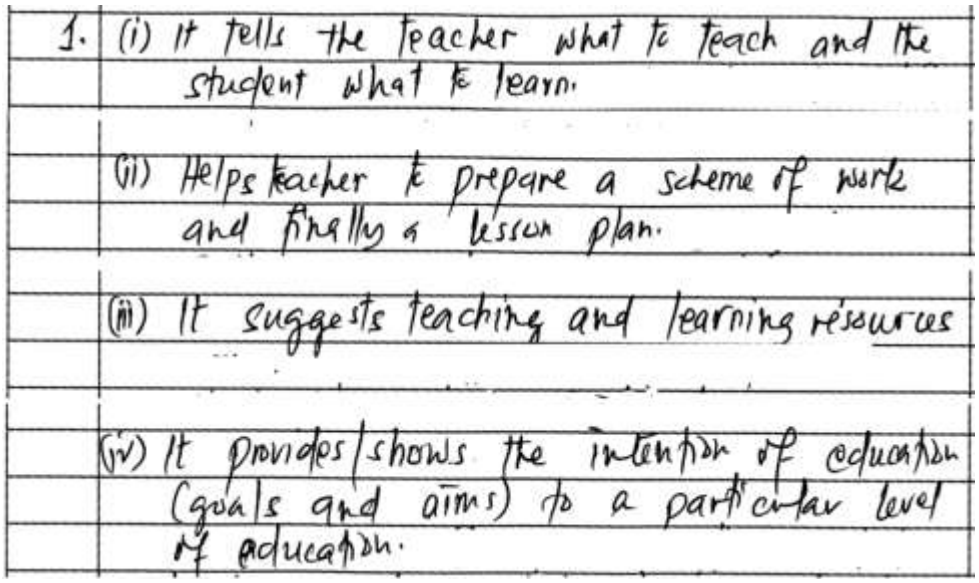


Figure 1: Distribution of the candidates' scores on question 1

Figure 1 shows that 82.3 per cent of the candidates scored 3 and 4 marks, 11.9 per cent scored 2.0 to 2.5 marks, while 5.8 percent scored 1.5 marks.

Analysis of the candidates' responses showed that the ones who scored 3 to 4 marks were able to explain the importance of chemistry syllabus in four points correctly. Most of them explained the importance of the chemistry syllabus such as*; to guides a subject teacher to teach the right content to the right students, helps a teacher to prepare scheme of work, lesson plans and lesson notes for specific lesson and learners, guides the teacher in setting internal examination like terminal examination and tests and finally, it guides the national examination council in setting national examination.* These correct responses suggest that they had adequate knowledge of curriculum materials in chemistry. Extract 1.1 shows an example of a correct response.

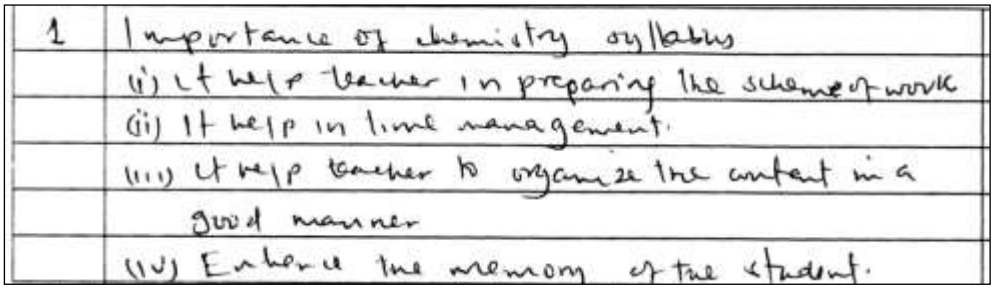


Extract 1.1: A sample of correct responses on question 1

In Extract 1.1, the candidate gave correct points to state the importance of chemistry syllabus.

Most of the candidates who scored average marks (2.0 to 2.5) provided few correct responses, and others gave mixed up responses. For example, one candidate wrote: *it acts as a catalyst that guide the teacher on what and how to teach student teachers at a certain level, it guides teachers in the preparation of scheme of work and lesson plan, it units students to the schools and it helps the teacher to teach the topic from simple to complex.* The first two responses correctly fulfil the requirement of the question.

In contrast, the candidates who scored low marks (0 to 1.5) showed insufficient knowledge of explaining the importance of the chemistry syllabus. For example, one of the candidates wrote: *it helps the teacher to teach in chronological manner, it guide the teacher to reflect on his/her own teaching progress, and it makes the teacher to be slavery on the document as he/she is not allowed to go beyond or outside the syllabus.* This candidate was not aware of the fact that the points given comprised of the importance of a lesson plan and not a syllabus. This implies that the candidates lacked knowledge about the distinction between the two concepts. Extract 1.2 shows more examples of incorrect responses.


1 Importance of chemistry syllabus
(i) It help teacher in preparing the scheme of work
(ii) It help in time management.
(iii) It help teacher to organize the content in a good manner
(iv) Enhance the memory of the student.

Extract 1.2: A sample of incorrect responses on question 1

With the exception of the first point, the rest points in Extract 1.2 are for the importance of a lesson plan.

2.1.2 Question 2: Planning and Preparation for Teaching

In this question, the candidate was instructed to identify four features of micro-teaching that differentiate it from other teaching practices.

The statistics show that the question was well performed as 566 (82.0%) of the candidates passed by scoring 2 marks and above, whereas 122 (17.7%) candidates scored below 2 marks. The distribution of the candidates scores are summarized in Figure 2.

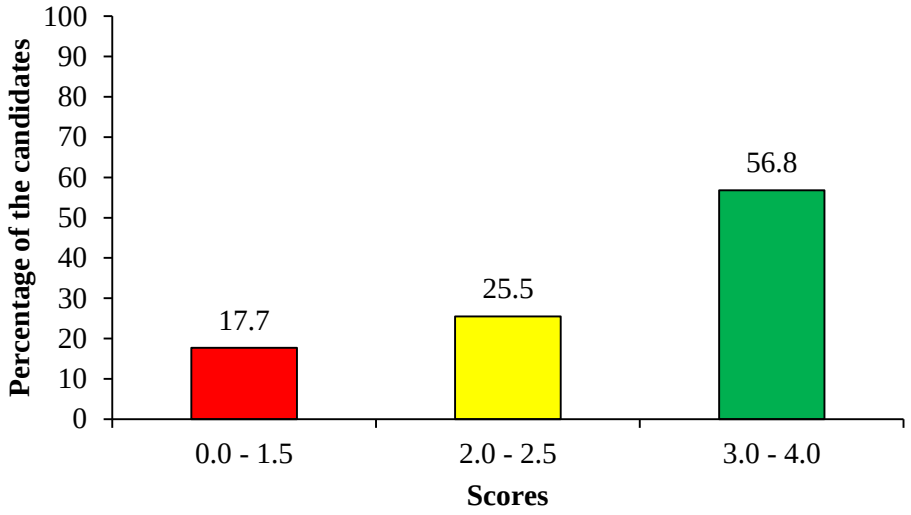
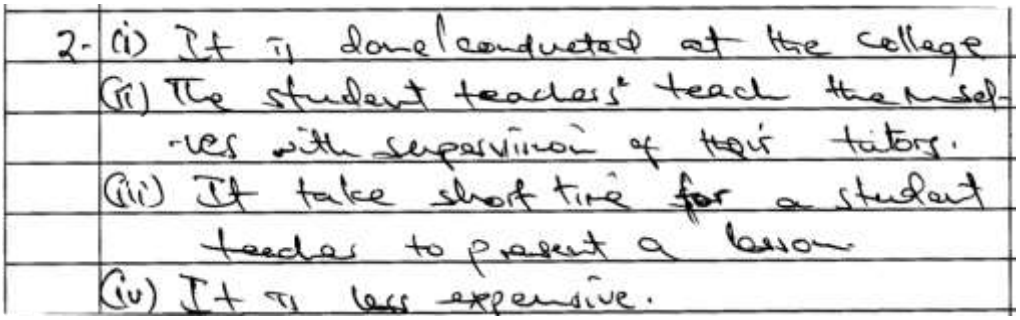


Figure 2: Distribution of the candidates' scores on question 2

The graph in Figure 2 shows that the majority of the candidates (56.8%) scored at 3 to 4 marks; 25.5 per cent scored averagely 2.0 to 2.5 marks, and 17.7 per cent scored 0 to1.5 marks.

The analysis from the candidates' responses revealed that those candidates who scored 3 to 4 marks demonstrated mastery of the content assessed. They correctly stated the features of micro-teaching that distinguish it from the rest of teaching practices. For example, one of the responses from a candidate was: *the micro-teaching is usually conducted within the college premises, the student teachers teach amongst themselves, during the teaching and learning session some students acts as students while assessing and evaluating the teaching process, and finally its less time consuming.* Similar responses are shown in Extract 2.1.

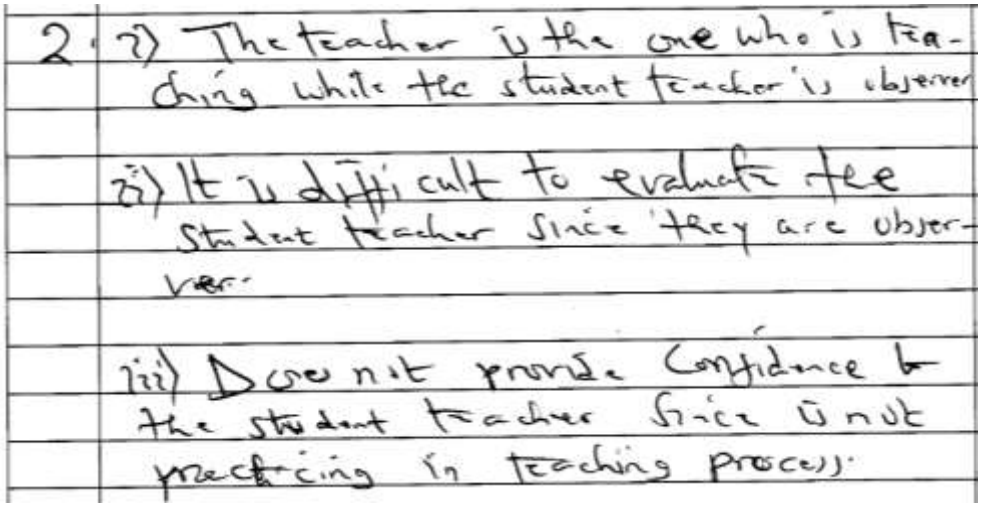

2- (i) It is done/conducted at the college
(ii) The student teachers' teach themselves with supervision of their tutors.
(iii) It take short time for a student teacher to present a lesson
(iv) It is less expensive.

Extract 2.1: A sample of correct responses on question 2

In Extract 2.1, the candidate gave correct points that make microteaching distinct from other types of teaching practices, such as block teaching practice and single lesson practice.

Further analysis showed that the candidates whose scores ranged from 2 to 2.5 marks gave mixed responses of correct and incorrect ones. For instance, one candidate wrote; *it does not involve assessment and evaluation, it does not expose student teachers to real life situation, spend little time and it is always conducted at the college.* Another candidate wrote: *it requires assessors for student evaluation, it is conducted before going to the BTP, its presentation or content or topic must be short and clear*. Those responses suggest that the candidates had inadequate knowledge of micro-teaching. These candidates failed to understand that, the comments about strengths and weakness of a lesson from fellow student teachers or tutor after presentation is part of formative assessment.

Besides, the candidates who scored low marks (0 to 1.5) they failed to meet the requirement of the question due to either insufficient knowledge of micro-teaching, or confused micro-teaching from other types of teaching practices. An example of the response from candidates who showed misconception is written: *it should be systematic, it should be understanding and well organized, it should be relevant to the learner, it should be relate to the environment.* These responses show that the candidate understood the question in the context of lesson preparation. Of the irrelevant responses, one candidate gave the features of micro-teaching as: *it creates friendships, no problem of language and vocabulary barriers since they meet with their fellow teachers, it does not require preparation of teaching methods and teaching aids*. Another one wrote; *it can be conducted outside the college, an experienced teacher teaches while student teachers observing, its session ranges from 40 minutes to one hour.* Such responses imply inadequate knowledge of micro- teaching. Another example is given as Extract 2.2.



Extract 2.2: A sample of incorrect responses on question 2

In Extract 2.2 the candidate gave points which are not related to microteaching practice.

2.1.3 Question 3: Chemical Kinetics, Energetic and Equilibrium

The question had two parts, (a) and (b). In part (a), the candidates were required to explain the difference between homogeneous and heterogeneous equilibria. In part (b), they were given an equilibrium reaction $2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$ at 230^{o}C and instructed to (i) write an expression of an equilibrium constant, (Kc), and (ii) explain what will happen on the equilibrium if NO_2 is removed from the system.

The overall performance in this question was good as 637 (91.7%) candidates scored 2 to 4 marks and only 57 (8.3%) scored below 2 marks. The distribution of the candidates' scores is summarized in Figure 3.

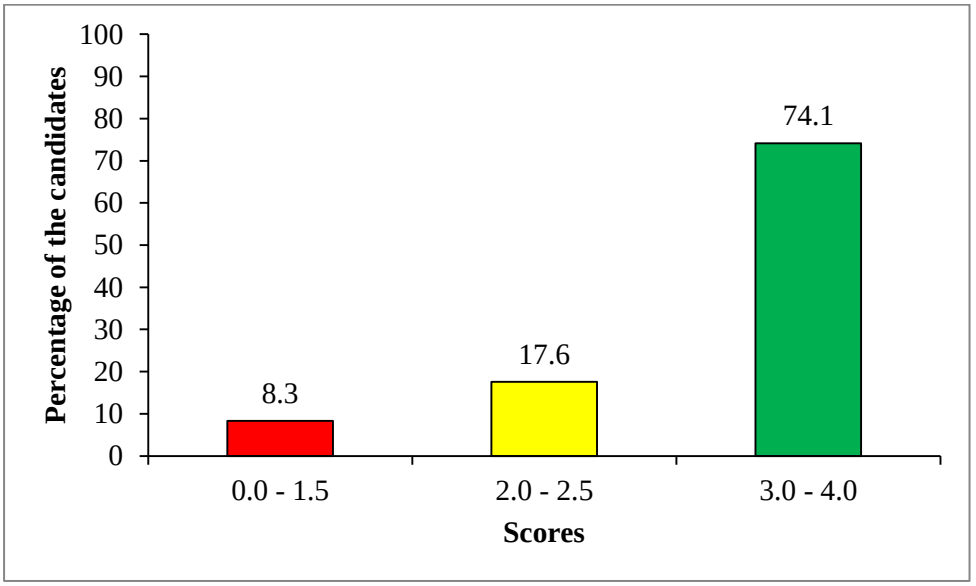


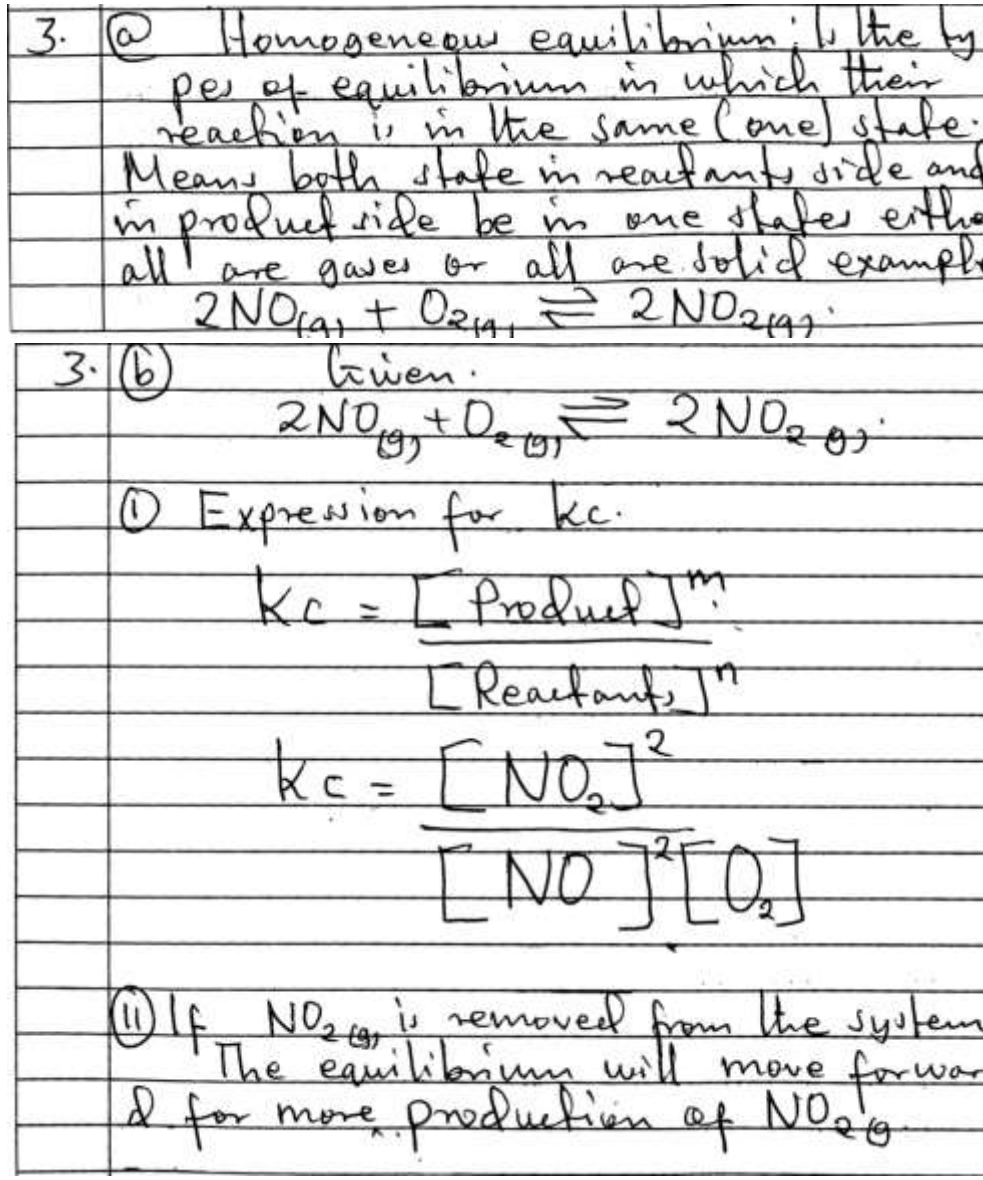
Figure 3: Distribution of the candidates' scores on question 3

Statistics shown in Figure 3 indicate that, about three quarters of the candidates (74.0%) scored from 3 to 4 marks; 17.6 per cent scored 2 to 2.5 marks, and the remaining 8.3% scored from 0 to 1.5 marks.

The analysis of the candidates' responses showed that those who scored 3 to 4 marks gave correct responses in both part (a) and (b). In part (a), they managed to describe the features of homogeneous and heterogeneous by using both words and symbols. For example, one candidate wrote that homogeneous equilibrium is *the reaction in which all reacting species are in the same phase* while heterogeneous equilibrium *is the reaction in which the reactants and products are in different phase.* In part (b) (i), the candidates managed to write the required equilibrium constant, Kc expression as

$$K_C = \frac{[NO_2]^2}{[NO]^2[O_2]}$$

In part (b)(ii), the candidates correctly applied the Le'Chatelier's principle to specify that when NO_2 gas is removed from the system, the equilibrium will shift forward to counteract the effect of change, hence favour more production of NO_2 gas. Extract 3.1 is an example of correct responses.

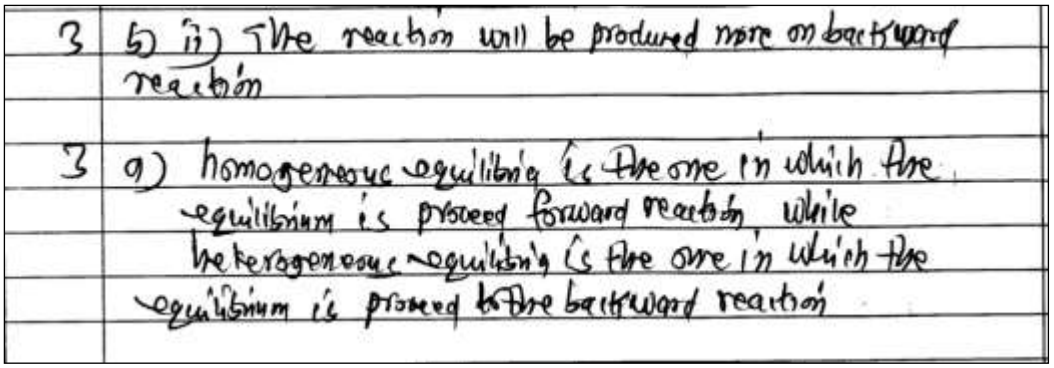


Extract 3.1: A sample of incorrect responses to question 3

In Extract 3.1, the candidate was able to state the differences between homogeneous and heterogeneous reaction, showed the required Kc expression and finally stated what is going to occur when nitrogen dioxide gas is removed from the system.

On the other hand, the candidates who scored 2.0 to 2.5 marks showed weakness in part (b) where the majority managed to write correct Kc expression, but failed to explain what will happen if the NO_2 is removed from the system.

Conversely, the candidates who scored below 2 marks gave incorrect responses in either both parts of the question, or skipped some parts of the question. An example of incorrect response is from a candidate whose response was: homogeneous equilibrium *are the elements used in reactant side are the same as those in product side* while heterogeneous equilibrium *are type of equilibrium in which elements used in reactant side are different from those used in product side.* In part (b) the response given was *when NO_2 is removed from the equilibrium the equilibrium will be unstable with no formation of product*. These responses imply that the candidate had inadequate skills and knowledge of chemical equilibrium. Additionally, the candidate was not familiar with the concept of Le'Chatelier's principle, which requires that when one species in equilibrium is removed from the system the reaction shifts to another side so as to resolve the effect of change. Extract 3.2 is an example incorrect response.


3 b) ii) The reaction will be produced more on backward reaction

3 a) homogeneous equilibria is the one in which the equilibrium is proceed forward reaction while heterogeneous equilibria is the one in which the equilibrium is proceed to the backward reaction

Extract 3.2: A sample of incorrect responses to question 3

In Extract 3.2 the candidate wrote about the "direction of the equilibrium" instead of the concept of state phase asked.

2.1.4 Question 4: Organic Chemistry

The question had two parts: (a) and (b). The candidates were required to explain why (a) alkenes are slightly more soluble than their corresponding alkanes and (b) the major product of the reaction between 1-butane and hydrogen bromide gas is secondary bromobutane, not primary bromobutane.

Statistics show that the general performance in this question was average as 301 (44.0%) scored 2 to 4 marks and, 385 (56.0%) candidates scored less than 2 marks. The distribution of the candidates' scores is shown in Figure 4.

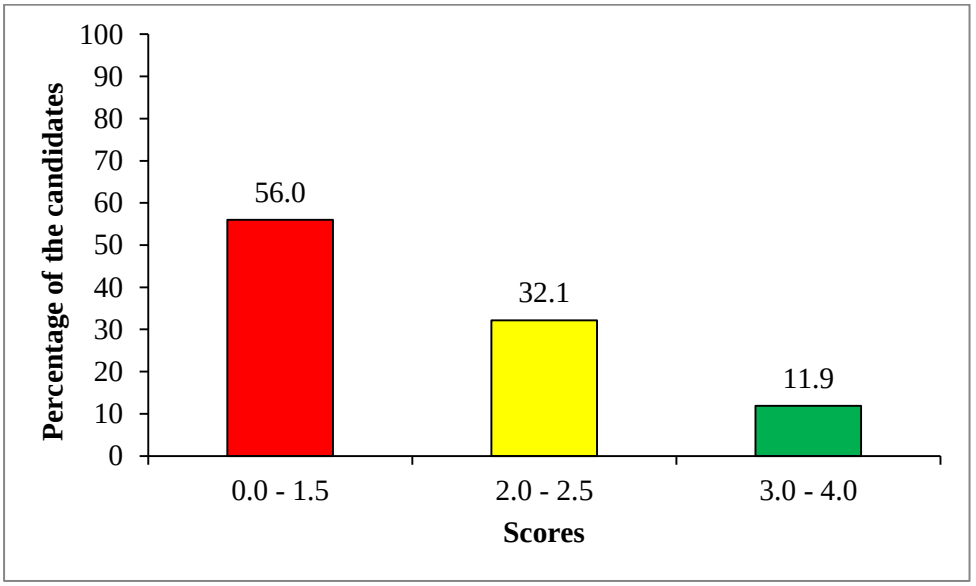
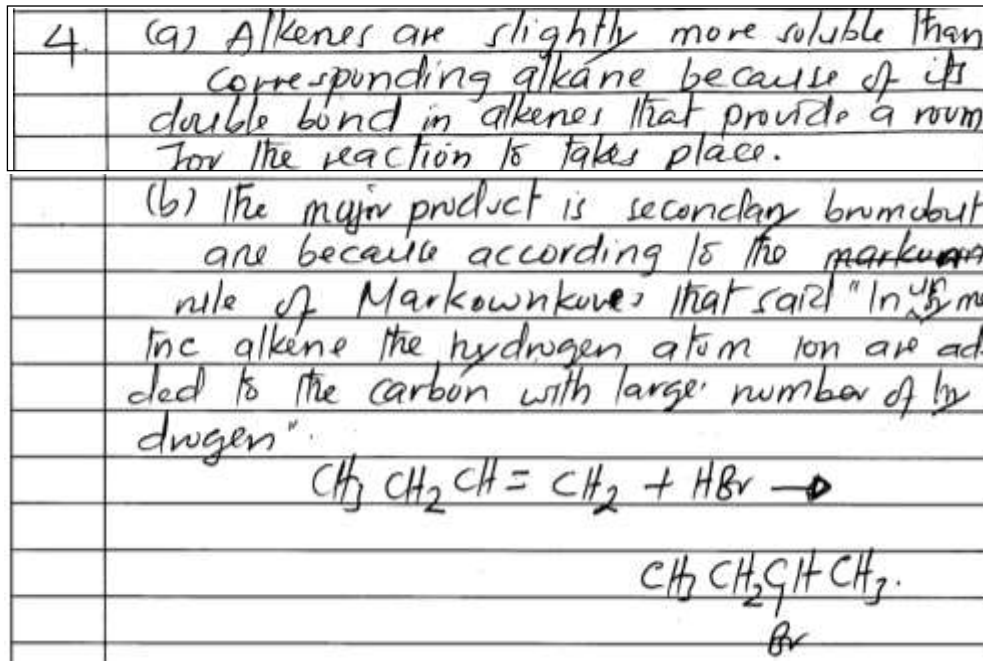


Figure 4: Distribution of the candidates' scores on question 4

From Figure 4, the data show that the majority (56.0%) of the candidates 0 to 1.5 marks, 32.1 per cent scored 2 to 2.5 marks while only 11.9 per cent scored 3 to 4 marks.

The analysis of the candidates' responses revealed that most of the candidates who scored 3 to 4 marks managed to provide correct responses on both parts (a) and (b). In part (a) for instance, they were able to give correct responses like; *the alkenes are slightly soluble in water than the corresponding alkanes due to the presence of pie-bond electrons which makes the alkenes slightly polar. This property makes the pie-electron to attract electron from water*. Likewise, in part (b), the candidates explained that the major product of the reaction between the compounds is $CH_3CH_2CHBrCH_3$. On the justification, the responses were based on the Markonikov's rule. For example, one candidate wrote: *This is due to the Markonikov's rule which requires that on addition compound HX to unsaturated compound, the favourable product will be the one in which the H-atom adds to the carbon atom with larger number of hydrogen atom.* This indicates that candidates had relevant knowledge of the reactions in organic chemistry particularly aliphatic hydrocarbon. Extract 4.1 is another example of correct responses.



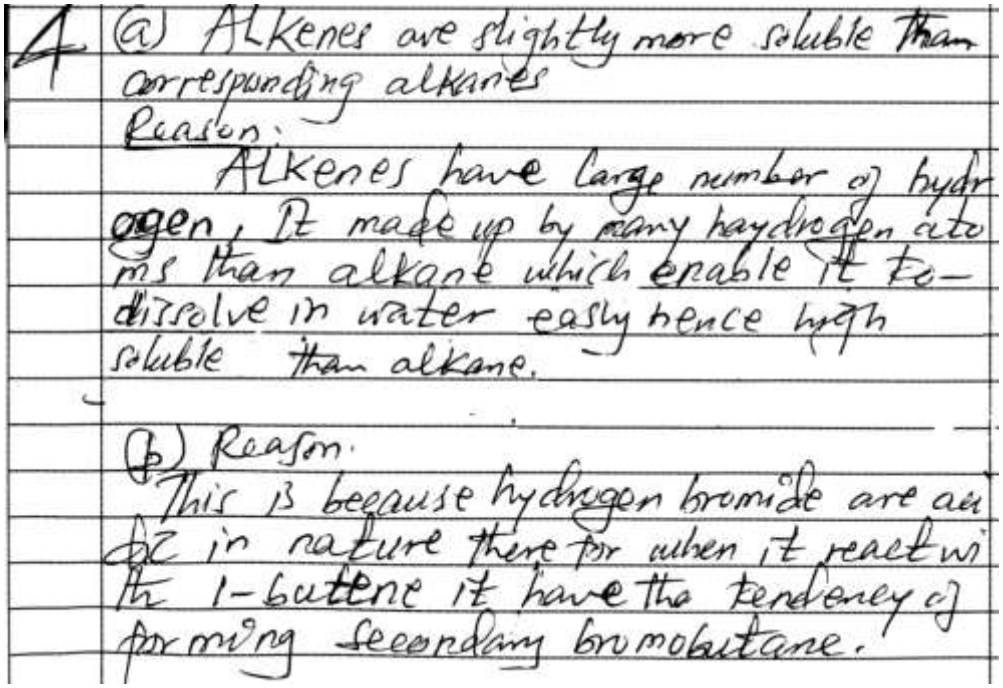
Extract 4.1: A sample of correct responses to question 4

In Extract 4.1, the candidate correctly gave the reason for the high solubility of alkenes compared to alkanes and applied Markonikov's rule to determine the major product for the reaction given.

The candidates with average performance provided unsatisfactory reasons in part (a) while others failed to answer part (b). For example, in part (a) one candidate wrote: *the alkenes slightly soluble in water than alkanes due to the presence of double bonds between carbon-carbon atoms that makes the alkenes to be partially polar.* In part (b) the candidate wrote; the *formation of secondary bromoalkane is much easier that primary bromoalkanes*. Others gave correct response in part (a) and showed the reaction equation between the compounds mentioned, instead of giving reasons. Nonetheless, others outlined the properties of the subsequent product of primary bromine in part (b), contrary to the demand of the question.

Some of those who scored 0 to 1.5 marks provided incorrect response on both parts of the questions by writing the general physical properties of organic chemistry. For example, in part (a), one candidate wrote *alkenes have higher density and melting points than alkanes.* Other candidates included the concepts of Vander-waal forces of attraction and intermolecular forces which are not applicable. In part (b), one candidate wrote *secondary*

bromoalkane obeys anti-markonikov's rule while primary bromoalkane adheres markonikov's rule. Another candidate wrote that the formation of secondary bromoalkane is due to principles of organic reactions which favour the formation of secondary bromoalkane than primary bromoalkane. Such responses indicate that these candidates had insufficient knowledge of organic chemistry or did not understand the question demands. Extract 4.2 is a sample of incorrect responses.


4 (a) Alkenes are slightly more soluble than corresponding alkanes
Reason:
Alkenes have large number of hydrogen, It made up by many haydrogen atoms than alkane which enable it to dissolve in water easly hence high soluble than alkane.

(b) Reason.
This is because hydrogen bromide are acid in nature therefor when it react with 1-buttene it have the tendeney of forming secondary bromobutane.

Extract 4.2: A sample of incorrect responses to question 4

Extract 4.2 indicates that the candidate had no idea of the factors responsible for the solubility of organic compounds; in part (a), they lacked knowledge of the applicability of the Markonikiv's rule in asymmetrical hydrocarbons.

2.1.5 Question 5: Assessment in Chemistry

The question required the candidates to state four merits of classroom tests.

Data analysis of data revealed that performance in this question was good as 681 (99.0%) candidates passed as they scored from 2 to 4 marks, while only 7 (1.0%) candidates scored below the pass mark. Figure 5 shows distribution of these data.

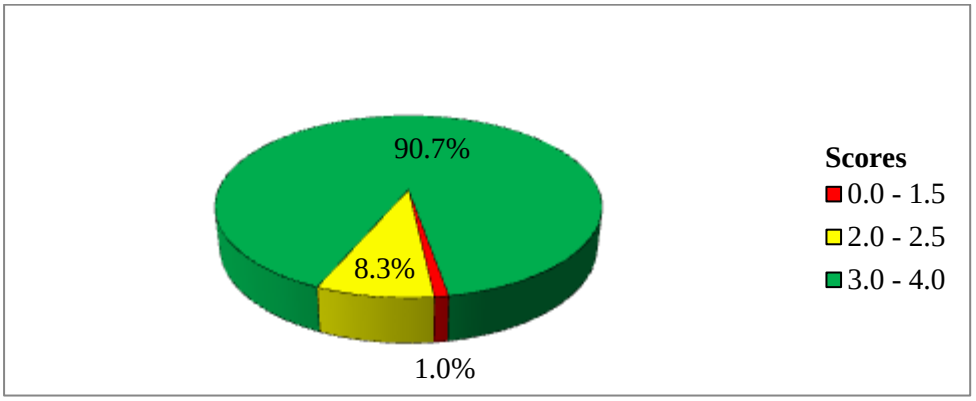
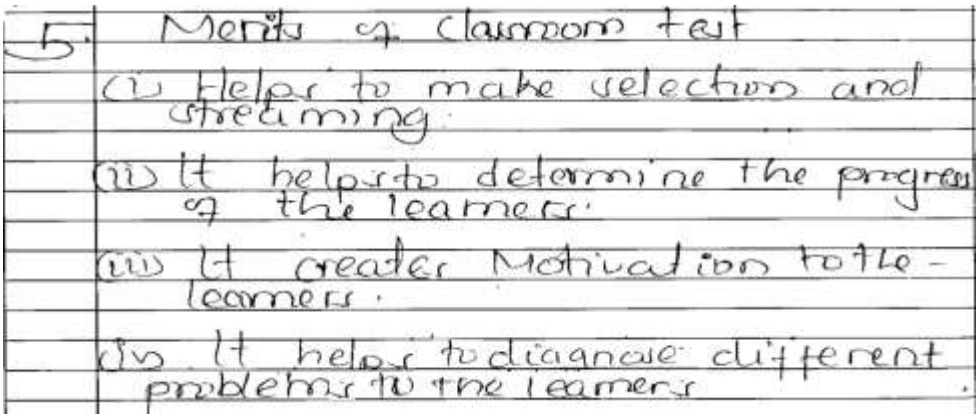


Figure 5: Distribution of the candidates' scores in question 5

Figure 5 shows that the majority of the candidates (90.7%) scored 3 to 4 marks, 8.3 per cent scored 2 to 2.5 and 1.0 per cent scored 0 to 1.5 marks.

The analysis of the candidates' responses showed that those who scored 3 to 4 marks managed to give the merits of classroom test. They stated correctly that the tests are used to *measure learners' progress, helps the teacher to make self-evaluation on content and pedagogical delivery, helps to identify learning diversities and individual differences among learners and serve as motivating agent for more learning.* Similar responses given were that the classroom test is used for *streaming and selection of learners, preparation of reports to parents and guardians, assessing relevance of the syllabus* and *prediction of future performance of the students.* These responses signify that candidates had mastered the topic of assessment in Chemistry. Extract 5.1 is another example of correct responses.

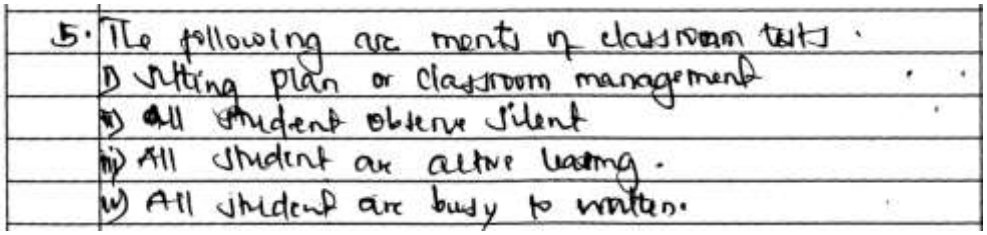

5. Merits of classroom test
(i) Helps to make selection and streaming.
(ii) It helps to determine the progress of the learners.
(iii) It creates Motivation to the learners.
(iv) It helps to diagnose different problems to the learners.

Extract 5.1: A sample of correct responses to question 5

Extract 5.1 shows that the candidate gave relevant points on the merits of classroom tests.

Further analysis revealed that, candidates who scored 2.0 to 2.5 marks provided unsatisfactory responses. For example, one candidate wrote; *it helps in summative evaluation, formative evaluation, diagnostic evaluation and content evaluation.* Another one wrote; *it helps to increase thinking capacity of the learners, makes the learners to be confident in answering the questions, it motivate learners and it help to identify strengths and weakness of the learners*. Such responses do not answer the question directly, hence they lost some marks. Generally, these candidates had basic knowledge of assessment in chemistry but failed to align the ideas properly.

Besides, the candidates who scored 0 to 1.5 marks failed to state correctly the merits of classroom tests for various reasons, including confusion between such a concept with a summative examination. As a result, some of them gave the functions of the summative examination by writing: *used for selection, certification, grading and placement*. Others gave irrelevant points emanated from trial and error. An example is a response from one candidate who wrote *helps to attain norm reference test, criteria reference test, for discrimination between higher achievers and lower achievers, and grading.* These candidates seem to possess basic knowledge of assessment in chemistry but failed to exactly locate the demand of the question. Other candidates, including the one whose response appears in Extract 5.2 gave points which do not match with the concept assessed.


5. The following are merits of classroom test:
i) Setting plan or classroom management
ii) All student observe silent
iii) All student are active learning.
iv) All student are busy to written.

Extract 5.2: A sample of incorrect responses to question 5

In Extract 5.2 the candidate wrote about merits of classroom management instead of classroom test. This is the effect of not reading the task of the question properly.

2.1.6 Question 6: Environmental Chemistry

The question had two parts: part (a) and (b). Part (a) required the candidates to explain the concept of soil reaction. In part (b) they were asked to describe two sources of acid in the soil.

The data analysis showed that 452 (65.7%) candidates scored 2 to 4 marks. This makes a general average performance. Figure 6 presents the distribution of the performance.

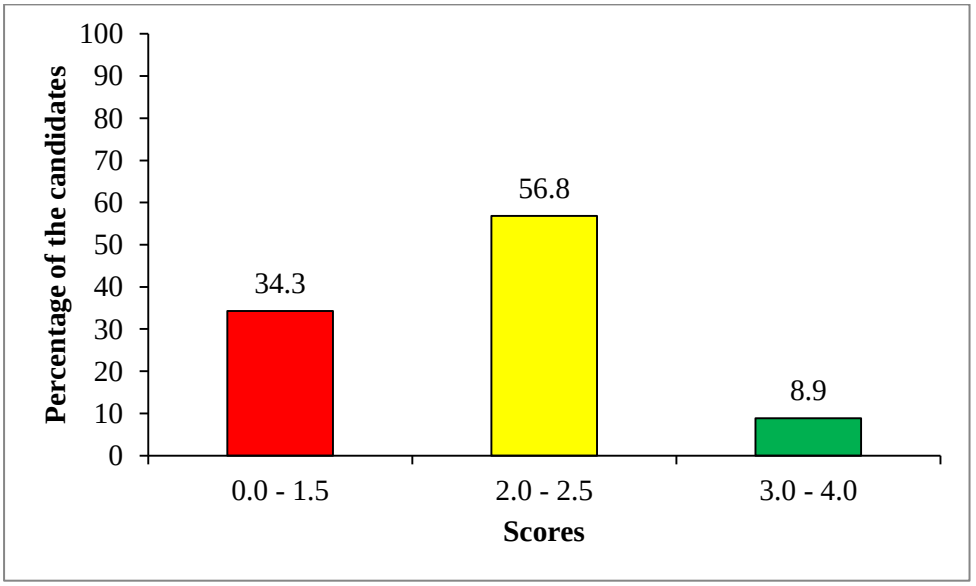
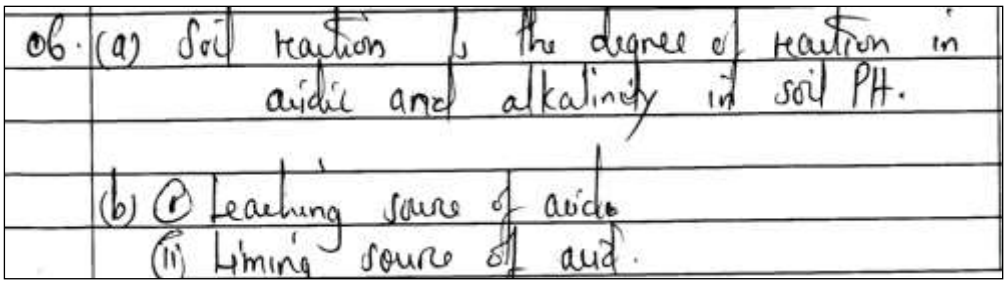


Figure 6: Distribution of the candidates' scores on question 6

As observed in Figure 6, about one third (34.3%) of the candidates scored 0 to 1.5 marks, 56.8 per cent scored 2 to 2.5 marks while only 8.9 per cent scored 3 to 4 marks.

The analysis of the candidates' responses showed that the ones whose scores were 0 to 1.5 failed to understand the requirement of the question. Some of them provided the responses which do not reflect the demands of the question. Others showed a general lack of knowledge of the concept of properties of soil. For instance, in part (a) one candidate wrote: *soil reaction is percentage purity in the soil*, while another one wrote it is a *percentage base of saturation in the soil*. In part (b) one candidates wrote two sources of acids in the soil as: *oxidation and reduction of ions in the soil due to increase and decrease of hydrogen ions concentration in the soil.* This candidate failed to differentiate the reaction processes involved in the soil

and not the sources of acids in the soils. Another examples of incorrect response is given as Extract 6.1.



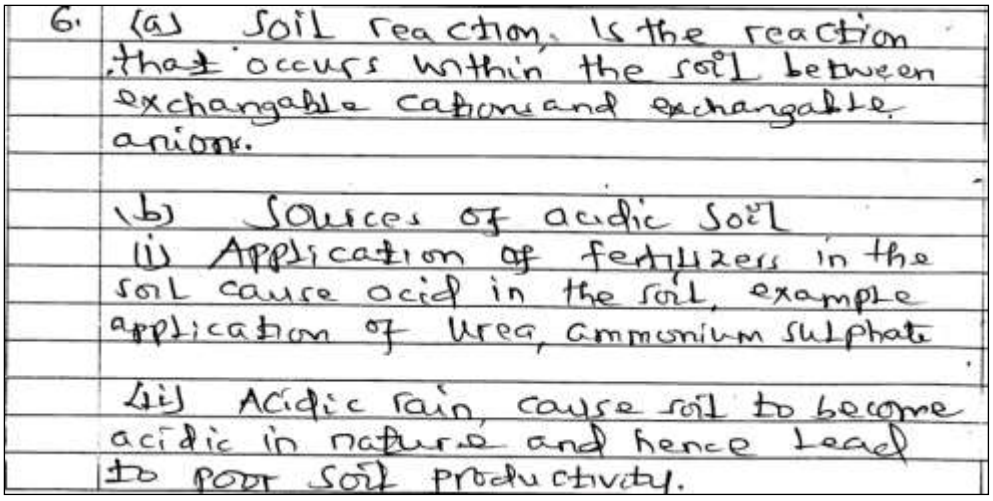
Extract 6.2: A sample of incorrect responses to question 6

Extract 6.2 shows an incorrect response whereby in part (a) the candidate gave the definition of soil pH instead of soil reaction. In part (b)(i), the candidate mentioned the process in which soil loses nutrients in (b)(ii) the treatment of the soil to reduce soil acidity.

Conversely, some of the candidates who scored 2.0 to 2.5 marks, some of them gave responses which were correct in content, but with little clarity due to lack of proficiency in the English language. Others wrote relevant responses in part (a) but irrelevant ones in part (b). For example, one candidate in part (a) wrote; *soil reaction is the percentage of alkaline and acidity in the soil*, while in part (b) mixed correct and incorrect points by writing: *acidic rain and adsorptions of sulphates ions, carbonates ions and nitrates ions in the soil leaching due to heavy rainfall and irrigation activities increases acidic in the soil.* This suggests that the candidates had knowledge of soil chemistry. In such a response, acidic rain, leaching and irrigation activities are correct points while the rest are not.

In contrast, the candidates who scored 3 to 4 marks managed to attempt both parts effectively. In part (a), they correctly indicated that soil reaction is a chemical combination or decomposition of mineral salts, acids and bases present in the soil. Such reactions are due to presence of metals, ions and water which results to acidic, basic or neutral type of soil. In part (b), most of them correctly wrote two sources of acids in the soil as; *acidic rain - which adds hydrogen ions in the soil, and presence of aluminium ions in the soil in which they are adsorbed on the soil colloidal particles*. Others mentioned chemicals applied in agriculture including artificial fertilizers, herbicides, pesticides and insecticides. Such responses are indication that the

candidates had enough knowledge on the concept of soil chemistry. Extract 6.1 is an example of correct responses'


6. (a) Soil reaction. Is the reaction that occurs within the soil between exchangable cations and exchangable anions.

(b) Sources of acidic soil

(i) Application of fertilizers in the soil cause acid in the soil, example application of Urea, ammonium sulphate

(ii) Acidic rain, cause soil to become acidic in nature and hence lead to poor soil productivity.

Extract 6.1: A sample of correct responses to question 6

Extract 6.1 shows the response from a candidate who correctly gave the meaning of soil reaction in part (a) and described the sources of acid in the soil.

2.1.7 Question 7: Electrochemistry

The candidates were provided with half-reaction equations:

$$MnO^{-}_{4(aq)} + 5e^{-} + 8H^{+} \text{®} Mn^{2+}_{(aq)} + 4H_2O_{(l)} \quad E^0 = 1.51V$$

$$ClO^{-}_{4(aq)} + 2H^{+}_{(aq)} \text{®} ClO^{-}_{3(aq)} + H_2O_{(l)} \quad E^0 = 1.19V$$

They were then required to: (a) give the overall balanced cell reaction, and (b) calculate E^o of the cell.

Statistics show that most of the candidates 479 (69.6%) failed since they scored below than 2 marks. Only 209 (30.4%) candidates passed by scoring 2 to 4 marks, suggesting a weak performance. Figure 7 shows the performance distribution.

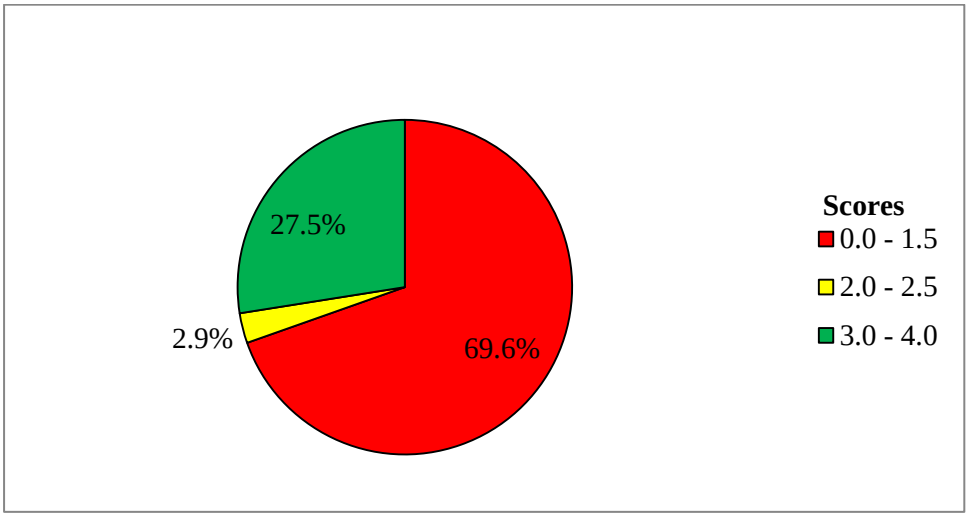
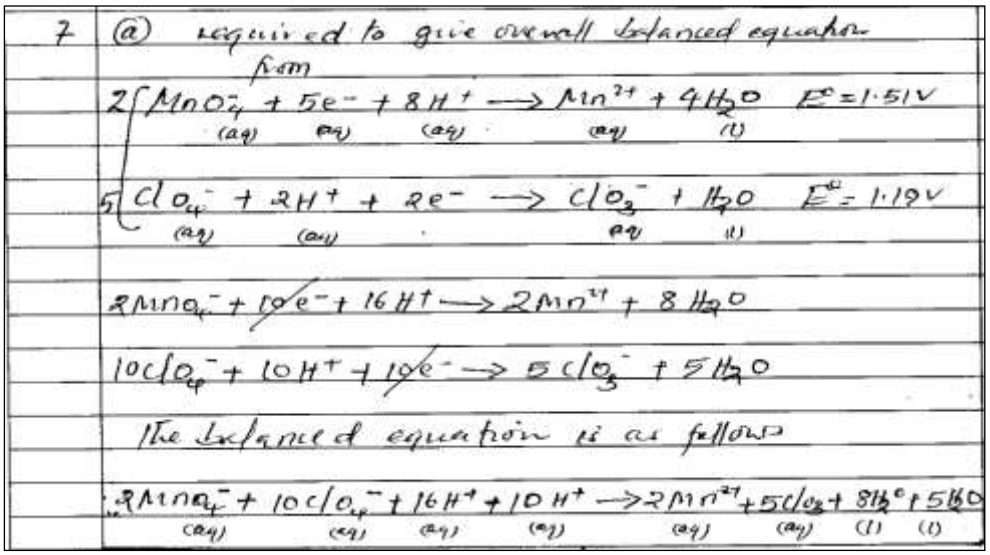


Figure 7: Distribution of the candidates' scores on question 7

The data in Figure 7 shows that most of the candidates (69.6%) scored 0 to 1.5 marks, 27.5per cent scored 3 to 4, and 2.9 per cent scored 2 to 2.5 marks.

The analysis of the candidates' responses revealed that most of the candidates who scored 0 to 1.5 marks failed to write correct responses due to incompetence in solving redox electrochemistry problems. They were specifically unaware that in order to be able to balance redox reaction, the reactants and products must be arranged in such a way to cancel common ions appearing in both sides of the reaction equation. Those who had the zero score failed even to calculate the electrode potential of the cell for the same reason of not rearranging the relevant equation. Extract 7.1 is given as a sample of incorrect response.



Extract 7.1 is an example of incorrect responses to question 7

In Extract 7.1 the second equation was not reversed, hence wrong balanced equation in part (a) and the value of electrode potential in part (b).

Some of those who scored from 2.0 to 2.5 marks gave responses that were either correct but lacked clear descriptions. Others could attempt only one of the parts. The general observation in this category was that the majority were challenged by the calculation in part (a). They failed to write the overall cell reaction, because they were unaware that one of these reactions needed to be reverse. Also, others reversed but could not multiply both half-cell reactions by respective integers in order to balance the number of electrons. Similarly, those who failed to find the electrode potential of a cell in part (b), few of them forgot to reverse the charge of voltage as a result of reversing the second cell reaction.

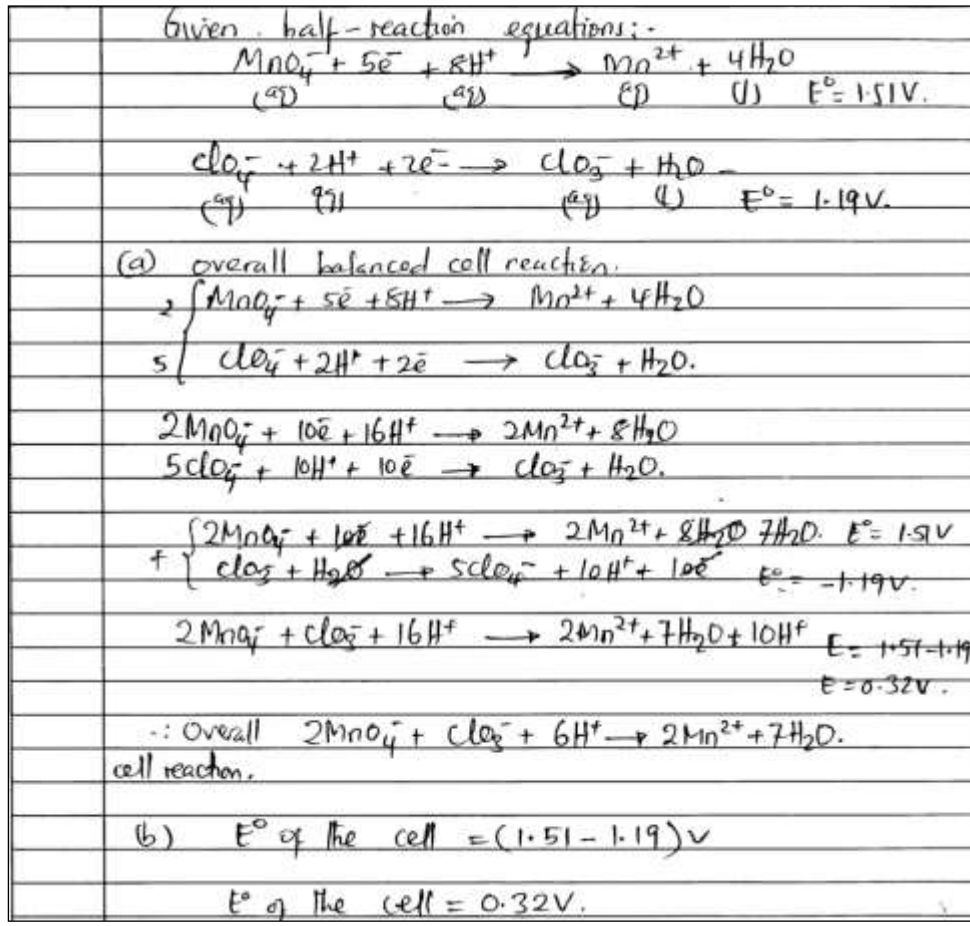
Further analysis on the candidates' responses indicates that those who scored 3 to 4 marks were able to give the overall balanced cell reaction and calculate electrode potential of the cell which is:

$$2(MnO^-_{4(aq)} + 5e^- + 8H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}) \qquad E^0 = 1.51V$$

$$5(ClO^-_{3(aq)} + H_2O_{(l)} \rightarrow ClO^-_{4(aq)} + 2H^+_{(aq)} + 2e^-) \qquad E^0 = 1.19V$$

$$2MnO^-_{4(aq)} + 6H^+_{(aq)} + 5ClO^-_{3(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 3H_2O_{(l)} + 5ClO^-_{4(aq)}$$

In part (ii), the standard electrode potential of the cell was calculated as E = 1.51V – 1.19V or E = 0.32V. another response from a candidate who managed to adhere to the expected procedure and the subsequent solution is shown in Extract 7.2.



Extract 7.1: A **s**ample relevant responses to question 7

In Extract 7.1 the candidate systematically followed the steps from the given half - cell reaction equations to get required overall equation and correct value of the electrode potential.

2.1.8 Question 8: General Chemistry

The question was divided into parts: part (a) and (b). In part (a) the candidates were required to write electronic configuration of (i) copper ($_{29}Cu$), (ii) calcium ion ($_{20}Ca^{2+}$) and (iii) chloride ion ($_{17}Cl^-$). In part (b) they were required to explain why atoms undergo hybridization.

The question was well performed since 447 (65.0%) candidates passed, whereas 241 (35.0%) failed. The details of performance are shown in Figure 8.

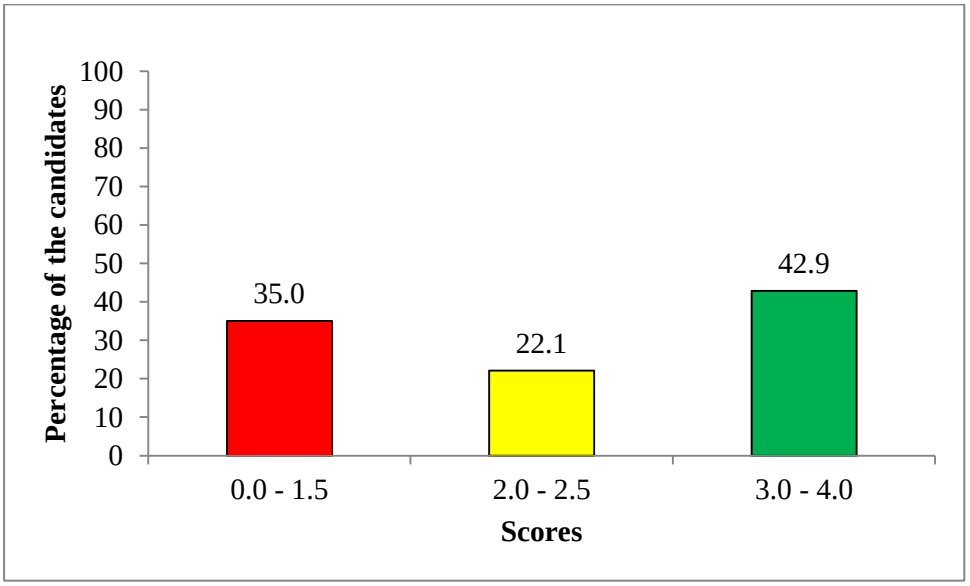


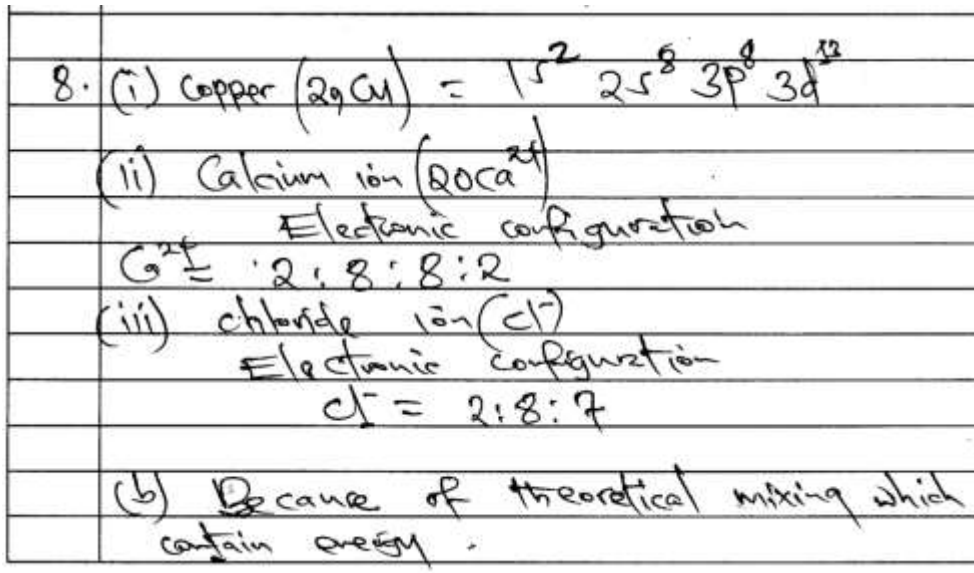
Figure 8: Distribution of the candidates' scores on question 8

in Figure 8, 42.0 per cent of the candidates scored 3 to 4 marks, 22.1 per cent scored 2 to 2.5 marks and 36.0 per cent scored 0 to 1.5 marks.

The analysis of the candidates' responses revealed that, those who scored 3 to 4 were able to attempt both parts (a) and (b) as per expected answers. For example in part (a) they correctly wrote electronic configuration of (i) Copper ($_{29}Cu$) as [Ar] $4s^1$ $3d^{10}$, (ii) Calcium ion ($_{20}Ca^{2+}$) as [Ar] and (iii) Chlorine ion ($_{17}Cl^-$) as [Ne] s^2 $3p^6$. In part (b), they indicated that atoms have to be *hybridized in order to gain stability*. These responses signify that the candidates had a good understanding of transition element specifically and general chemistry in general.

Most of the candidates who scored average marks, that is 2.0 to 2.5, faced difficulties in writing the electronic configuration of copper ($_{29}Cu$), that is [Ar] $4s^1$ $3d^6$ in part (a). They thought that "4s" could be full filled before the 3d according to Aufbau's principle, forgetting another principle governing electron filling in transition metals. In part (b), they provide unsatisfactory responses that attracted partial marks.

Similar observation revealed that those who scored 0 to 1.5 marks had inadequate knowledge of general chemistry and transition elements, hence wrote incorrect electronic configuration of all elements or ions. For instance, one candidate wrote electronic configuration of (i) copper ($_{29}Cu$) as 4s 3d, (ii) Calcium ion ($_{20}Ca^{2+}$) = $1s^2\ 2s^2\ 2p^6\ 3s^1\ 3p^2$ and Chlorine ion ($_{17}Cl^-$) = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$. In the first case, no number of electrons is shown, in the second particle, was expected a configuration of argon as the element given was oxidized, hence no outer shell. Also, the candidate did not consider the additional electron in chloride ion, hence gave the configuration of chlorine atom. In part (b) some of the candidates gave responses in the context of hybrid in living organism as one of them wrote: *atoms undergo hybridization so as to get improved hybrid in shape and energy.* More example is given in Extract 8.2.


8. (i) Copper (29Cu) = $1s^2\ 2s^8\ 3p^8\ 3d^{13}$

(ii) Calcium ion ($_{20}Ca^{2+}$)

Electronic configuration

Ca^{2+} = 2:8:8:2

(iii) chloride ion (Cl^-)

Electronic configuration

Cl^- = 2:8:7

(b) Because of theoretical mixing which contain energy.

Extract 8.2: A sample of incorrect responses to question 8

In Extract 8.2, the candidate wrote electronic configuration of calcium and chlorine atoms instead of writing the configuration of the ions of those atoms in part (a) and gave irrelevant response in part (b).

2.1.9 Question 9: Transition metals

The question had two parts: (a) and (b). In part (a) the candidates were required to find the oxidation state of iron in the complexes, $[Fe(CN)_6]^{4-}$ and $[Fe(CN)_6]^{3-}$. In part (b), they were required to identify the property of

cyanide ligand CN^- that makes it possible to form complexes with such a transition metal.

The performance statistics show that 579 (84.2%) of the candidates scored 2 to 4 marks while 109 (15.8%) candidates scored 0 to 1.5 marks. Figure 9 shows the distribution of these data.

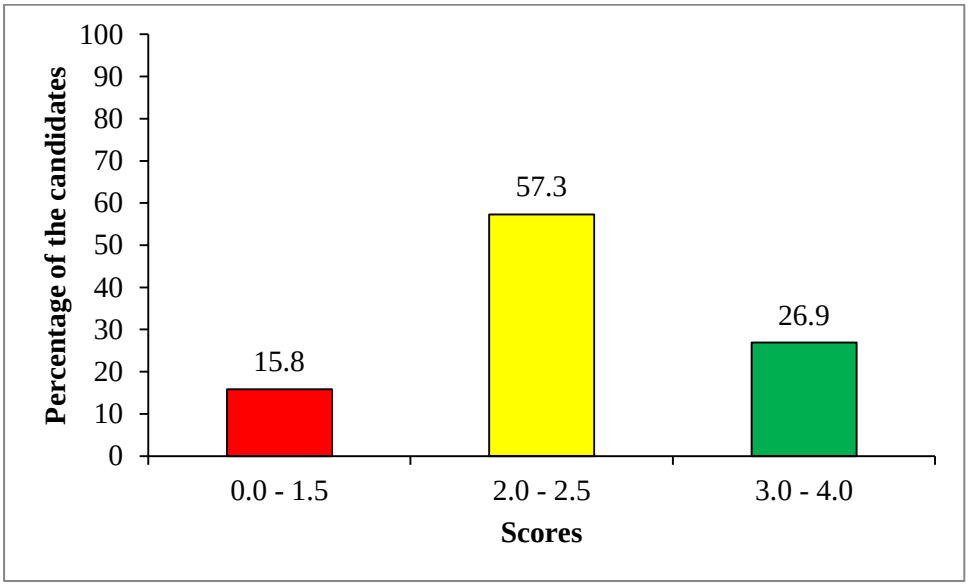
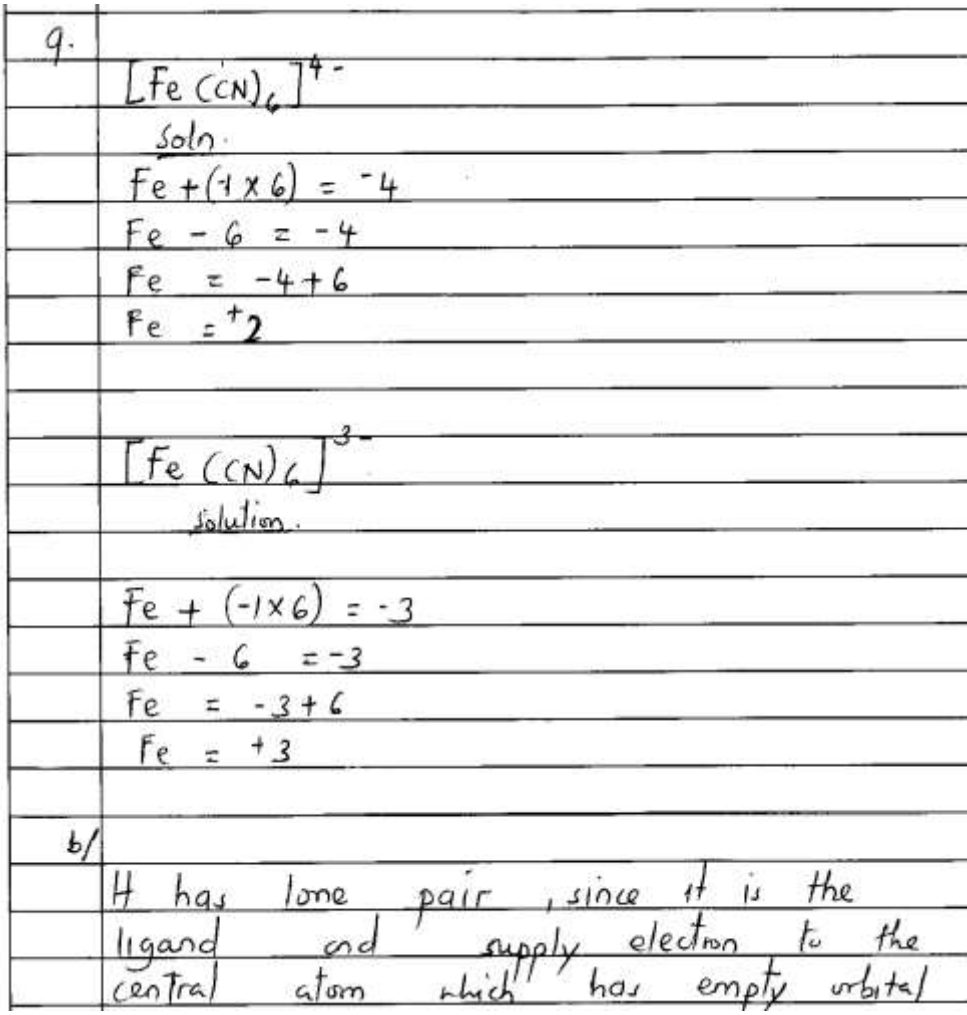


Figure 9: Distribution of the candidates' scores on question 9

The performance statistics in Figure 9 shows that, 26.91 per cent of the candidates scored 3 to 4 marks, 57.3 per cent scored 6 to 9.5 marks whereas 15.8% scored 0 to 1.5 marks.

The analysis of the candidates' responses revealed that those who scored 3 to 4 marks got in part (a), correct oxidation state of ion in complex $[Fe(CN)_6]^{4-}$ as +2 and in $[Fe(CN)_6]^{3-}$ as +3. In part (b) they correctly wrote that the ability of the cyanide ligang CN^- to form complexes with the given transition metal is due to the presence of lone pair in nitrogen atom. This implies that the candidate had sufficient knowledge of and skills in the concept of complex compounds, specifically central atoms and ligands. Extract 9.1 is an example of the correct response on question 9.



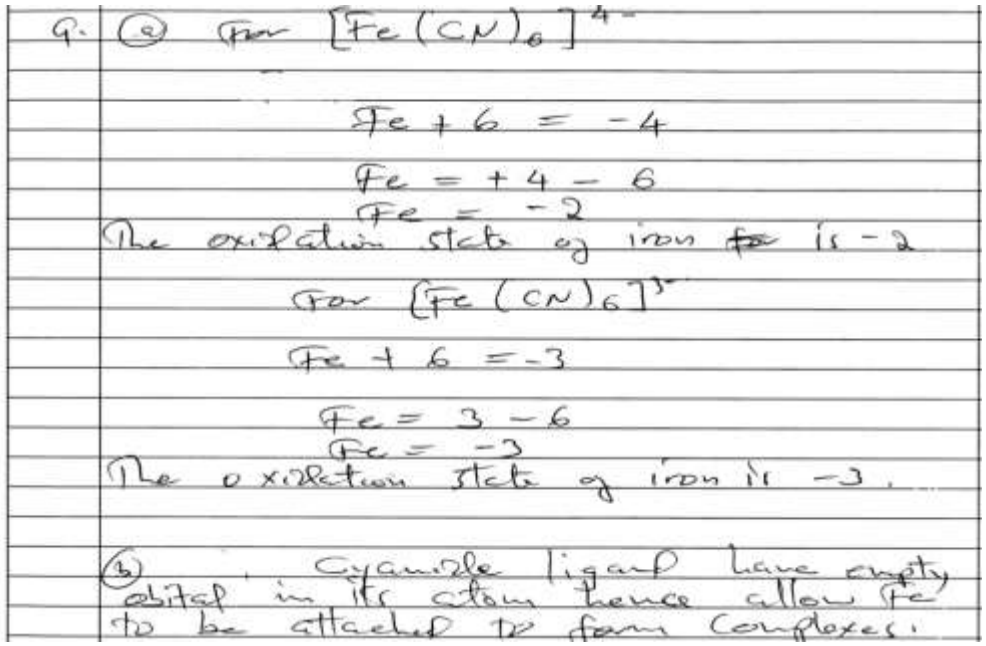
Extract 9.1: A sample of the correct responses to question 9

In Extract 9.1, a candidate computed the oxidation state of iron involved in $[Fe(CN)_6]^{4-}$ and $[Fe(CN)_6]^{3-}$ respectively. The candidate also showed an understanding of properties of CN^- as a ligand.

Likewise an analysis of responses showed that the candidates who scored 2.0 to 2.5 marks either got correct response in one of the parts, or gave partial responses in both parts. For instance, in part (a) one candidate wrote oxidation state of ion in $[Fe(CN)_6]^{4-}$ as +2 and $[Fe(CN)_6]^{3-}$ as +3. Besides, another candidate wrote in part (a) that *oxidation state of iron in* $[Fe(CN)_6]^{4-}$ *is -4 and* $[Fe(CN)_6]^{3-}$ *is -3.* This candidate confused oxidation state from net charges of -4 and -3 in respective complex compounds. In part (b) the

candidate wrote that CN^- has a property of forming *colouration,* hence scored marks.

On the contrary, the analysis showed that those who scored 0 to 1.5 marks had inadequate knowledge of transition metals hence failed to give the relevant responses in both parts of the question. In part (a), most candidates failed to calculate the oxidation states of iron in both complex compounds. An example is from one candidate who wrote the oxidation states of two complexes as *4-* and *3-* respectively. In part (b), some of the candidates showed incompetence about the types of elements hence treated iron as a non-metal. For instance, one candidate wrote: *CN^- has a property of forming complexes with non-metallic elements like Fe*. Others were unaware of the properties of ligands, as one of them wrote: *CN^- forms complexes with ion because it has variety of oxidation state of -4 and -3*. Another one gave a response which is not related to the concepts of complex compounds when writing: *due to diamagnetic and paramagnetic property of transition metals*. These responses justify that those candidates had insufficient knowledge of complex compounds. Extract 9.2 is a sample of incorrect response.



Extract 9.2: A sample of incorrect responses to question 9

In Extract 9.2 the candidate used incorrect formula to calculate the oxidation state of iron, hence got wrong final answer.

2.1.10 Question 10: Planning and Preparation for Teaching

The question required the candidates to state four uses of a lesson plan.

The performance was good as 679 (98.8%) candidates passed, and only 8 (1.2%) failed. Figure 10 illustrates the distribution of these scores.

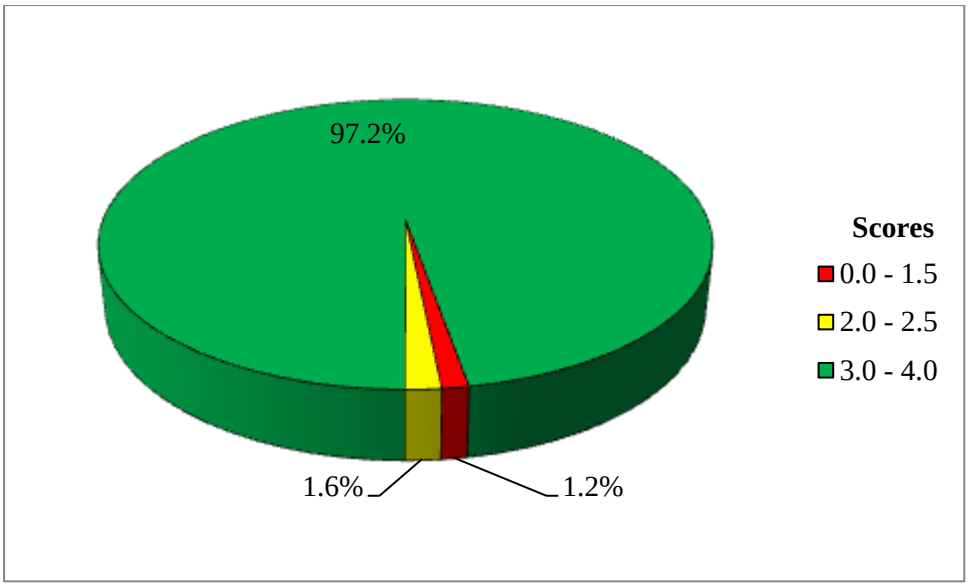
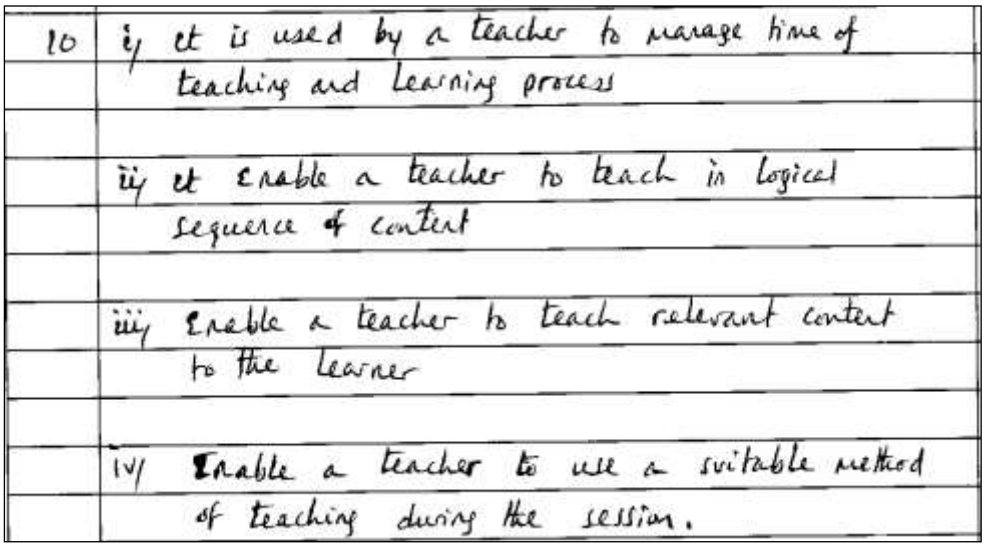


Figure 10: Distribution of the candidates' scores on question 10

As indicated in Figure 10, the candidates who scored 3 to 4 marks were 97.2 per cent, 1.6 per cent scored 2 to 2.5 and 1.2 per cent scored 0 to 1.5 marks.

The analyzed responses revealed that the candidates who scored 3 and 4 marks were able to state all four uses of lesson plan. They correctly stated that a lesson plan *enables the teacher to teach the in a logical and systematic manner, regulates speed of teaching to the teacher, enables the teacher to evaluate his own teaching and that of the learners* and *guides the teacher in preparation of teaching and learning materials.* Such responses imply that the candidate had adequate knowledge of topic Planning and Preparation for Teaching. An example of correct response is shown in Extract 10.



Extract 10: A sample of correct responses to question 10

In Extract 10, the candidate was able to provide correct points on the uses of lesson plan.

Furthermore, the responses from few candidates who scored 2.0 to 2.5 marks either provided partial responses or gave unsatisfactory responses. For instance, one candidate wrote; *it suggests the teaching strategies, it is used in summative assessment, it discriminate higher achievers from lower achievers and it suggest the time to be used in coverage of a certain topic.* Only the first response is correct while the rest are incorrect. This shows that the candidate lacked competence in presenting and organizing ideas on planning and preparation for teaching.

In contrast, the candidates who scored 0 to 1.5 marks misunderstood the demand of the question. For example, some of them wrote about the importance of the syllabus and the uses of a scheme of work, instead of a lesson plan. An example of the former is; *it is used to know the number of topic covered, it shows the objectives of the curriculum that are supposed to be covered, it suggests the mode of assessment to be used and it suggest ways of evaluating the curriculum*. Others gave responses reflecting the concept of assessment as one wrote; *it is used in formative assessment, summative assessment, norm reference test, criterion reference test*. These responses are due to either misconception or lack of concentration when answering the question.

2.1.11 Question 11: Volumetric analysis

The question was as follows:

A solution of $1dm^3$ was made by dissolving 28.6 g of impure sodium carbonate in distilled water. A 25 cm^3 of this solution was completely neutralized by 24.9 cm^3 of 3.65 g of hydrochloric acid in $1dm^3$ solution.

(a) Calculate the concentration of pure sodium carbonate in g/dm^3.

(b) If the impurity in sodium carbonate is water of crystallization, calculate the value of Z in the formula $Na_2CO_3.ZH_2O$.

The question was opted by 486 (70.6%) candidates. The data show that 352 (72.2%) candidates scored from 6 to 15 marks whereas 135 (27.8) scored 0 to 5.5 marks. This suggests good performance. Detailed analysis of these data is given in Figure 11.

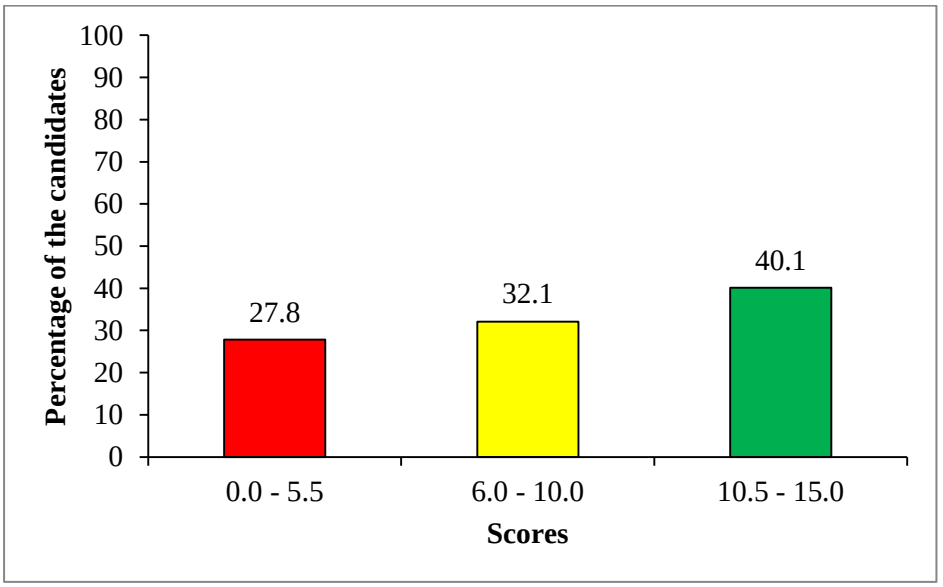
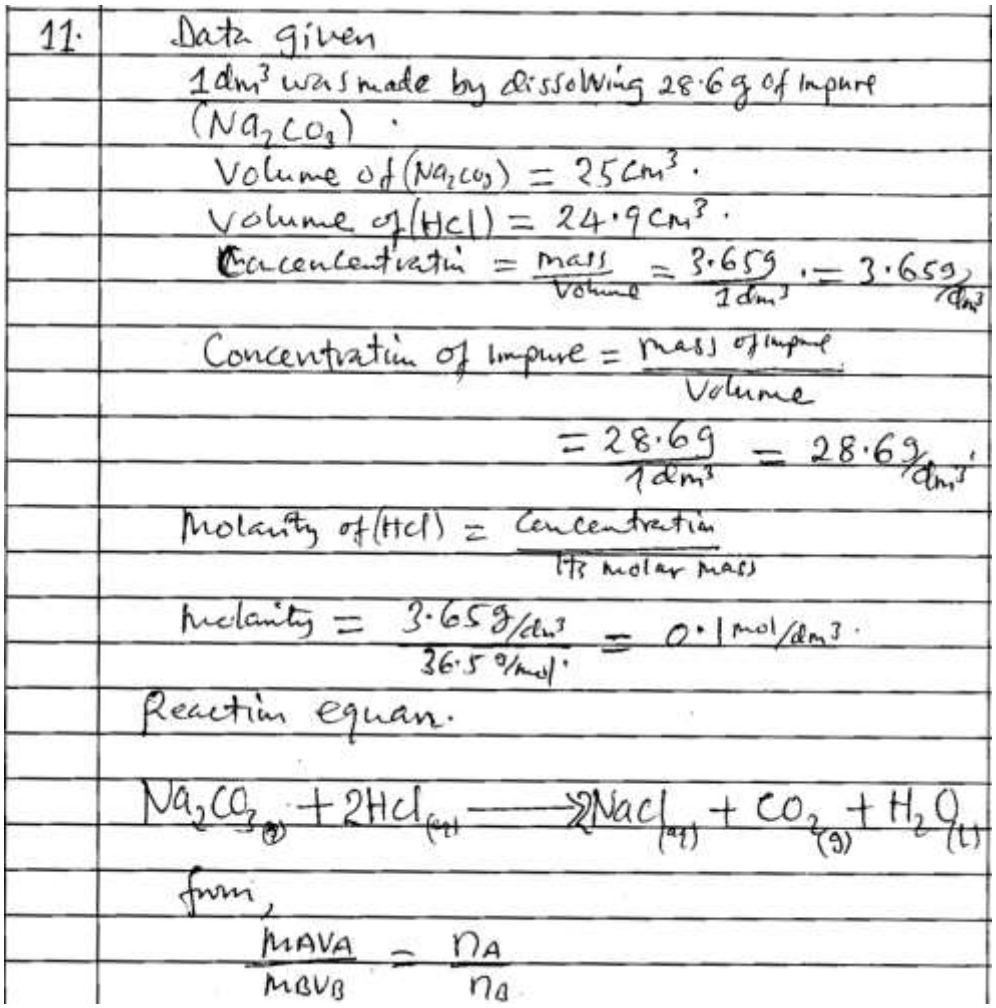


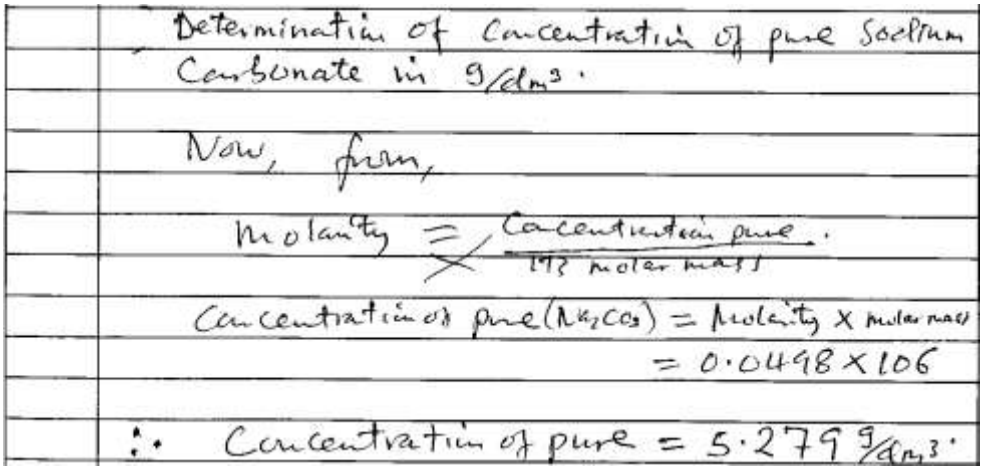
Figure 11: Distribution of the candidates' scores on question 11

The data presented in Figure 11 show that 40.1 per cent scored 10.5 to 15 marks, 32.1 per cent scored 6 to 10 marks and 27.8 per cent scored 0 to 5.5 marks.

The analysis of the candidates' responses showed that those who scored 10.5 to 15 marks had sufficient knowledge of solutions and competence in solving questions concerning concentration and dilution in volumetric

analysis. This knowledge and competence enabled them to find the concentration of the compound solution in part (a) and to solve for the value of water of crystallization in part (b). They understood that in order to find concentration of pure sodium carbonate in g/dm^3, the concentration of hydrochloric acid in mol/dm^3 had to be known. A sample of the correct response is shown in Extract 11.1.


11.
Data given
1 dm³ was made by dissolving 28·6 g of impure (Na_2CO_3).
Volume of (Na_2CO_3) = 25 cm³.
Volume of (HCl) = 24·9 cm³.
Concentration = mass / Volume = 3·65 g / 1 dm³ = 3·65 g/dm³
Concentration of impure = mass of impure / Volume
= 28·69 / 1 dm³ = 28·69 g/dm³
Molarity of (HCl) = Concentration / its molar mass
Molarity = 3·65 g/dm³ / 36·5 g/mol = 0·1 mol/dm³
Reaction equation.
$Na_2CO_{3(s)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$
from,
$\frac{nAVA}{nBVB} = \frac{nA}{nB}$

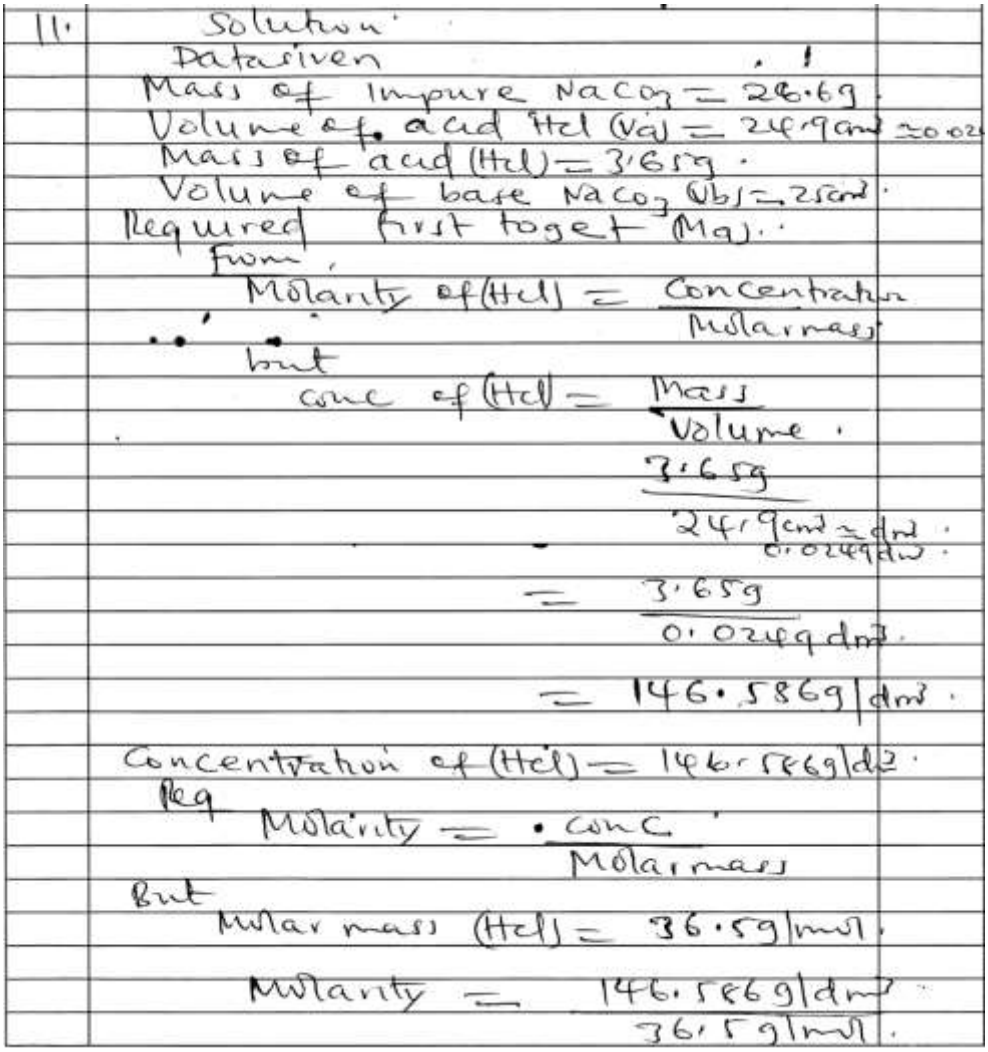


Extract 11.1: A sample of correct responses to question 11

The response in Extract 11.1 is a sample correct response in which the candidate went step by step to solve for the concentration of sodium carbonate solution in part (a) and the value of Z in part (b).

Furthermore, the analysis revealed that some of the candidates who got average scores of 6 to 10 marks showed few flaws such as writing incomplete responses. However, the majority managed to calculate the concentration in part (a) but failed to find the value of Z in the formula $Na_2CO_3.ZH_2O$ in part (b).

In the last category, some of the candidates who scored 0 to 5.5 marks failed due to misunderstanding of the task of the question. For instance, some of them ended up showing the formula for determining molarity, while others could only identify the constants given. Others could show the irrelevant conversion or applied wrong formula in some steps. In general, the irrelevant responses given emanated from both poor background of calculations and lacks knowledge of volumetric analysis. A similar incorrect response is shown in Extract 11.2 as an example of irrelevant attempts of the question.



Extract 11.2: A sample of incorrect responses to question 11

Extract 11.2 shows that to get the molarity, the candidate used the titre volume to find the concentration of the HCl instead of using the given HCl concentration to divide it by the molar mass.

2.1.12 Question 12: General Chemistry

In this question, the candidates were required to calculate the wavelength in meter, of a bulb light that is radiated by the energy of 2.76×10^5 Joules.

The question was opted by 380 (55.2%) candidates. Out of these, 370 (97.4%) passed by scoring from 6 to 15 marks while 10 (2.6%) failed by

scoring below 6 marks. This implies that the question was well performed. Figure 12 shows the distribution of these data.

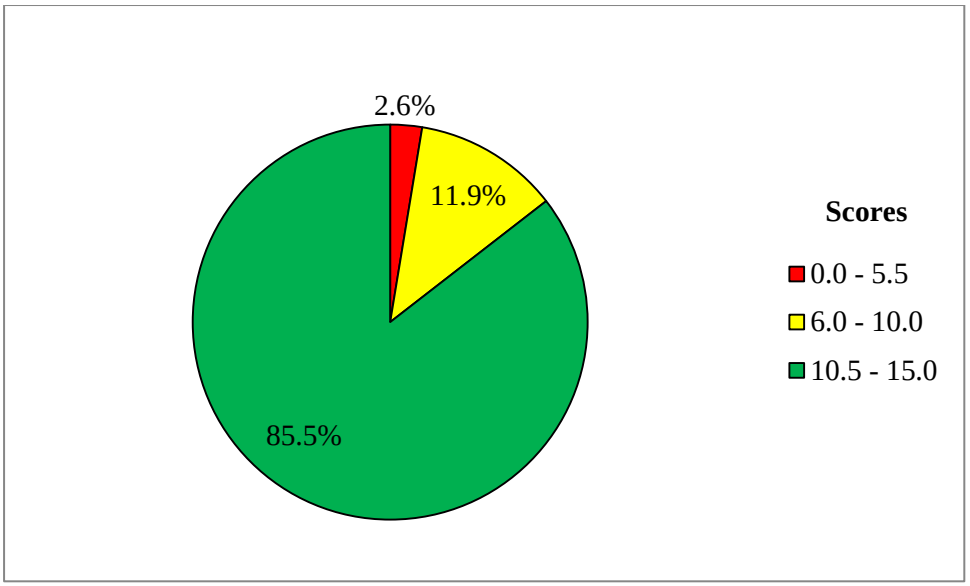
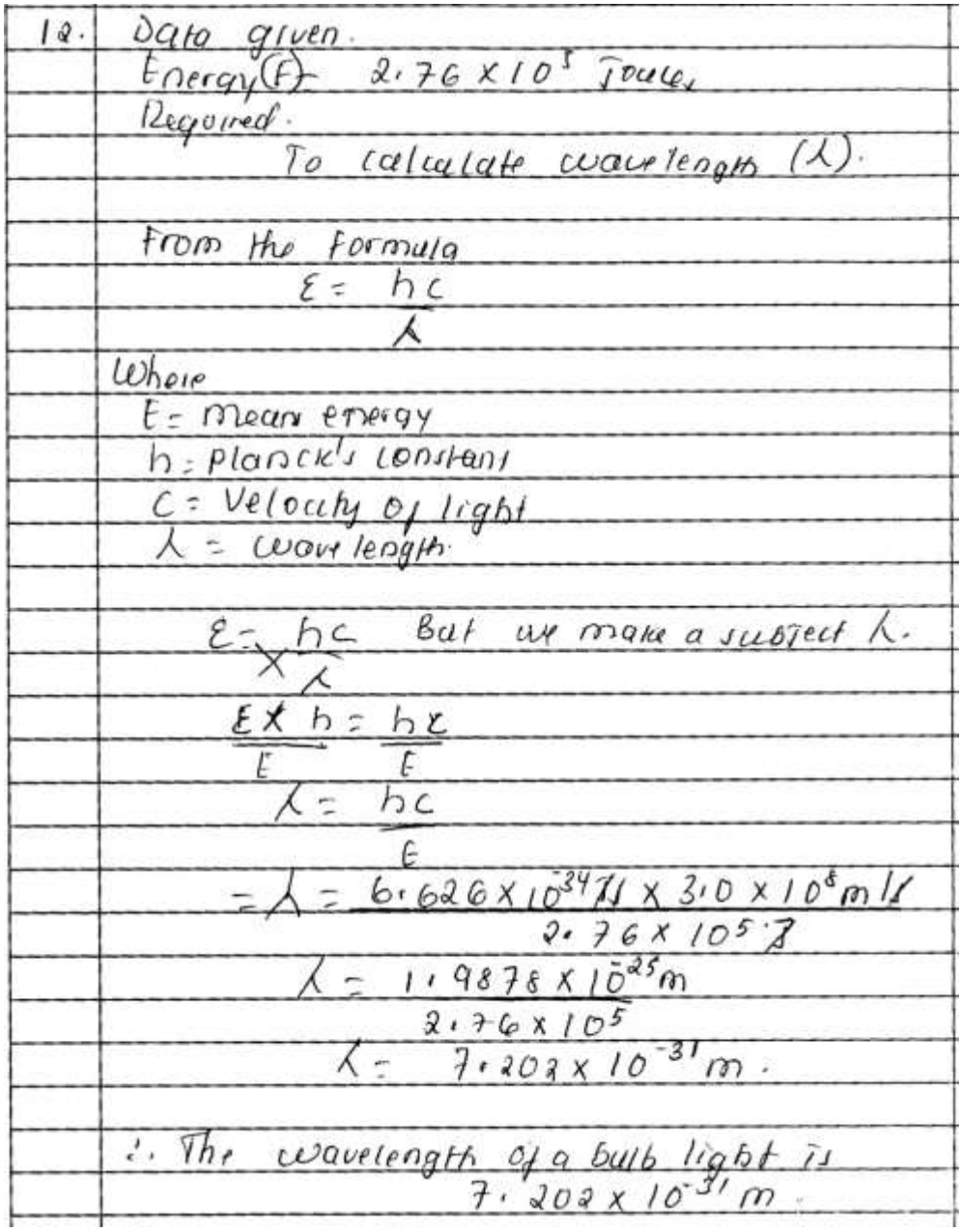


Figure 12: Distribution of the candidates' scores on question 12

The data in Figure 12 show that the majority (85.6%) of those opted the question scored 10.5 to 15 marks; 11.8 per cent scored 6 to 10 marks and only 2.6 per cent scored 0 to 5.5 marks.

In solving this question, the candidates were supposed to show basic knowledge of how energy (E), wave length (ƛ), and frequency (v) are related, thus: Energy is directly proportional to wavelength, E = hv, h is Planck's constant = 6.626 Js. They were also required to understand how to manipulate the formula of such variables with additional constant, velocity of light (c) whose value is 3.0 x 108 m/s.

The analysis of the candidates' responses revealed that the candidates who scored of 10.5 to 15 marks were able to calculate the wavelength asked, implying that they had sufficient knowledge of general chemistry. An example of a correct procedure and solution in calculating the wavelength is given in Extract 12.1.



Extract 12.1: A sample of correct responses to question 12

In Extract 12.1, the candidate showed a relevant formula and applied it in calculating correct value of the wavelength.

Conversely, some of the candidates who scored 6 to 10 marks either skipped some of important steps or had poor calculation skills. Since the question

had clear and direct steps to be involved, many of the candidates who attempted it got it correctly.

Furthermore, the analysis revealed that the few candidates (2.6%) who scored from 0 to 5.5 marks failed to calculate the required wavelength due to various reasons. They showed poor mathematical skills in performing calculations and poor background in general chemistry. For example, one candidate wrote:

Wavelength, ƛ can be calculated as

1/ƛ = Rh (energy radiated)

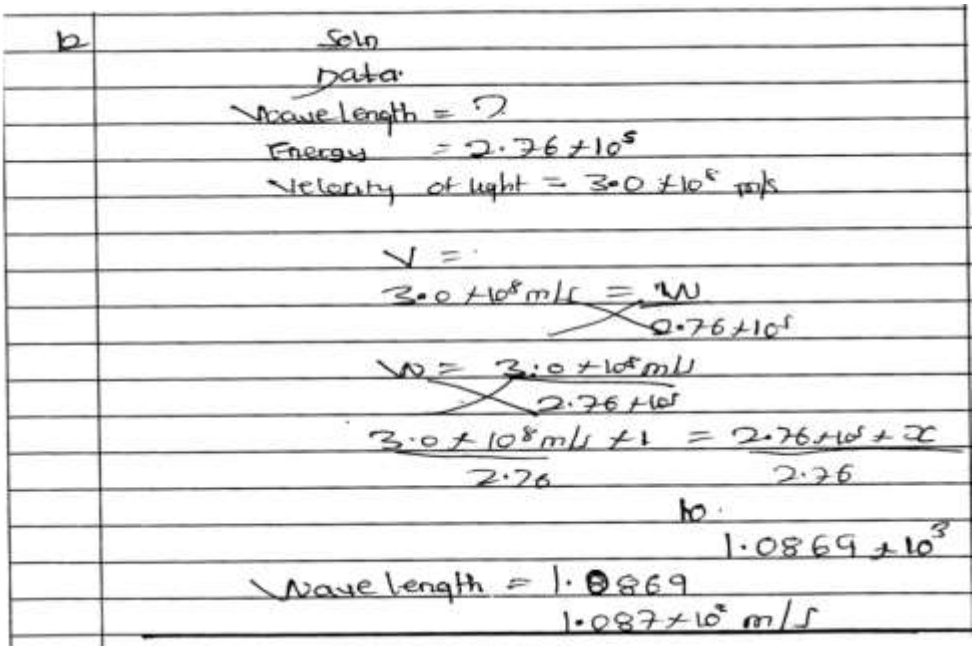
= 6.626 x 10-34 (2.76 x 105)

= 1.8287 x 10-28

ƛ = 1/1.8287 x 10-28

= 5.468 x 1027 m

This candidate used the wrong formula and did not include the velocity of light as an important constant in the calculation of wavelength, hence attained an incorrect answer. Another example of an incorrect response is shown in Extract 12.2.



Extract 12.2: A sample of incorrect responses to question 12

In the shown Extract 12.2 a candidate used the provided constants as the only data for calculation. The candidate used incorrect formula as well.

2.1.13 Question 13: Organic chemistry

This question had two parts, (a) and (b) as follows:

(a) Using a relevant example in each case, describe five characteristics of homologous series.

(b) Hydrocarbon **R** was found to contain 84% by mass carbon, and the rest percentage was hydrogen. If its molecular mass was 60 g, find:
(i) empirical formula (ii) molecular formula.

The question was opted by 508 (73.8%) candidates. The performance was average since two thirds, 335 (65.9%) scored 6 marks and above. The distribution of these data is presented in Figure 13.

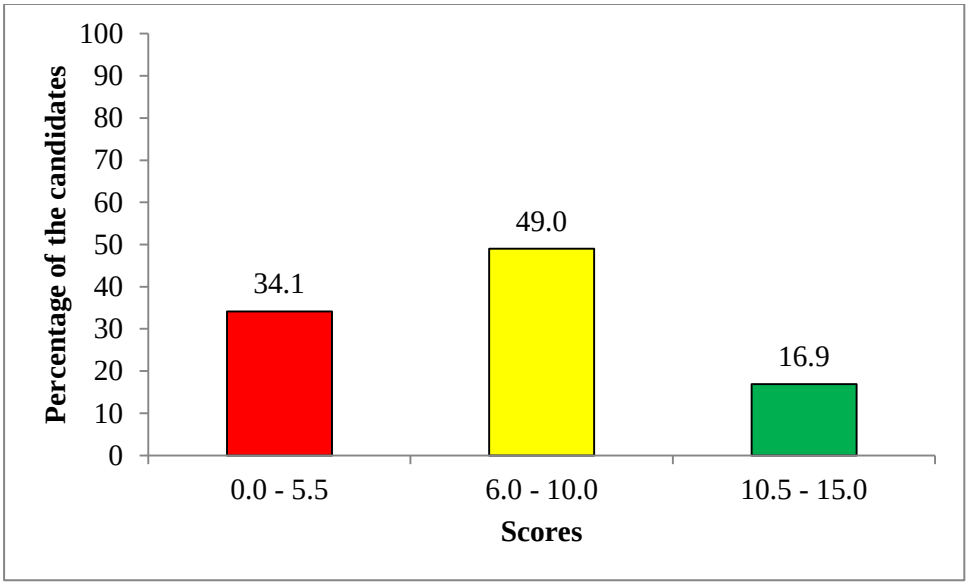


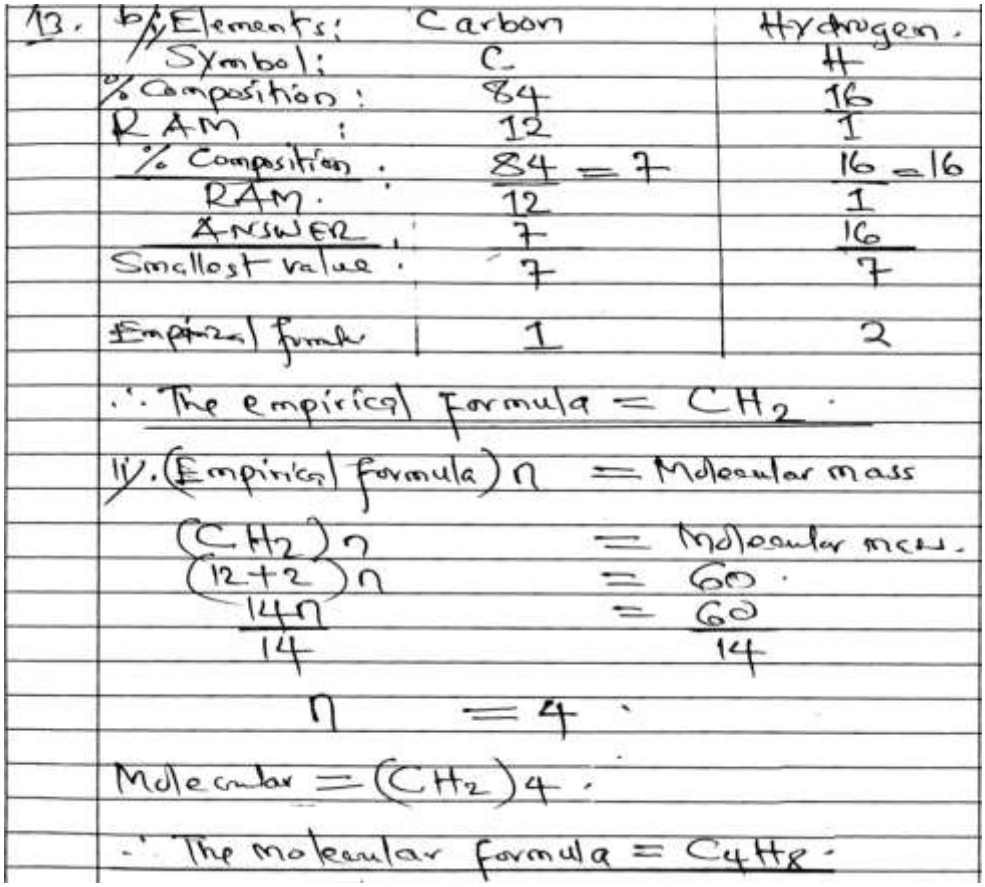
Figure 13: Distribution of the candidates' scores on question 13

The statistics in Figure 13 show that 16.9 per cent scored 10.5 to 15 marks, 49.0 per cent scored 6 to 10 marks and 34.1 per cent scored 0 to 5.5 marks.

The analysis of the responses revealed that, those who scored 10.5 to 15 marks had sufficient knowledge of the organic chemistry that enabled them to describe the characteristics of homologous series. They presented the following response: (i) *all members conform to a general molecular*

formula. Example; a general formula of alkane is $C_nH_{2n}+2$ (ii) the successive members in the same family differ in molecular formula by CH_2. Example, successive members of alkanes are CH_4, C_2H_6, C_3H_8 (iii) Members of the series have the same functional group, hence exhibit similar chemical reactions. Example; all alkanes whose functional group is C-C undergo substitution reactions with halogen like chlorine, (iv) physical properties of members vary gradually along the series. Example; boiling point and freezing points increase as the chain increases. (v) Members have the general methods of preparation. Example; Alkenes can be prepared by dehydration of alcohol.

In part (b), the candidates used various approaches to find the empirical and molecular formula of the compound R. They then reached the final answer such that the empirical formula is CH_2 and molecular formula is C_4H_8. Extract 13.1 is an example of correct response from one of the candidates.


13. b)

Elements:	Carbon	Hydrogen.
Symbol:	C	H
% Composition:	84	16
RAM :	12	1
% Composition / RAM.	84/12 = 7	16/1 = 16
ANSWER:	7	16
Smallest value:	7	7
Empirical formula	1	2

∴ The empirical formula = CH_2.

ii. (Empirical formula) n = Molecular mass

$(CH_2)n$ = Molecular mass.

$(12+2)n = 60$.

$\frac{14n}{14} = \frac{60}{14}$

$n = 4$.

Molecular = $(CH_2)4$.

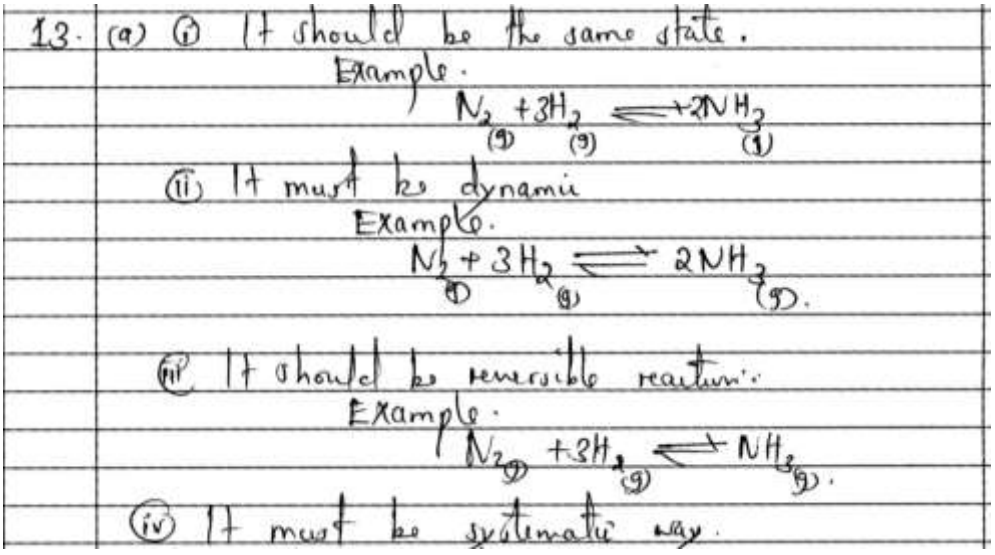
∴ The molecular formula = C_4H_8.

Extract 13.1: A sample of correct responses to question 13.

In extract 13.1 the candidate described correctly the characteristics of homologous series in part (a) and used correct procedure in finding empirical and molecular formula in part (b). However, the candidate was supposed to show how the whole number, 4 was estimated.

Many of those who scored 6 to 10 marks wrote correct responses in part (b) while some of them either wrote mixed responses in one or both parts of the question.

On the contrary, most of the candidates who scored 0 to 5.5 marks provided responses which were not related to the demands of the question. For example, in part (a) one candidate gave a response related to the concept of reactivity series by writing: (i) *it determines the electronegativity of the element. Example Magnesium (ii) it shows the sequence of elements from the highest to the lowest level such as potassium to zink, (iii) it indicates elements having large oxidation states and lower oxidation states such as hydrogen (iv) it indicates elements which higher ionization energy example iron, (v) it has electronegativity property such as halogens. In the same part, another candidate wrote; it should be the same state such gases, it must be dynamic or in equilibrium, it should be reversible reaction, it must be systematic way, it has to react slowly so that to allow all the species can react.* Another example of incorrect responses is given in Extract 13.2.



Extract 13.2: A sample of incorrect responses to question 13

In Extract 13.2, the candidate gave incorrect characteristics of a homologous series by giving the same example in all points. The examples given involve the reaction between nitrogen gas and hydrogen gas to form ammonia gas. This suggests that the candidate treated the question as if it was about homogeneous reaction.

2.1.14 Question 14: Laboratory Management

This question required the candidates to suggest five safety precautions for the storage of chemicals in chemistry laboratory.

The question was attempted by 507 (73.7%) candidates. Out of these, 485 candidates equivalent to 95.7 per cent scored from 6 to 15 marks and 22 (4.3%) failed, suggesting the general good performance. The data shown in Figure 14 are illustrative.

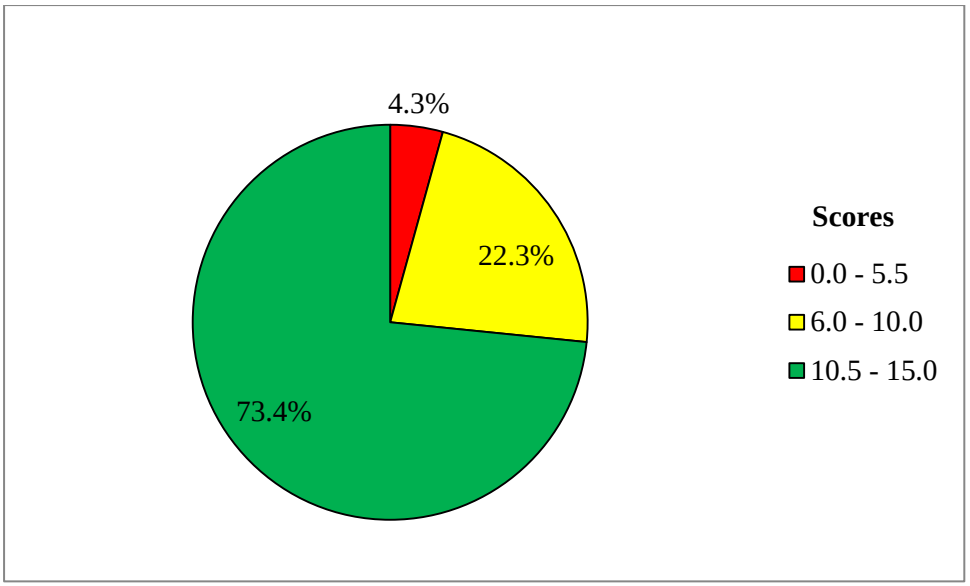
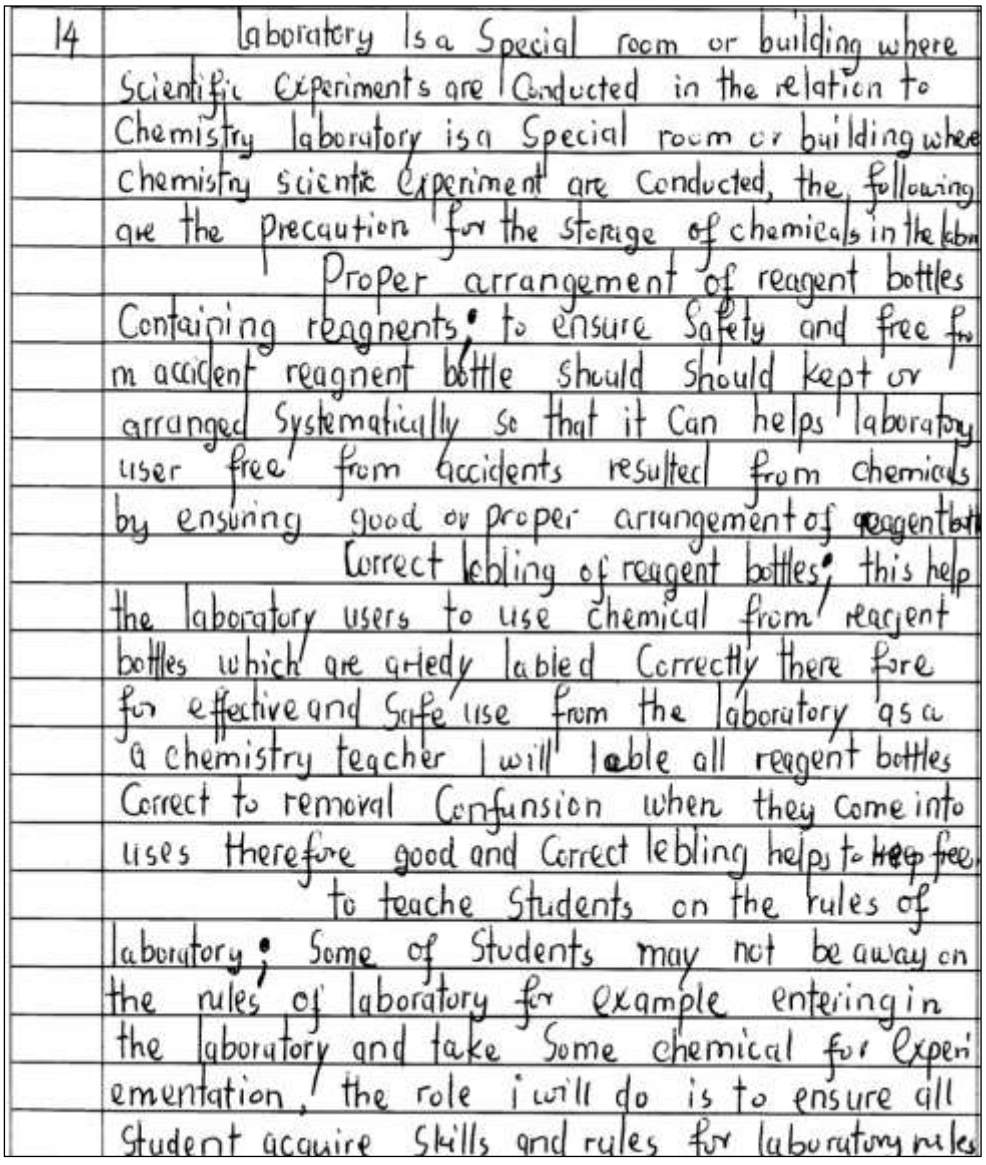


Figure 14: Distribution of the candidates' scores on question 14

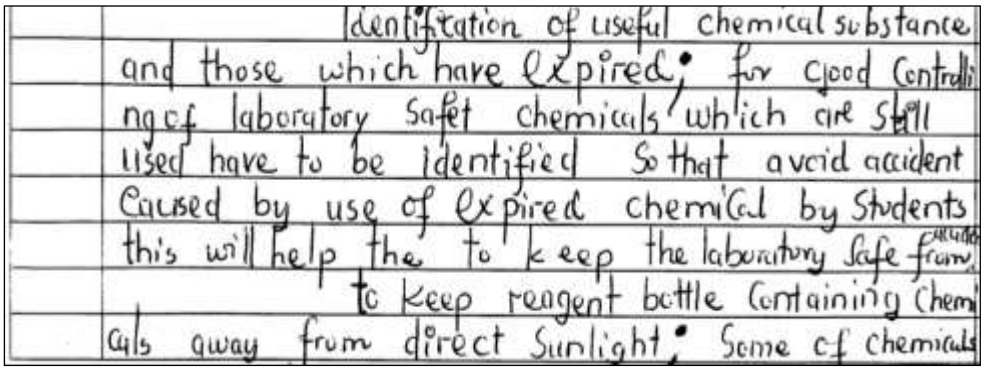
In Figure 14, 73.4 per cent scored 10.5 to 15 marks, 22.3 per cent scored 6 to 10 marks and 4.3 per cent scored 0 to 5.5 marks.

The analysis of the candidates' responses showed that, those who scored 10.5 to 15 marks had sufficient skills in and knowledge of laboratory management. This enabled them to write relevant responses like*: all containers holding chemicals must be labelled; chemicals that react violently should be stored closely together; the containers holding corrosive*

chemicals should be stored in shelves at least shoulder height, chemical stocks should be examined regularly and *flammable liquids should be kept in floor level trough which should be lined with lead metals.* Extract 14.1 is an example of correct responses.



14 laboratory Is a Special room or building where Scientific Experiments are Conducted in the relation to Chemistry laboratory is a Special room or building where Chemistry scientic Experiment are Conducted, the following are the precaution for the storage of chemicals in the lab
Proper arrangement of reagent bottles Containing reagnents; to ensure Safety and free fro m accident reagnent bottle should Should kept or arranged Systematically so that it Can helps laboratory user free from accidents resulted from chemicals by ensuring good or proper arrangement of reagent bott
Correct lebling of reagent bottles; this help the laboratory users to use chemical from reagent bottles which are gtedy labled Correctly there fore for effective and Safe use from the laboratory as a a chemistry teacher I will leble all reagent bottles Correct to removal Confunsion when they come into uses therefore good and Correct lebling helps to keep free.
to teache Students on the rules of laboratory; Some of Students may not be away on the rules of laboratory for example entering in the laboratory and take Some chemical for Experi ementation, the role i will do is to ensure all Student acquire Skills and rules for laboratory rules


identifation of useful chemical substance
and those which have expired; for good Controlli
ng of laboratory safet chemicals which are still
used have to be identified So that avoid accident
Caused by use of expired chemical by Students
this will help the to keep the laboratory safe from
to keep reagent bottle containing Chem
cals away from direct Sunlight; Some of chemicals

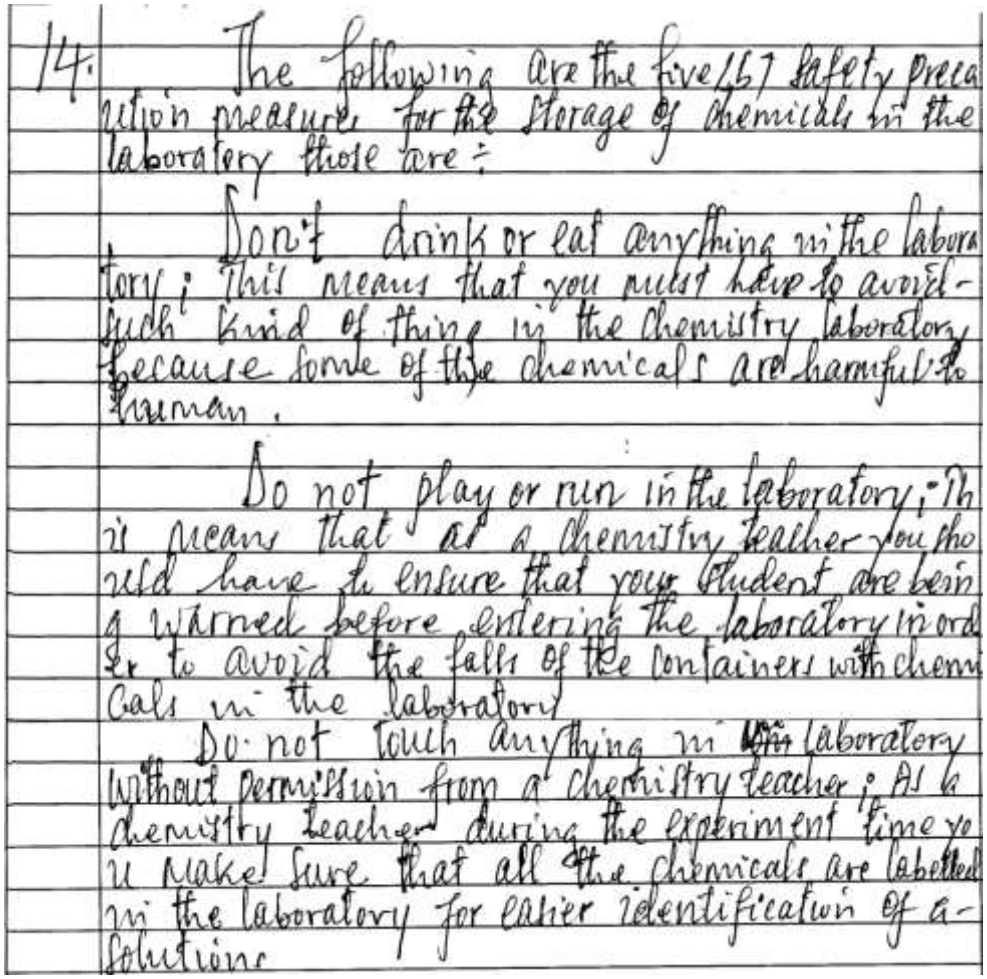
Extract 14.1: A sample of correct responses to question 14

In Extract 14.1 a candidate was able to state some of precautionary measures for chemical storage in the laboratory. However, the response has some grammatical and spelling errors.

In addition, the analysis of the candidates' scripts revealed that those who scored 6 to 10 marks gave partial responses by writing mixed responses which were correct and incorrect. For example, a candidate wrote; *do not test chemicals or eat anything in the laboratory, all chemicals should be stored in strong room, chemicals that are more corrosive should not be stored in transparent bottles, do not run or fight or play in the laboratory, do not enter in the laboratory without permission, do not perform practical without permission of the chemistry teacher or laboratory technician.* In such a response not all the points are correct. This candidate and others with similar responses failed to differentiate laboratory rules and precautions in chemical storage.

Besides, the analysis showed that the candidates who scored 0 to 5.5 marks had inadequate knowledge of various safety precautions that need to be taken in the chemistry laboratory. Consequently, some of them mentioned the firefighting instruments blanket and sand by writing: *do not test chemicals or eat anything in the laboratory, do not run or fight or play in the laboratory, do not enter in the laboratory without permission, do not perform practical without permission of the chemistry teacher or laboratory technician.* Others gave incorrect responses, as one of them wrote*: presence of mobile phone that will help in communication in case of emergence, waring heavy clothes that will not be able to be contaminated with chemicals, and a teacher should ask for assistance from students when dealing with dangerous chemicals like concentrated sulphuric acid*. The first

two candidates' responses imply that they had skills in laboratory management but lacked concentration and scanning of the question. Others misconceived the question as shown in Extract 14.2.


14. The following are the five (5) safety precaution measure for the storage of chemicals in the laboratory those are :-

Don't drink or eat anything in the laboratory ; This means that you must have to avoid such kind of thing in the chemistry laboratory because some of the chemicals are harmful to human .

Do not play or run in the laboratory ; This means that as a chemistry teacher you should have to ensure that your student are being warned before entering the laboratory in order to avoid the falls of the containers with chemicals in the laboratory

Do not touch anything in the laboratory without permission from a chemistry teacher ; As a chemistry teacher during the experiment time you make sure that all the chemicals are labelled in the laboratory for easier identification of a solutions

Extract 14.2: A sample of incorrect responses to question 14

In Extract 14.2 the candidate wrote about laboratory rules instead of writing about precautions for the storage of chemicals in the laboratory.

2.1.15 Question 15: Principles of Teaching and Learning Chemistry

This question required the candidates to elaborate five principles of teaching and learning chemistry.

The question was attempted by 675 (98.1%) candidates. The performance in this question was good as 639 candidates corresponding to 94.4 per cent

passed while only 38 (5.6%) scored 0 to 5.5 marks. Figure 15 shows the distribution of these data.

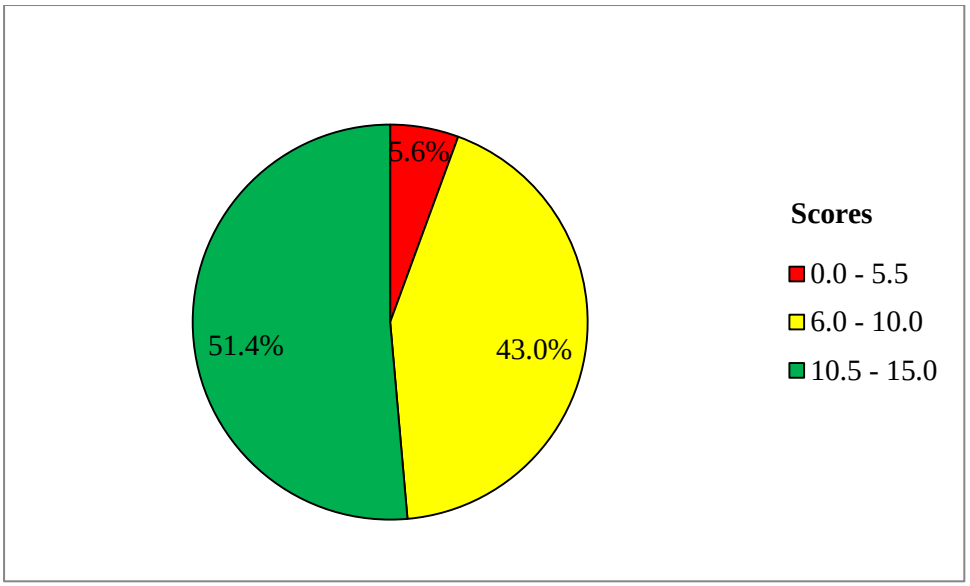
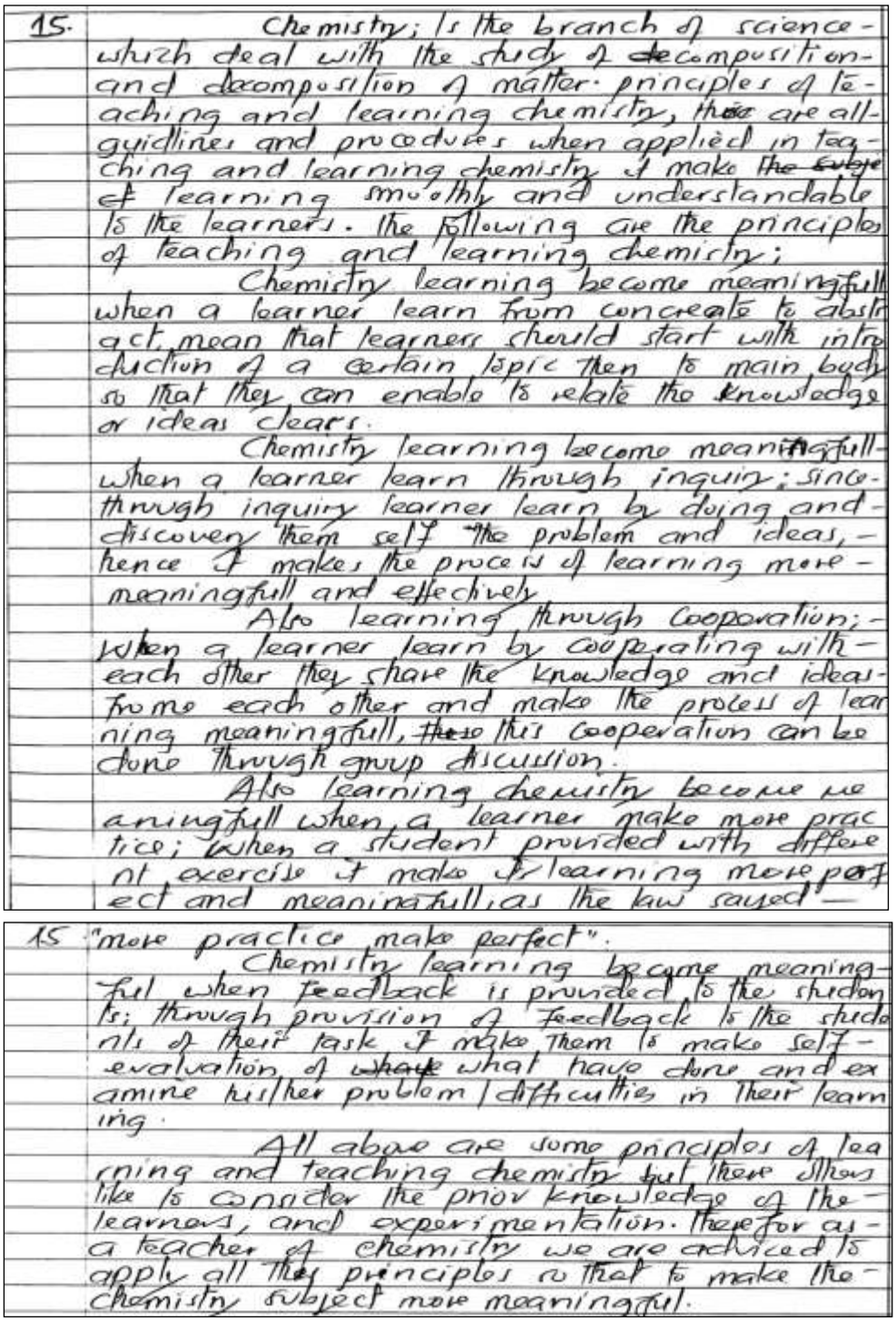


Figure 15: Distribution of the candidates' scores in question 15

The data in Figure 15 shows that 51.4 per cent of the candidates scored 10.5 to 15 marks, 43.0 per cent scored 6 to 10 marks and 5.6 per cent scored 0 to 5.5 marks.

The analysis of the candidates' responses revealed that, those who scored 10.5 to 15 marks managed to elaborate the principles of teaching and learning chemistry. Some of the key points on the given responses include: *chemistry students learn better when the teaching and learning is inquiry – oriented, in teaching and learning chemistry students usually acquire knowledge by learning from concrete to abstract or simple to complex, practice makes the teaching and learning of chemistry more meaningful since chemistry is activity oriented lesson.* They also wrote: *students' learning is enhanced by safe and supportive environment, cooperative teaching and learning facilitate chemistry understanding and the teaching and learning of chemistry should involve provision of feedback*. Extract 15.1 is an example of correct responses.



15. Chemistry; Is the branch of science which deal with the study of decompusition and decomposition of matter. principles of teaching and learning chemistry, those are all guidlines and procedures when applied in teaching and learning chemistry it make the ~~subje~~ of learning smoothly and understandable to the learners. The following are the principles of teaching and learning chemistry;

Chemistry learning become meaningfull when a learner learn from concreate to abstract mean that learners cherold start with introduction of a certain topic then to main body so that they can enable to relate the knowledge or ideas clears.

Chemistry learning become meaningfull when a learner learn through inquiry; since through inquiry learner learn by doing and discovery them self the problem and ideas, hence it makes the process of learning more meaningfull and effectively

Also learning through cooporation; when a learner learn by cooperating with each other they share the knowledge and ideas from one each other and make the process of learning meaningfull, ~~these~~ this cooperation can be done through group discussion.

Also learning chemistry become meaningfull when a learner make more practice; when a student provided with different exercise it make the learning more perfect and meaningfull, as the law sayed —

15 "more practice make perfect".

Chemistry learning become meaningful when feedback is provided to the studen ts; through provision of feedback to the studen nts of their task it make them to make self-evaluation of ~~what~~ what have done and examine his/her problem/difficulties in their learning.

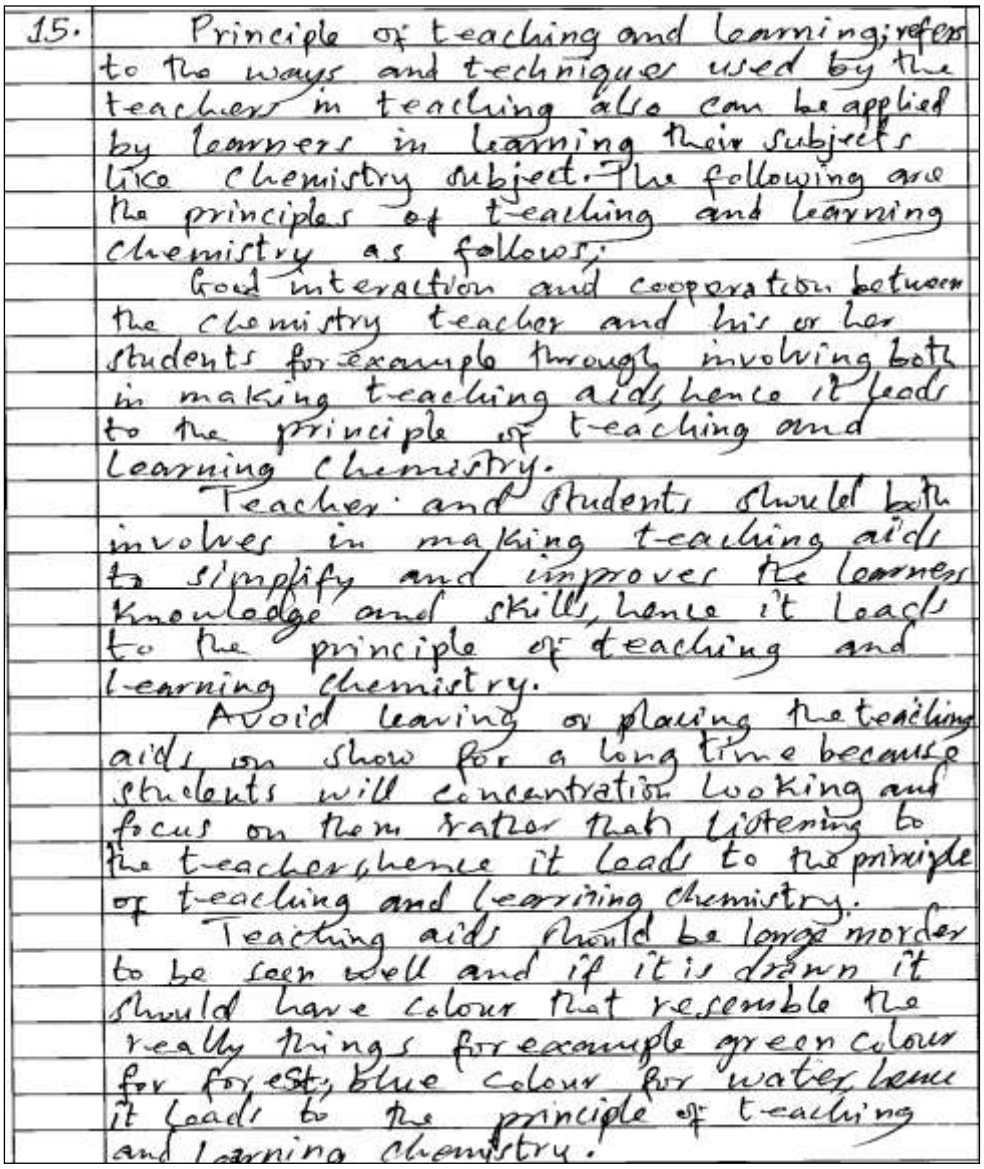
All above are some principles of learning and teaching chemistry but there others like to consider the prior knowledge of the learners, and experimentation. Therefore as a teacher of chemistry we are advised to apply all the principles so that to make the chemistry subject more meaningful.

Extract 15.1: A sample of correct responses to question 15

In extract 15.1, the candidate gave correct responses, despite a few grammatical errors.

Conversely, the analysis revealed that most of the candidates who scored of 6 to 10 marks wrote partially correct points. Some of them gave fewer points than required while others could highlight the points without elaboration. In few instances, some of the candidates provided mixed responses; relevant and irrelevant. For example, one candidate wrote: *cooperative teaching and learning facilitates chemistry understanding, students learning are enhanced by safe and supportive environment, do not run in the laboratory, do not enter in the laboratory without permission, do not perform experiment without permission of the laboratory technician, practice makes teaching and learning of chemistry more meaningful*. Such a candidate mixed concept of principles of teaching and learning chemistry with laboratory rules.

However, some of the candidates who scored 0 to 5.5 marks, either incorrect or partially correct points. It was also observed that, few candidates under this category wrote the responses related to things that facilitate teaching and learning of chemistry like *the use of teaching aids, motivation, the use of different teaching methods and use of simple language.* Another candidate wrote: *it should involve guidance and counselling, should reflect students with different disabilities, learning environment and should be based on thinking capacity of students*. This candidate misconceived the concept with the concept of teaching and learning difficulties. More examples of incorrect response is shown in Extract 15.2.


15. Principle of teaching and learning; refers to the ways and techniques used by the teachers in teaching also can be applied by learners in learning their subjects like chemistry subject. The following are the principles of teaching and learning chemistry as follows;

Good interaction and cooperation between the chemistry teacher and his or her students for example through involving both in making teaching aids, hence it leads to the principle of teaching and learning chemistry.

Teacher and students should both involves in making teaching aids to simplify and improves the learners knowledge and skills, hence it leads to the principle of teaching and learning chemistry.

Avoid leaving or placing the teaching aids on show for a long time because students will concentration looking and focus on them rather than listening to the teacher, hence it leads to the principle of teaching and learning chemistry.

Teaching aids should be large in order to be seen well and if it is drawn it should have colour that resemble the really things for example green colour for forest, blue colour for water, hence it leads to the principle of teaching and learning chemistry.

Extract 15.2: A sample of correct responses to question 15

In extract 15.2 the candidate wrote about the concept of teaching and learning aids instead of writing about procedure for moderation of the chemistry test items.

2.1.16 Question 16: Assessment in Chemistry

In this question the candidates were required to describe five procedures to be followed when moderating chemistry test items.

The question was opted by 187 (27%) candidates. The performance was good as 75.9 per cent passed and 45 (24.1%) failed. Figure 16 shows the distribution of the performance data.

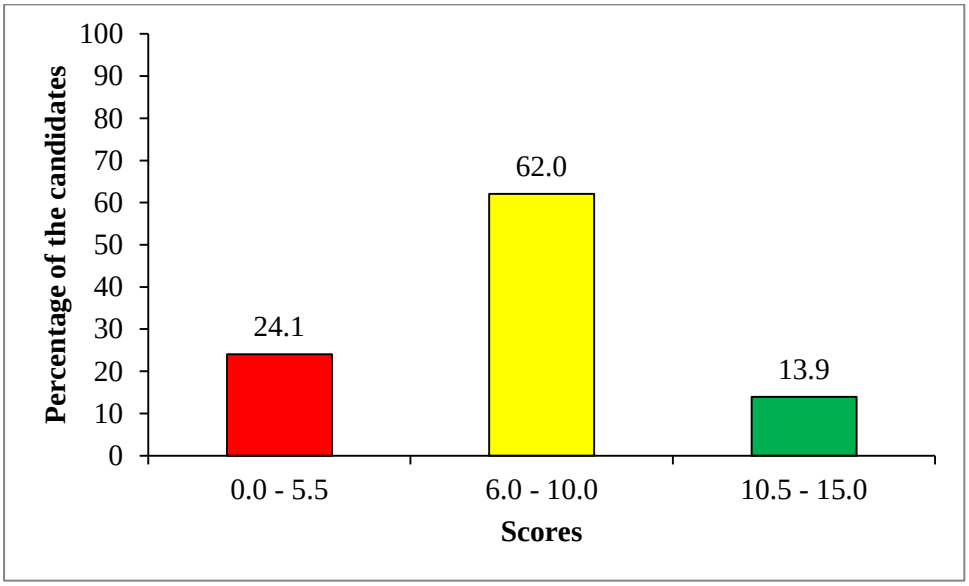


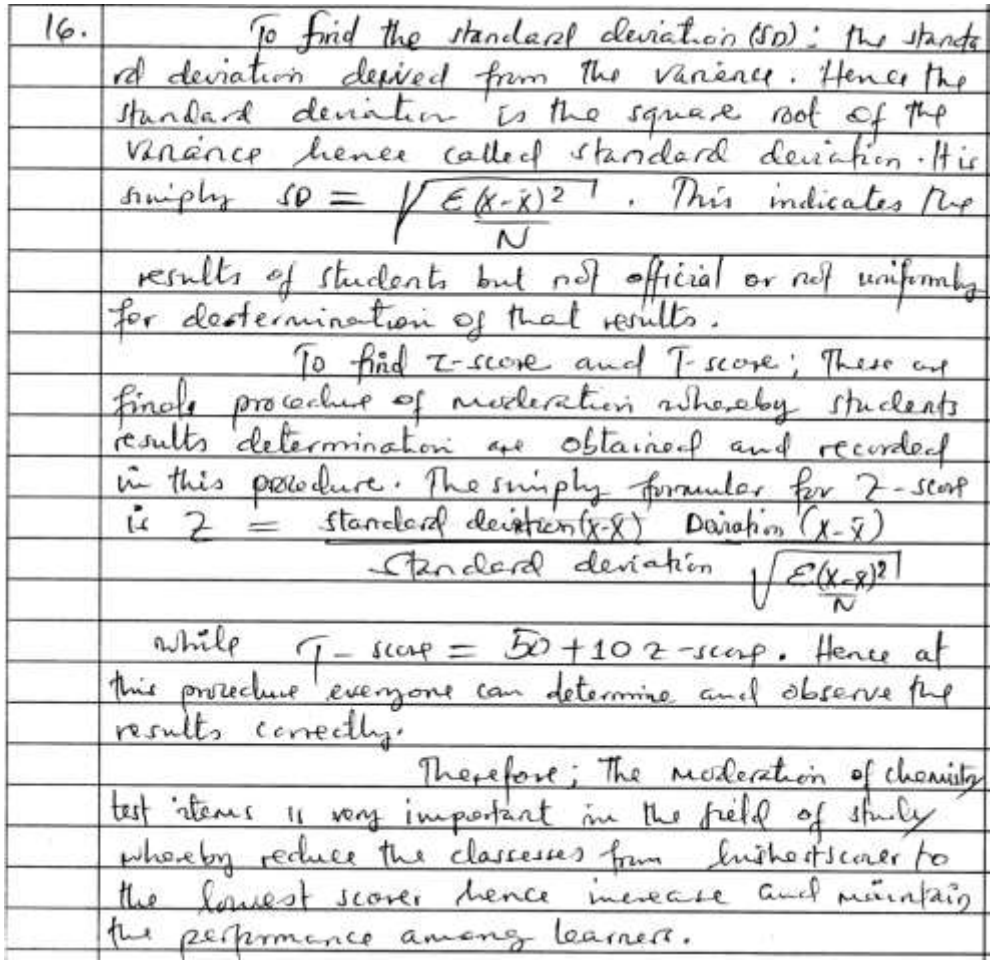
Figure 16: Distribution of the candidates' scores on question 16

Data in Figure 16 indicates that 62.0 per cent scored 6 to 10 marks, 24.1 per cent scores 0 to 5.5 marks and only 13.9 per cent scored 10.5 to 15 marks.

The analysis of the candidates' responses revealed that the candidates who scored 6 to 10 marks, some of them wrote incomplete responses while others presented correct but unsatisfactory points. For example, one candidate wrote: *consider the chemistry learning outcomes, determine the nature of paper whether is objective and subjective, consider the cognitive ability of the learners, consider the table of specification, consider the purpose of the test like either it's for selection or certification.* This response some of the points are correct while others are not.

The candidates whose scores were 0 to 5.5 marks either failed to understand the requirement of the question, or had inadequate knowledge of assessment in chemistry. For instance, one candidate wrote: *prepare a marking scheme, read thorough to familiar with the marking scheme, start marking the questions in chronological order, count out all the scores for each question, record the marks in the template prepared or designed and then get the total scores of all questions from one to end.* This candidate confused the concept

of moderation of the test item with procedures of marking students' papers in classroom tests or examinations. Others failed to provide correct responses simply due to inadequate knowledge of the content on assessment. For example, one candidate explained the factors to consider during test preparation by writing; *should be relevant to the test item, consider norm reference test, criterion reference test, the nature of the chemistry test item and learning environment*. More examples are as shown in Extract 16.2.


16. To find the standard deviation (SD); The standard deviation derived from the variance. Hence the standard deviation is the square root of the variance hence called standard deviation. It is simply $SD = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N}}$. This indicates the results of students but not official or not uniformly for determination of that results.

To find z-score and T-score; These are finals procedure of moderation whereby students results determination are obtained and recorded in this procedure. The simply formular for z-score is $z = \frac{\text{standard deviation}(x-\bar{x})}{\text{standard deviation}} \quad \frac{\text{Deviation}(x-\bar{x})}{\sqrt{\frac{\Sigma(x-\bar{x})^2}{N}}}$

While $T\text{-score} = 50 + 10\,z\text{-score}$. Hence at this procedure everyone can determine and observe the results correctly.

Therefore; The moderation of chemistry test items is very important in the field of study whereby reduce the classesses from highest scorer to the lowest scorer hence increase and maintain the performance among learners.

Extract 16.2: A sample of incorrect responses to question 16

In extract 16.2 the candidate wrote about the procedure on how to standardize a classroom test instead of writing about the procedure for moderation of the chemistry test items.

Besides, some of the candidates who attained the scores from 10.5 to 15 marks, they were able to write relevant procedures amid few flaws in their

responses. Some of the responses were: *the teacher should use the table of specification, give a test to students with equivalent academic ability level, distribute the marks based on the difficult of the item, determine the discrimination and item difficulty of the item, change the poor items with good ones.*

2.2 732/2 Chemistry 2: Practical Paper

Chemistry practical paper assessed knowledge, skills and competences of learners in carrying out the actual practical to prove the theoretical facts and principles. The paper had three alternatives, namely 732/2A Chemistry 2A, 732/2B Chemistry 2B and 732/2C Chemistry 2C. Each alternative had three questions. Question 1 was about volumetric analysis, while questions 2 and 3 assessed chemical kinetics and qualitative analysis respectively. Each candidate was required to answer all the three questions from one of the alternatives. The analysis of the candidates' responses in each question is as follows:

2.2.1 Question 1: Volumetric Analysis

The question required candidates to carryout titration experiment and answer the subsequent questions.

Data analysis showed that 626 (91.1%) candidates passed the question, while only 61 (8.9%) candidates failed. Figure 17 shows the distribution of the candidates' performance.

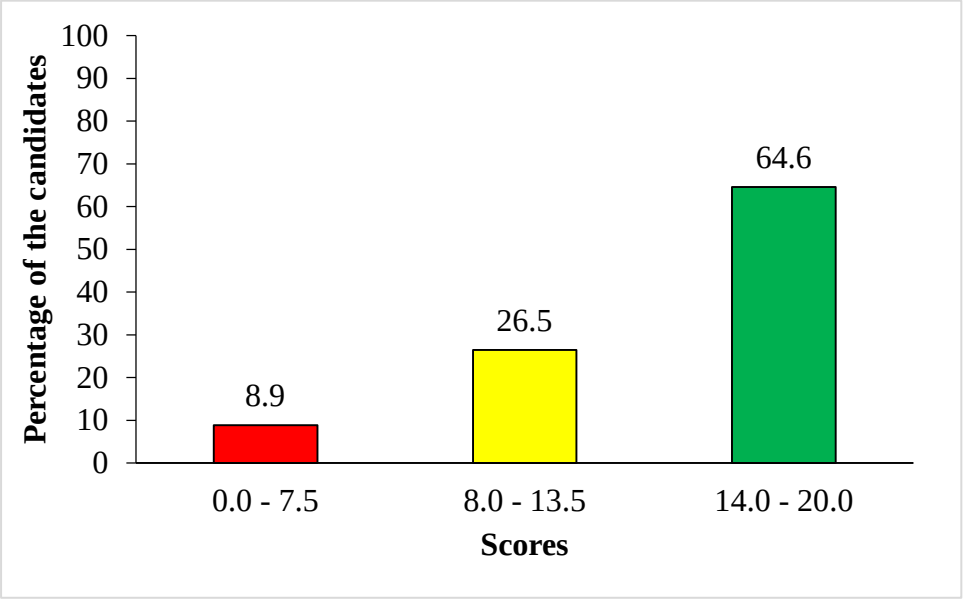


Figure 17: Distribution of the candidates' scores on question 1Chemistry 2

The data in Figure 17, show that the candidate who scored 14 to 20 marks were 64.6 per cent; those scored 8 to 13.5 were 26.5 per cent while only 8.9 per cent scored 0 to 7.5 marks.

The instructions and questions for each paper were as follows:

2.2.1.1 732/2A Chemistry 2A

In alternative paper 2A, the candidates were required to perform titration using sulphuric acid solution denoted as **X1**, sodium hydroxide denoted as **X2,** using the Phenolphthalein (POP) indicator. They were instructed to follow systematic procedure as follows:

*Titrate **X1** (from the burette), against 20.00 cm^3 or 25.00 cm^3 of **X2** (in a titration flask) using **POP** until the end point. Record the results including one rough and three accurate volumes in a tabular form.*

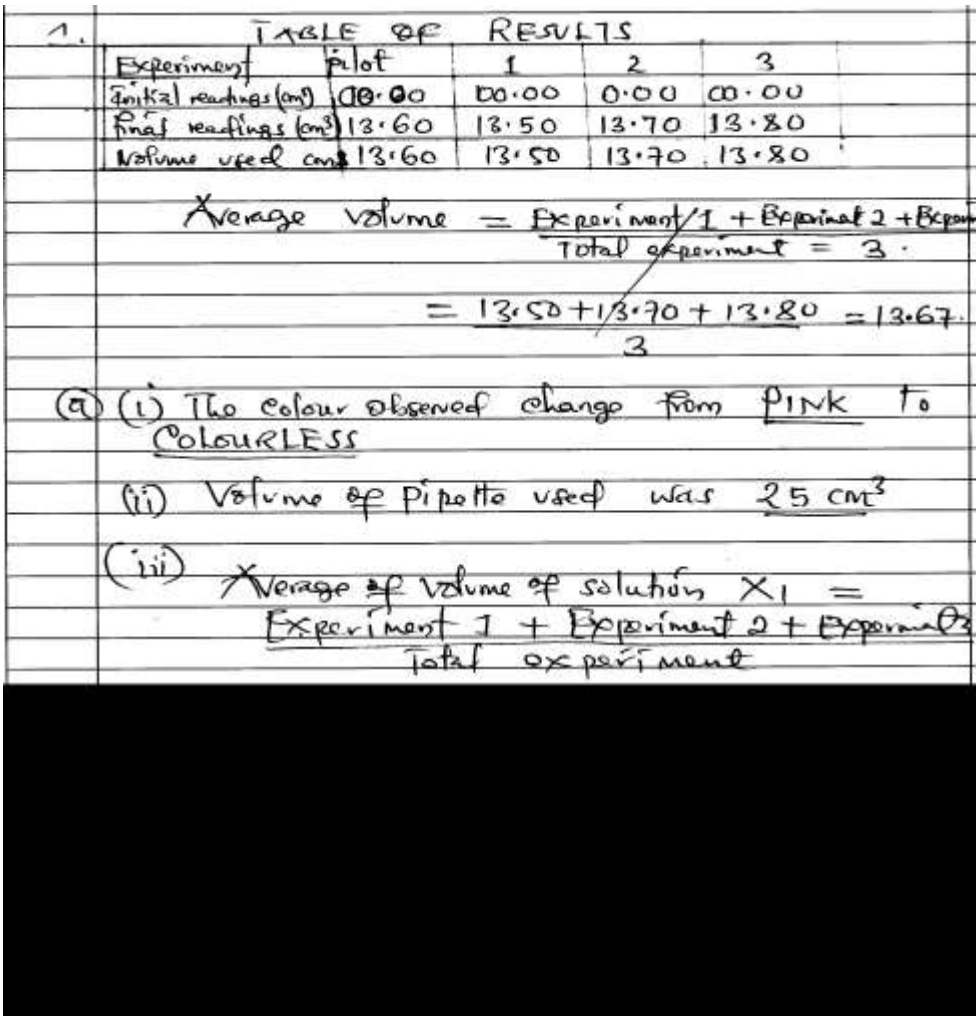
After titration, they were required to answer the following questions:

(a) (i) What was the colour change observed during this titration experiment?
(ii) What was the volume of the pipette used?
*(iii) Calculate the average volume of solution **X1** that was used to neutralize solution **X2**.*

*(b) Write a balanced chemical equation between **X2** and **X1** with all state symbols and the corresponding ionic equation.*

(i) Calculate the concentration of the following:
(ii) Solution X1 in moles/dm3.
*(iii) Solution **X1** in g/dm^3.*

The analysis from the candidates' responses showed that, ones who scored 14 to 20 marks had enough competence in carrying out titration. In part (a) they were able to take accurate measurements and recordings of the volume of solutions and identification of colour changes. In part (b), they were able to show the balanced equation. The correct measurements and reaction equations enabled them to solve part (c). Extract 17.1 is a sample of correct responses.



1. TABLE OF RESULTS

Experiment	Pilot	1	2	3
Initial readings (cm^3)	00.00	00.00	0.00	00.00
Final readings (cm^3)	13.60	13.50	13.70	13.80
Volume used cm^3	13.60	13.50	13.70	13.80

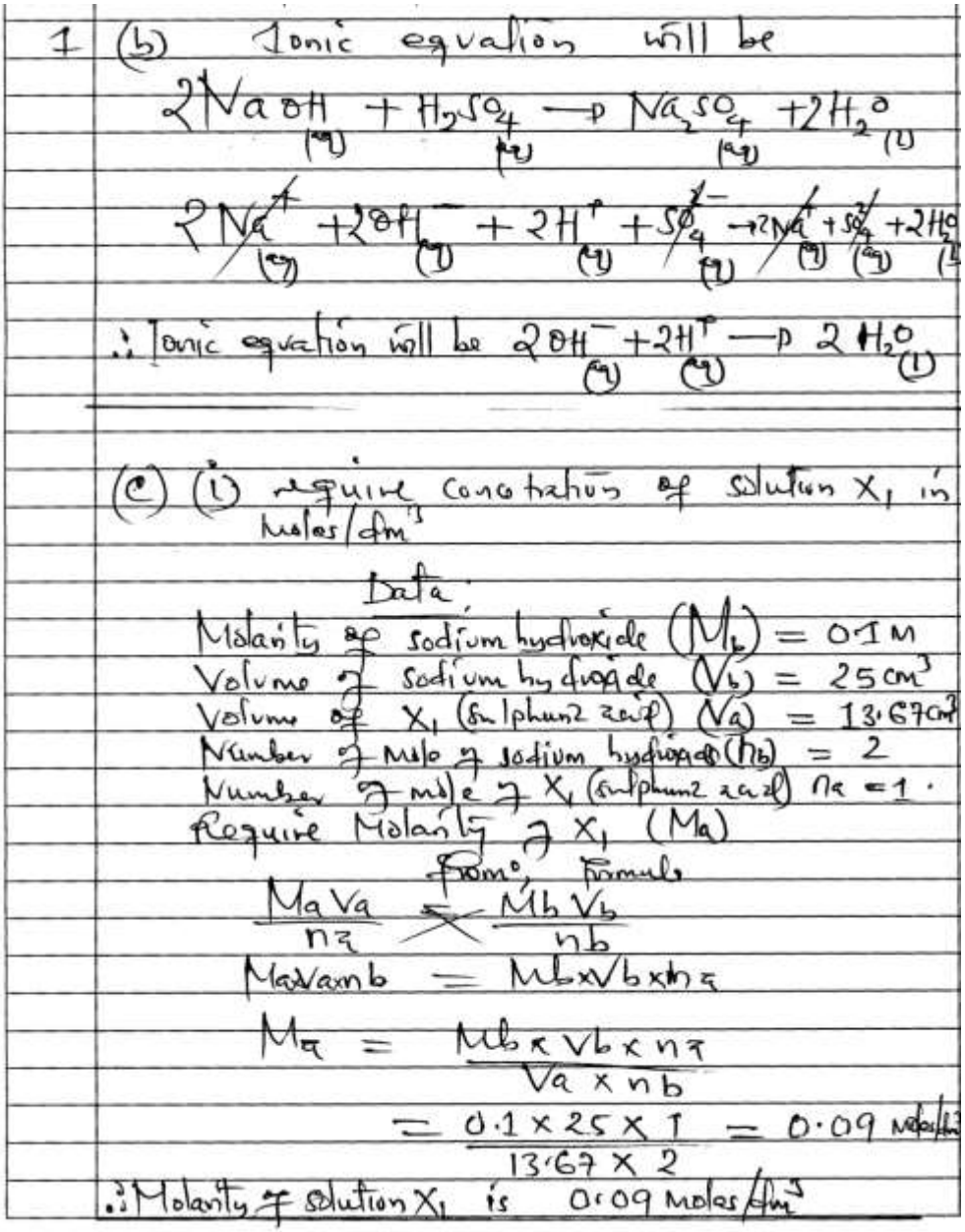
Average volume = Experiment 1 + Experiment 2 + Experiment 3 / Total experiment = 3.

= 13.50 + 13.70 + 13.80 / 3 = 13.67.

(a) (i) The colour observed change from PINK to COLOURLESS

(ii) Volume of Pipette used was 25 cm^3

(iii) Average of volume of solution X_1 = Experiment 1 + Experiment 2 + Experiment 3 / Total experiment



Extract 17.1: A sample of correct responses to question 1 Chemistry 2A

Extract 17.1 shows that in part (a), the candidate titrated the given solutions and recorded the volume of acid correctly and in part (b) gave correct molecular and ionic equations respectively. The accurate volume recorded facilitated the calculations in part (c).

Further analysis revealed that the majority of the candidates who scored 8 to 13.5 marks were challenged by the computation of the concentration

required in part (c). Among them, there were few who used incorrect formulae in calculating the molarity of acid as they used the relation.

$$Ma = \frac{Mb \times Vb \times nb}{na \times Va} \text{ instead of } Ma = \frac{MbVb\ na}{nbVa}$$

Others wrote a reaction equation which was not correctly balanced as they used incorrect stoichiometric coefficients of the reacting species.

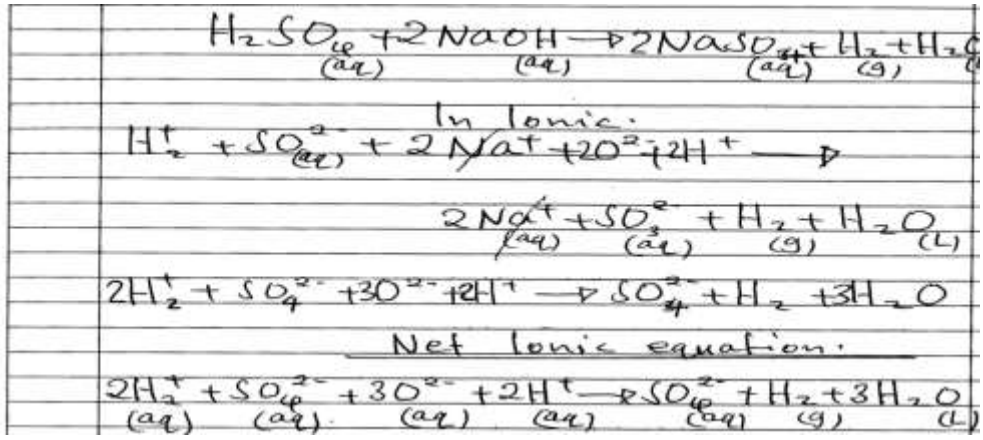
Besides, some of the candidates who scored 0 to 7.5 marks, some of them failed to understand the requirement of the question and others lacked basic knowledge of volumetric analysis. Consequently some of these candidates could get and record correct readings of initial and final volume of acid but made summation instead of subtracting to get the required difference. Others forgot to apply the coefficient used in balancing the neutralization equation to the calculation at the number of moles of base (nb) in the formula $Ma = \frac{MbVb\ na}{nbVa}$.

There was also the challenge of writing correct chemical formula of some of the compounds in part (b) as one candidate wrote:

HSO4(aq) + NaOH ⟶ SO4Na + H2O(l) instead of

$H_2SO_4(aq) + NaOH \longrightarrow Na_2SO_4 + H_2O(l)$.

Another example is given as Extract 17.2.



Extract 17.2: Sample of incorrect responses to question 1 Chemistry 2A

In Extract 17.2, the candidate failed to write both molecular and ionic reaction equations. Also, the candidate wrote the hydrogen ion (H^+) as H_2^+ while such a formula does not exist.

2.2.1.2 732/2B Chemistry 2B

The candidates were provided with the following solution: sodium carbonate (Na_2CO_3) coded **E1** with unknown concentration; solution **E2** containing 2.92 g of hydrochloric acid (HCl) in 1 dm^3 and **MO** methyl orange indicator.

The instruction was: *Titrate E2 (from the burette), against E1 (in the titration flask) using MO until the end point. Record the results including one rough and three accurate titrations in a tabular form.*

They were then required to answer the questions:

(a) (i) What was the colour change observed during this titration experiment?

(ii) What was the volume of the pipette used?

*(iii) Calculate the average volume of solution **E2** that was used to neutralize solution **E1**.*

*(b) Write a balanced chemical equation (include state symbols) between **E2** and **E1** and the corresponding ionic equation.*

*(c) Calculate the concentration in moles/dm^3 of solution **E1**.*

The analysis of the candidates' responses revealed that, those who scored 14 to 20 marks managed to (a) titrate the provided solutions and get the accurate titre value (25.00cm^3) of the acid and (b) write correct equations as required in part (b). In part (c), they applied the information given in the question and use appropriate formula to get molarity of E2 (HCl) using the following procedure:

$$molarity\ (E2) = \frac{mass\ \ concentration}{molar\ mass} = \frac{2.92g/l}{36.5} = 0.08\,M$$

Using this molarity, they could get the molarity of **E1** (Na_2CO_3) as follows:

$$molarity\ (E1) = \frac{volume\ of\ acid\ X\ molarity\ of\ acid}{volume\ \ of\ \ base\ X\ number\ of\ moles\ of\ acid}$$ Mb =

$$molarity\ (E1) = \frac{25\ X\ 0.08}{2\ X\ 25} = 0.04\,M$$

Extract 18.1 provides an example of correct responses.

4 (c) Data given

Volume of acid (Va) = 20.09 cm³

Volume of base (Vb) = 20.00 cm³

Number of mole of acid $n_a = 2$

$n_b = 1$

Molarity of acid Ma = ?

Molarity of base Mb = ?

Recall from

Concentration of HCl = $\frac{\text{mass}}{\text{volume}}$

conc of HCl = $\frac{2.929}{1\ dm^3}$

Then

$Ma = \frac{\text{conc}}{Mr}$

$Ma = \frac{2.929\ g/dm^3}{36.5\ g/mol}$

$Ma = 0.08\ mol/dm^3$

Then from

$\frac{MaVa}{MbVb} = \frac{Na}{Nb}$

$Mb = \frac{MaVa\,Nb}{Vb\,Na}$

$Mb = \frac{0.08 \times 20.09 \times 1}{20 \times 2}$

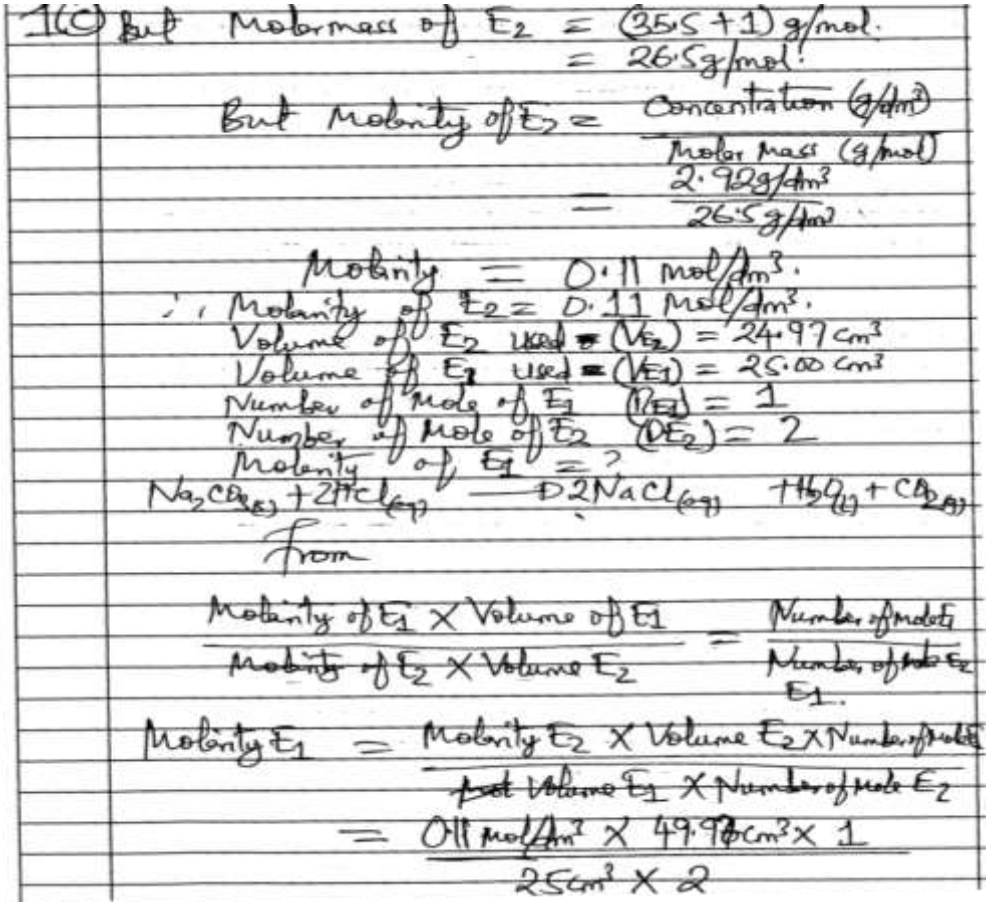
$= 0.04\ mol/dm^3$.

Extract 18.1: Sample of correct responses to question 1 Chemistry 2B

Extract 18.1 is a part of the correct response in which the candidate applied relevant formulae in part (c) to find the molarity of both acid and base solutions.

Further analysis revealed that the majority of the candidates who scored 8 to 13.5 marks failed to get the correct volume of the HCl within an acceptable range. For example, one candidate got 28.00 cm^3, another one got 27.00 cm^3; instead of approximately 25.00cm^3. This affected every stage that involved use of volume of acid, especially in part (a)(iii) and in part (c) to find molarity of base. However, the majority failed to solve part (c) of this question.

In contrast, most of the candidates who scored 0 to 7.5 marks failed to get or record correct readings of initial and final volume. Also, as observed in Chemistry 2A, others forgot to apply the coefficient used in balancing the neutralization equation to get both ionic and molecular balanced chemical equations. Apart from that, they also failed to give correct responses in part (c) as shown in Extract 18.2.


1(c) But Molarmass of E_2 = (35.5 + 1) g/mol.
= 26.5 g/mol.
But Molarity of E_2 = Concentration (g/dm³) / Molar mass (g/mol)
= 2.92 g/dm³ / 26.5 g/dm³
Molarity = 0.11 mol/dm³.
∴ Molarity of E_2 = 0.11 mol/dm³.
Volume of E_2 used = (V_{E_2}) = 24.97 cm³
Volume of E_1 used = (V_{E_1}) = 25.00 cm³
Number of mole of E_1 (N_{E_1}) = 1
Number of mole of E_2 (N_{E_2}) = 2
Molarity of E_1 = ?
$Na_2CO_{3(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$
from
Molarity of E_1 × Volume of E_1 / Molarity of E_2 × Volume E_2 = Number of mole E_1 / Number of mole E_2
Molarity E_1 = Molarity E_2 × Volume E_2 × Number of mole E_1 / Volume E_1 × Number of mole E_2
= 0.11 mol/dm³ × 49.94 cm³ × 1 / 25 cm³ × 2

Extract 18.2: A sample of incorrect responses to question 1Chemistry 2B

In Extract 18.2 the candidate calculated the concentration of solution **E2** (HCl) while the question was about **E1** (Na_2CO_3). Also, the candidate wrote the mass of HCl is 26.5 cm^3 instead of 36.5 cm^3.

2.2.1.3 732/2C Chemistry 2C

In this question, the candidates were provided with the following solutions: A 43.99 g of contaminated anhydrous sodium carbonate in 1 dm^3 of solution**,** denoted as **A**; 7.30 g of hydrochloric acid per 1 dm^3 of solution denoted as **B** and **MO**, methyl orange indicator.

The instruction was as follows:

*(i) Measure 20 cm^3 of **A** and pour into 100 cm^3 measuring cylinder. Carefully, add distilled water up to 100 cm^3 mark, then stir. Name the resulting solution as **L**. Pipette 20 cm^3 or 25 cm^3 of **L** and pour it into a titration flask.*

*(ii) Titrate **B** against **L** using two drops of the indicator to the end point. Repeat the procedure to obtain three more titre value and record the results in a tabular form.*

The questions were:

(a) (i) What was the colour change observed during this titration experiment?

(ii) What was the volume of the pipette used?

*(iii) Calculate the average volume of solution **B** that was used to neutralize solution **L**.*

*(b) Write a balanced chemical equation for the reaction between **L** and **B**.*

*(c) Showing your procedures clearly, calculate the percentage purity of **A**.*

The analysis of the candidates' responses showed that, the candidates who scored 14 to 20 marks were able to titrate the solutions B against L to get correct measurements of solution B. They were also able to record the readings in a table of results in part (a) and to write the balanced equation at part (b). In part (c) the candidates calculated the percentage purity of solution L (0.07M) obtained from dilution of 0.35 M as follows:

From the relation $\frac{MaVa}{na} = \frac{MbVb}{nb}$

$$Mb = \frac{0.2 \times 14.00 / 17.50 \times 1}{20.00 / 25.00 \times 2}\ 0.07\ M$$

Therefore, molarity of A = 0.07 M

From dilution:

$McVc = MdVd$

$$Mc = \frac{MdVd}{Vc} = \frac{0.07 \times 100}{20} = 0.35 M$$

Concentration of Na_2CO_3 = molarity x molecular mass

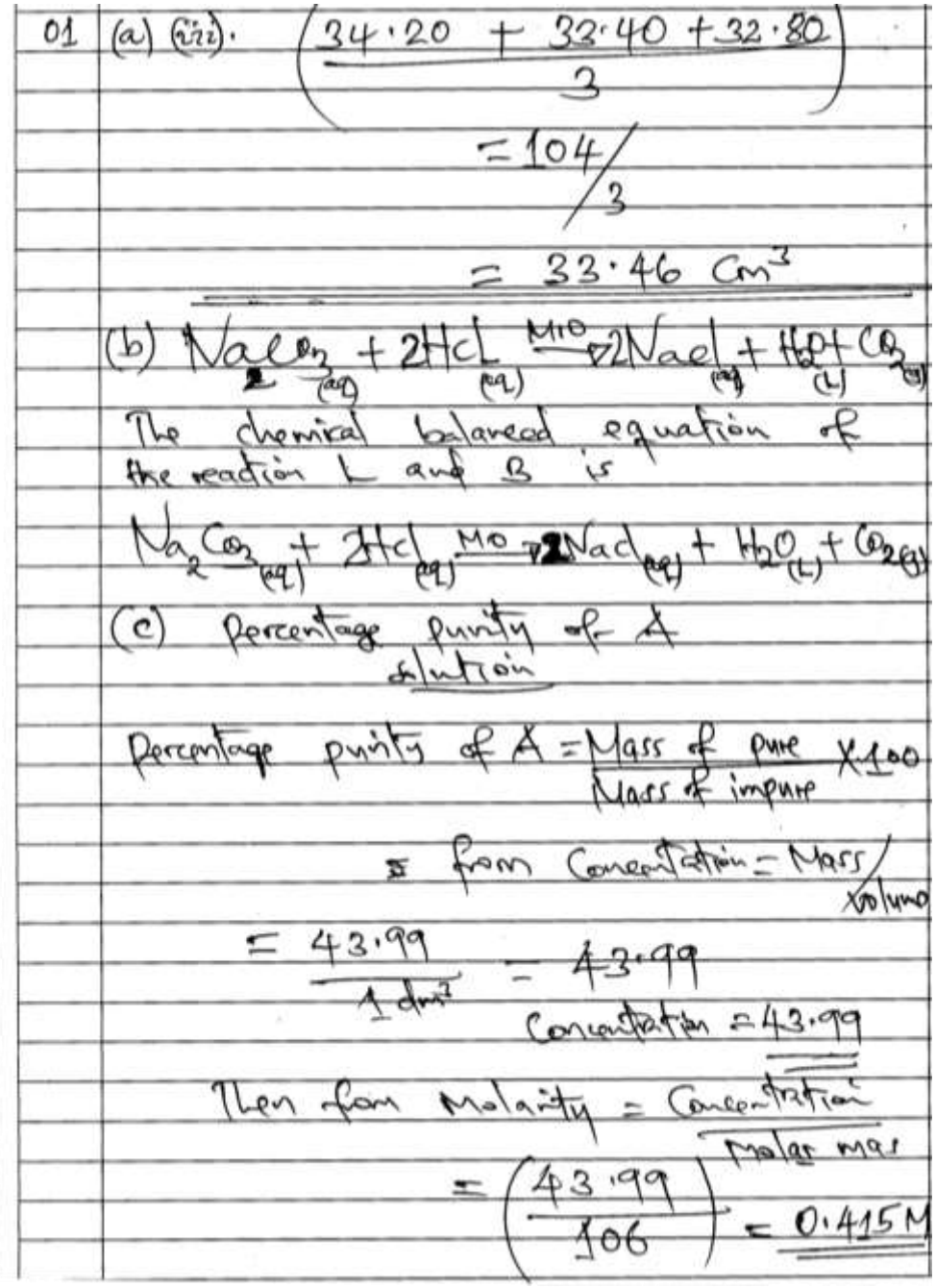
$= 0.35\ moles/dm^3\ x\ 106\ g/mole = 37\ g/dm^3$

$$\%\ purity = \frac{mass\ concentration\ of\ \ pure\ Na_2CO_3}{mass\ concentration\ of\ \ impure\ Na_2CO_3}$$

$$= \frac{37\ g\ /\ dm^3}{43.99\ g\ /\ dm^3}\ x\ 100 = 84.3\%.$$

Further analysis revealed that, many of the candidates who scored 8 to 13.5 marks failed to write the correct chemical reactions. Others could get correct answers in some parts while giving irrelevant ones in other parts. It was also observed that, some candidates failed to calculate the purity of sodium carbonate, hence missed some marks.

Conversely, most of the candidates who scored 0 to 7.5 marks failed to calculate the percentage purity as they computed the molarity of solution B (0.35M) instead of solution L (0.07 M) obtained from dilution of the former. As a result, the majority failed to get the correct value of percentage purity as shown in Extract 19.



Extract 19: A sample of incorrect responses to question 1Chemistry 2C

Extract 19 is a part of an incorrect response in which the candidate got incorrect titre value and applied irrelevant formulae in part (c) by finding molar concentration instead of mass concentration. Subsequently, the final answer was incorrect.

2.2.2 Question 2: Chemical Kinetics

In alternative paper 2A and 2C, the experiment involved studying the effect on the rate of reaction by varying the concentration of sodium thiosulphate solution. In alternative paper 2B temperature was used as a variable factor for the rate of chemical reaction.

The statistical data shows that 662 (96.4%) passed implying that only 25 (3.6%) failed. Figure 18 shows the distribution of these data.

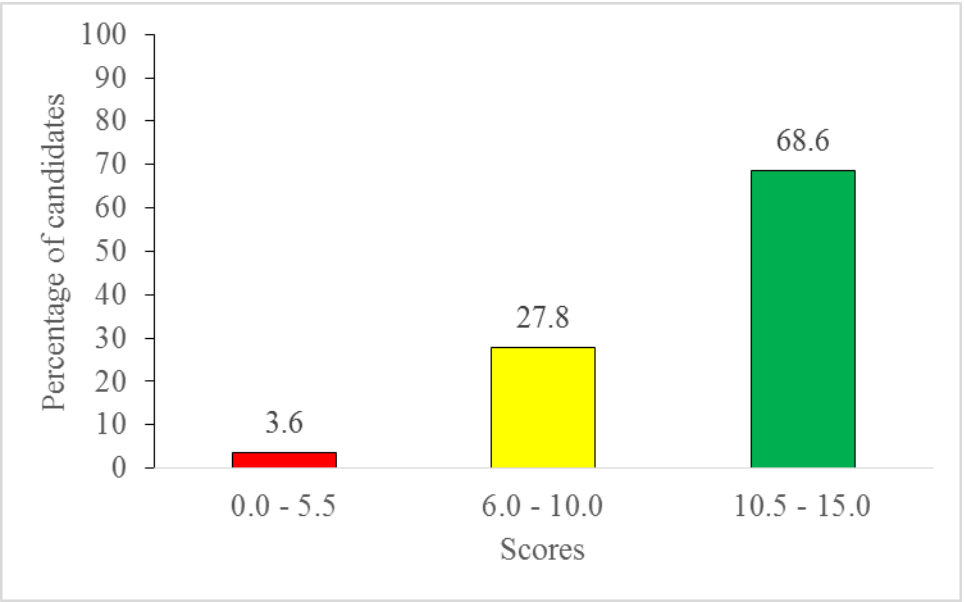


Figure 18: Distribution of the candidates' scores on question 2

From the data given in Figure 18, 68.6 per cent candidates scored 10.5 to 15 marks, and 27.8 per cent scored 6 to 10 marks. The least, 3.6 per cent scored 0 to 5.5 marks.

The analysis of the responses in each alternative is provided as follows:

2.2.2.1 732/2A Chemistry 2A

In question 2 of alternative paper 2A, the candidates were provided with 0.5 M sodium thiosulphate, 1 M hydrochloric acid, distilled water, stop watch and a white sheet of paper marked X. They were instructed to perform the experiment in following procedure:

*(i) Pour 30 cm^3 of **B1** into 100 cm^3 beaker.*

*(ii) Take a white sheet of paper provided with a letter **X** drawn on it and place it under the 100 cm^3 beaker in such a way that **X** is seen through the bottom of the beaker.*

*(iii) Add 10 cm^3 of **B2** into the beaker containing 30 cm^3 of **B1** and at the same time start the stop watch. Swirl the mixture twice and look through the solution from above.*

*(iv) Stop the clock when **X** disappears from the sight and record the time.*

(v) Repeat steps (i) to (iv) using the specifications shown in the following table.

Experimental Data

Exp.	***Volume of B1 (cm^3)***	***Volume of water (cm^3)***	***Volume of B2 (cm^3)***	***Time, t for X to disappear (s)***	***1/time (s^{-1})***
1	*30*	*0*	*10*		
2	*25*	*5*	*10*		
3	*20*	*10*	*10*		
4	*15*	*15*	*10*		
5	*10*	*20*	*10*		
6	*5*	*25*	*10*		

After the experiment, they were required to answer the following questions:

(a) Write a balanced chemical equation for the reaction which took place during the experiment.

*(b) (i) Plot a graph of volume of **B1** (cm^3) against $\frac{1}{time}$ (s^{-1}).*

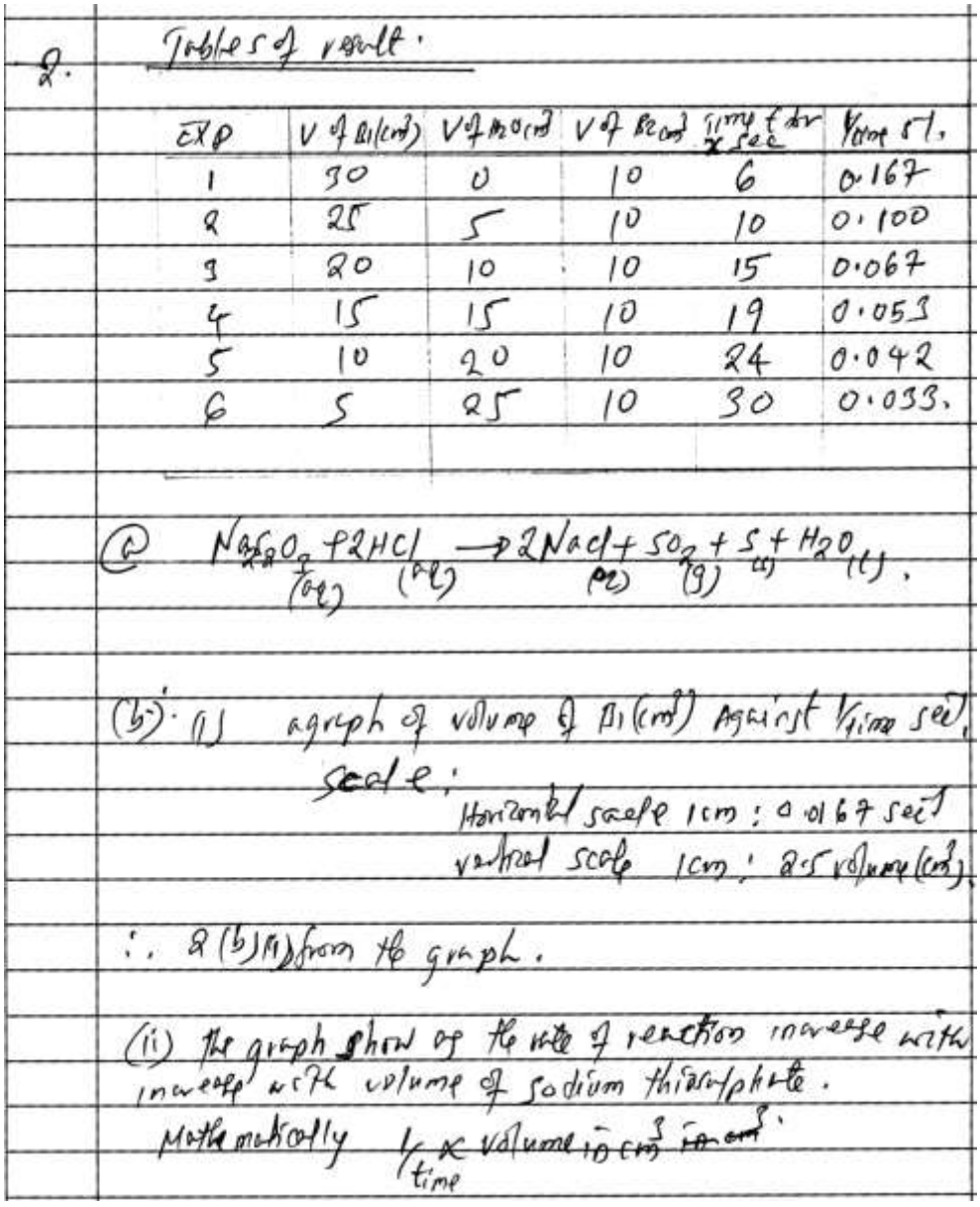
(ii) Interpret the graph.

(iii) What does $\frac{1}{time}$ represent?

(iv) If temperature was to be the factor affecting the rate of reaction, how would the two relate?

(v) Draw a conclusion about this experiment.

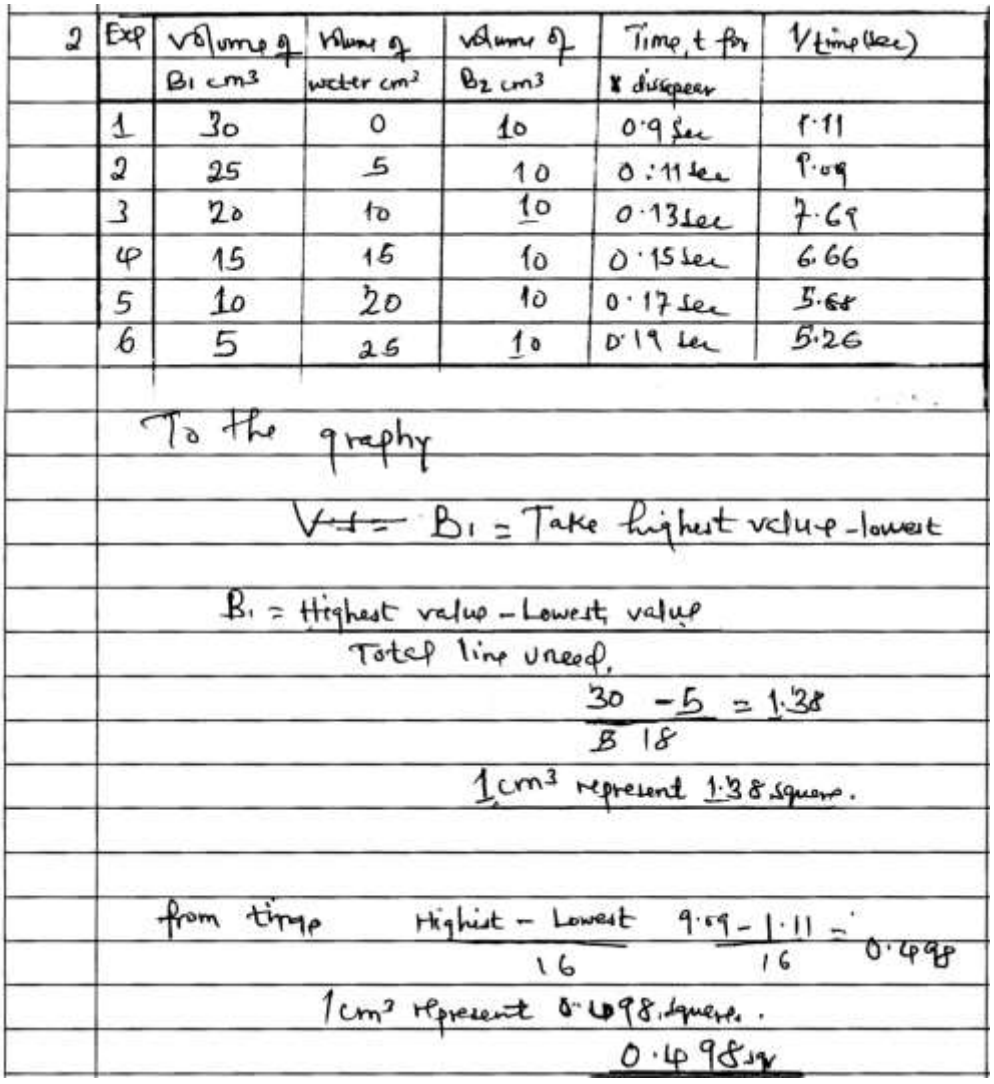
The analysis of the candidates' responses revealed that, those who scored 10.5 to 15 marks were able to use the stop watch in recording the time range expected for precipitation to form. They also showed competence in attending reaction equation, although few of them did not take care of the state symbols which are important aspects in writing ionic reaction equation. Extract 20.1 is a sample of correct responses.



Extract 20.1: A sample correct responses to question 2 Chemistry 2A

Besides, the analysis revealed that many of the candidates, who scored 6 to 10 marks, were able to fill the table and answer the subsequent questions. However, they failed to draw the graphs and give reasonable conclusion. Others failed to write the reaction equation but could give the reason why cloud was formed. This suggests that those candidates have inadequate skills in graphs as a scientific method of presentation of data/statistics.

In the other category, the few candidates (3.6%) who scored 0 to 5.5 marks they generally showed inadequate knowledge of the concept of the rate of chemical reaction. The main observed challenge was how to record time and make appropriate recordings. In addition, some of them skipped parts of graphs. An example of incorrect responses is given in Extract 21.2.



2	Exp	Volume of B_1 cm^3	Volume of water cm^3	Volume of B_2 cm^3	Time, t for ✗ disappear	1/time (sec)
	1	30	0	10	0·9 sec	1·11
	2	25	5	10	0·11 sec	9·09
	3	20	10	10	0·13 sec	7·69
	4	15	15	10	0·15 sec	6·66
	5	10	20	10	0·17 sec	5·88
	6	5	25	10	0·19 sec	5·26

To the graphy

$V \cdot t = B_1$ = Take highest value - lowest

B_1 = Highest value - Lowest value / Total time used

$\frac{30 - 5}{B\ 18} = 1.38$

$1\ cm^3$ represent 1·38 square.

from time $\frac{\text{Highest} - \text{Lowest}}{16}$ $\frac{9.09 - 1.11}{16} = 0.498$

$1\ cm^3$ represent 0·498 square.

0·498 sq

Extract 20.2: A sample of incorrect responses in question 2 Chemistry 2A

In Extract 20.2 the candidate gave incorrect titre value, hence incorrect final answer. In addition, one candidate got incorrect by writing a chemical formula of oxalic acid ($H_2C_2O_4$) instead of writing sodium chloride (NaCl), sulphur dioxide (SO_2), Sulphur (S) and water (H_2O) from the equation:

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

2.2.2.2 732/2B Chemistry 2B

In alternative paper 2B, the candidates were provided with 0.1 M sodium thiosulphate, 0.1 M hydrochloric acid, distilled water, stop watch and a white sheet of paper marked **M**. They were instructed to perform the experiment by following the procedure that follow:

*(i) Place a 50 cm^3 beaker on top of a letter **M** marked on the sheet of paper provided.*
(ii) Prepare a water bath using a 250 cm^3 or 300 cm^3 beaker.
(iii) Measure 10 cm^3 of EE and 10 cm3 of FF, and then put them into two different test tubes.
(iv) Place a thermometer in one of the test tubes, then place both test tubes into the water bath prepared in step (ii) and warm the test tube contents to 40^0C.
(v) Immediately pour the hot solutions EE and FF into the 50 cm3 beaker in step (i) and simultaneously start the stop watch/clock. Record the time taken in seconds, for the mark to disappear completely.
(vi) Repeat procedure (i) to (v) at different temperatures as shown in the following table.

Experimental Data

Experiment	***Temperature ($^{\circ}C$)***	***Time (s)***	***Temperature (K)***
1	*40*		
2	*50*		
3	*60*		
4	*70*		
5	*80*		

They were then required to answer the following questions:

(a) Record the room temperature in Kelvin (K).
*(b) Why did the mark **M** disappear?*
(c) Complete the table by filling the blank columns.

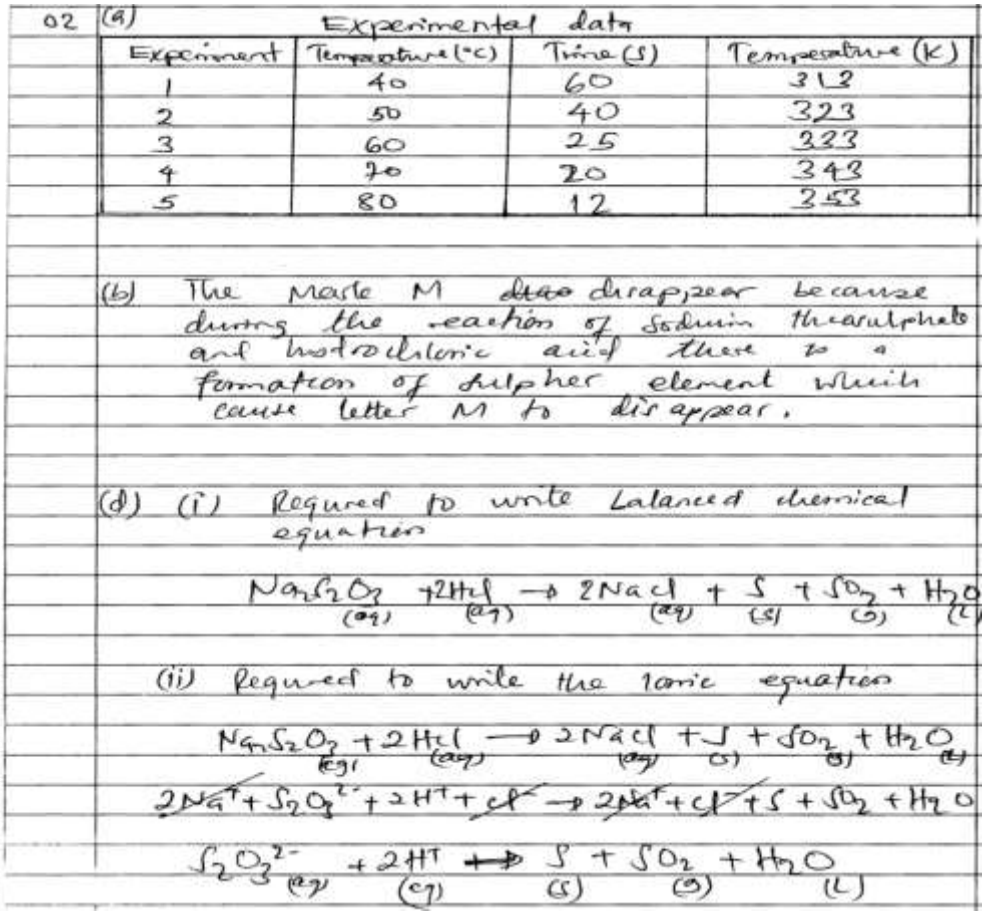
(d) *(i)* *Write a balanced chemical equation for the reaction taking place between **EE** and **FF**. Show all the state symbols.*

(ii) *Write the ionic equation for the reaction between **EE** and **FF**.*

(e) *Plot a graph of time(s) against temperature (K).*

(f) *What conclusion can be drawn from the graph that you plotted in (e)?*

The candidates who scored 10.5 to 15 marks had enough skills to manipulate the stop watch and record the time. They also showed good mastery of using graphs as a way of presenting scientific data and draw the conclusion from the trend of the information therefrom. As in alternative paper 2A, these candidates were also able to write the required balanced equations. Extract 21.1 is a sample of correct responses.



02 (a) Experimental data

Experiment	Temperature (°C)	Time (S)	Temperature (K)
1	40	60	313
2	50	40	323
3	60	25	333
4	70	20	343
5	80	12	353

(b) The Marke M disappear because during the reaction of Sodium thiosulphate and hydrochloric acid there is a formation of sulpher element which cause letter M to disappear.

(d) (i) Required to write balanced chemical equation

$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$

(ii) Required to write the ionic equation

$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$

$2Na^+ + S_2O_3^{2-} + 2H^+ + Cl^- \rightarrow 2Na^+ + Cl^- + S + SO_2 + H_2O$

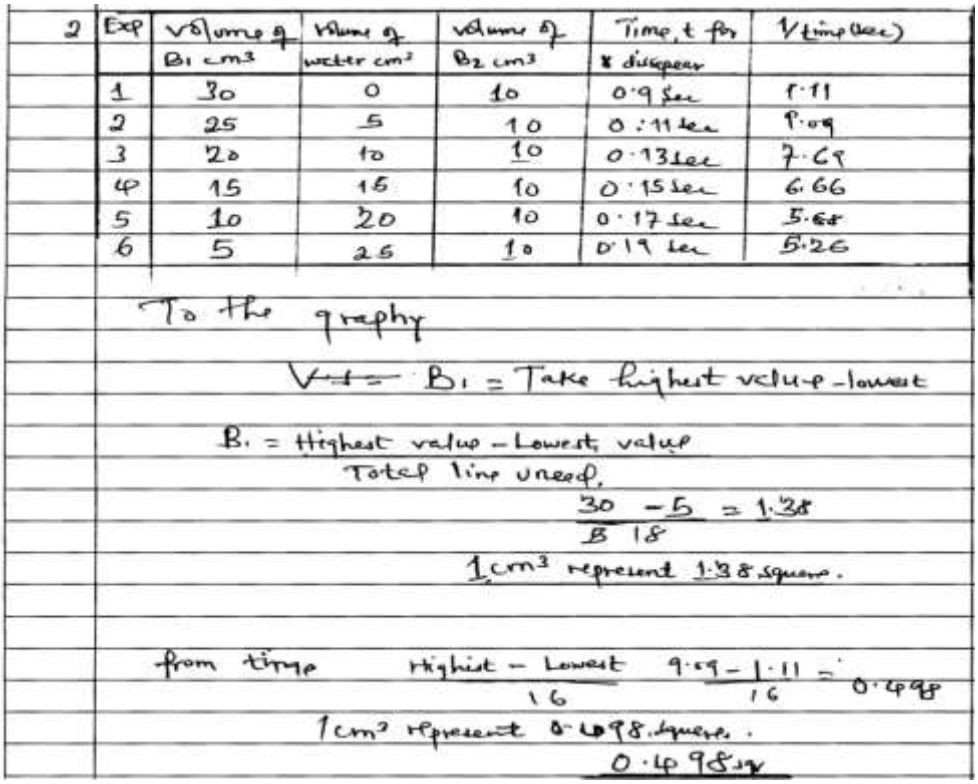
$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(g) + H_2O(l)$

Extract 21.1: A sample of correct responses to question 2 Chemistry 2B

In Extract 21.1, a candidate recorded time taken to complete the reaction between thiosulphate and acid. Also, the candidate gave the reason for cloud formation in the solution, and correctly wrote the reaction equation.

Conversely, the analysis revealed that many of the candidates who scored 6 to 10 marks were able to fill the table of results and answer the subsequent questions. However, they failed to draw the graphs and give reasonable conclusions. This implies that those candidates have inadequate skills on graph as one of scientific methods of presentation of data/statistics. It was also noted that, as observed in other alternative papers, some of the candidates failed to state why the precipitations were formed.

In the last category, the analysis showed that the few candidates (3.6%) whose scores ranged from 0 to 5.5 marks generally showed inadequate knowledge of the concept of the rate of chemical reaction. The main observed challenge affected the majority in this category was how to take time and make appropriate recording. An example of correct responses is given in Extract 21.2.



2	Exp	Volume of B_1 cm^3	Volume of water cm^3	Volume of B_2 cm^3	Time, t for X disappear	1/time (sec)
	1	30	0	10	0·9 sec	1·11
	2	25	5	10	0·11 sec	9·09
	3	20	10	10	0·13 sec	7·69
	4	15	15	10	0·15 sec	6·66
	5	10	20	10	0·17 sec	5·88
	6	5	25	10	0·19 sec	5·26

To the graphy

V_{of} B_1 = Take highest value - lowest

B_1 = Highest value − Lowest value / Total line uneed

$\frac{30 - 5}{B\ 18} = 1.38$

1 cm^3 represent 1·38 square.

from time: Highist − Lowest / 16 = 9·09 − 1·11 / 16 = 0·498

1 cm^3 represent 0·498 square.

0·498 sq

Extract 21.2: A sample of incorrect responses to question 2 Chemistry 2B

In Extract 21.2 the candidate got incorrect reaction time, hence incorrect final answer.

2.2.2.3 732/2C Chemistry 2C

In this question, the candidates were provided with the following:
A solution **AA** containing 0.3 M sodium thiosulphate ($Na_2S_2O_3$); solution **BB** containing 2 M nitric acid (HNO_3); distillated water, white sheet of paper marked **X** and Stopwatch.

The following procedures to perform the experiment were provided:

*(i) Measure 5 cm^3 of solution **AA** and put it into the 100 cm^3 beaker. Add 15 cm^3 of distilled water and place the beaker on top of the letter **X** marked on the sheet of paper provided.*

*(ii) Measure 5 cm3 of **BB** and place it into the 100 cm3 beaker containing **AA** and distilled water, immediately start the stopwatch.*

(iii) Swirl the contents, watch from above and observe the changes.

*(iv) Switch off the stop watch when the mark **X** disappears.*

*(v) Record the time taken for the letter **X** to disappear.*

(vi) Repeat the experiment using different data as shown in the following table.

Table: Experimental Data

Experiment Number	***1***	***2***	***3***	***4***
Volume of AA (cm^3)	*20*	*15*	*10*	*5*
Volume of Distilled water (cm^3)	*0*	*5*	*10*	*15*
Volume of BB (cm^3)	*5*	*5*	*5*	*5*
Time (s)				
1/Time (s^{-1})				

Questions

(a) Complete filling the table.

*(b) Why mark **X** disappeared in this experiment?*

*(c) (i) Indicating the states of the reactants and the products, write a balanced chemical equation for the reaction between **AA** and **BB**.*

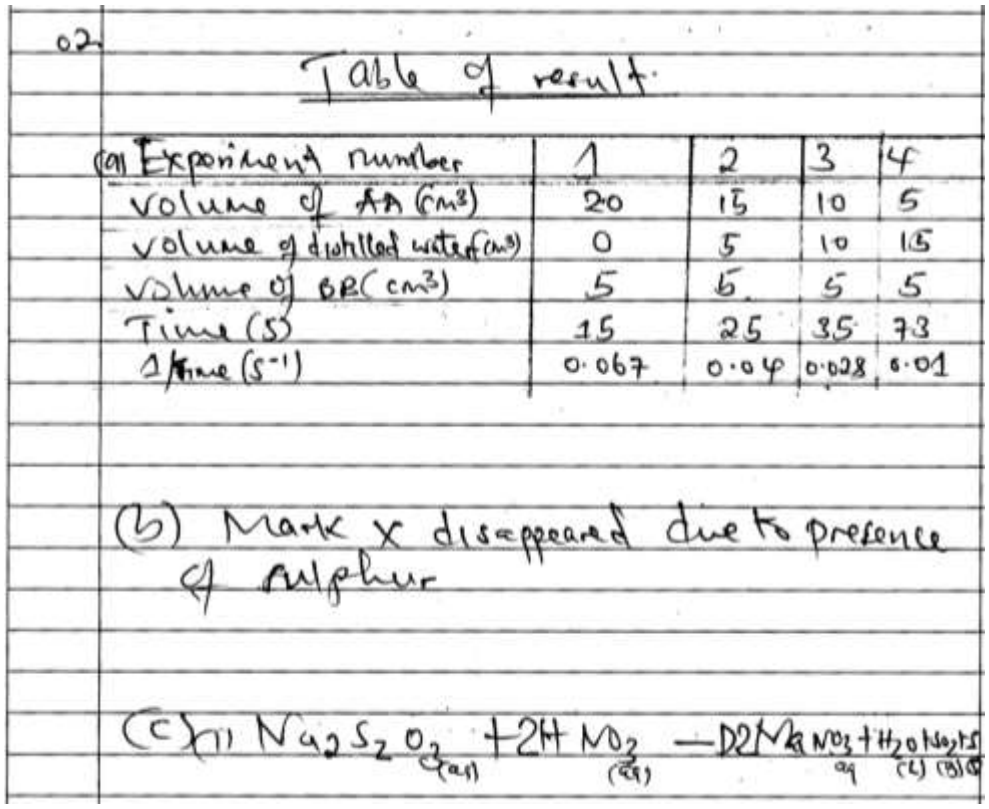
(ii) *Write the corresponding ionic equation for the reaction between* ***AA*** *and* ***BB****.*

(d) *Plot a graph of volume of* ***AA*** *(cm^3) against* $\frac{1}{time}$ (s^{-1})*. Explain the shape of your graph.*

(e) *How would the rate of reaction vary if the concentration of* ***BB*** *is increased while the concentration of* ***AA*** *is kept constant? Explain.*

(f) *What does the value* $\frac{1}{time}$ *mean?*

The analysis of the candidates' responses showed that those who scored 10.5 to 15 marks were able to apply the stop watch and record time appropriately. They also had enough knowledge of the concept of factors responsible for altering the rate of chemical reaction. This knowledge enhanced the answer in part (e) of the question. Moreover, the candidates demonstrated good skill in the use of graphs to present and interpreted data. Extract 22.1 is a sample of correct responses.



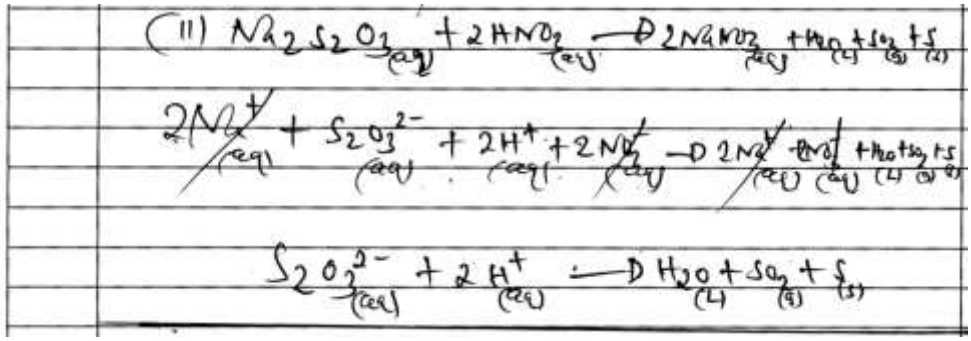
02

Table of result.

(a) Experiment number	1	2	3	4
volume of AA (cm^3)	20	15	10	5
volume of distilled water (cm^3)	0	5	10	15
volume of BB (cm^3)	5	5	5	5
Time (S)	15	25	35	73
1/time (S^{-1})	0.067	0.04	0.028	0.01

(b) Mark x disappeared due to presence of sulphur

(c) (i) $Na_2S_2O_3(aq) + 2HNO_3(aq) \rightarrow 2NaNO_3(aq) + H_2O(l) + SO_2(g) + S(s)$



Extract 22.1: A sample of correct responses to question 2 Chemistry 2C

In Extract 22.1, a candidate recorded time correctly, wrote reaction equations and correctly gave the reason for disappearance of mark **X**.

Further analysis revealed that many of the candidates who scored 6 to 10 marks were able to answer some of the parts and failed to answer others. In general, the majority were able to answer some areas of the question. However, their responses were either incomplete or unsatisfactory, a phenomenon that suggests inadequate knowledge and skills for the concept assessed. The observation in the way candidates responded in this alternative paper, especially in graphs related questions has no significant difference with other alternatives, suggesting that the candidates have common problem in graphs related concepts.

Conversely, few candidates (3.6%) whose scores ranged from 0 to 5.5 marks most of them failed to answer part (d) and (f), suggesting low knowledge and skills in application of graphs in data presentation. Extract 22.2 is an example of correct responses.

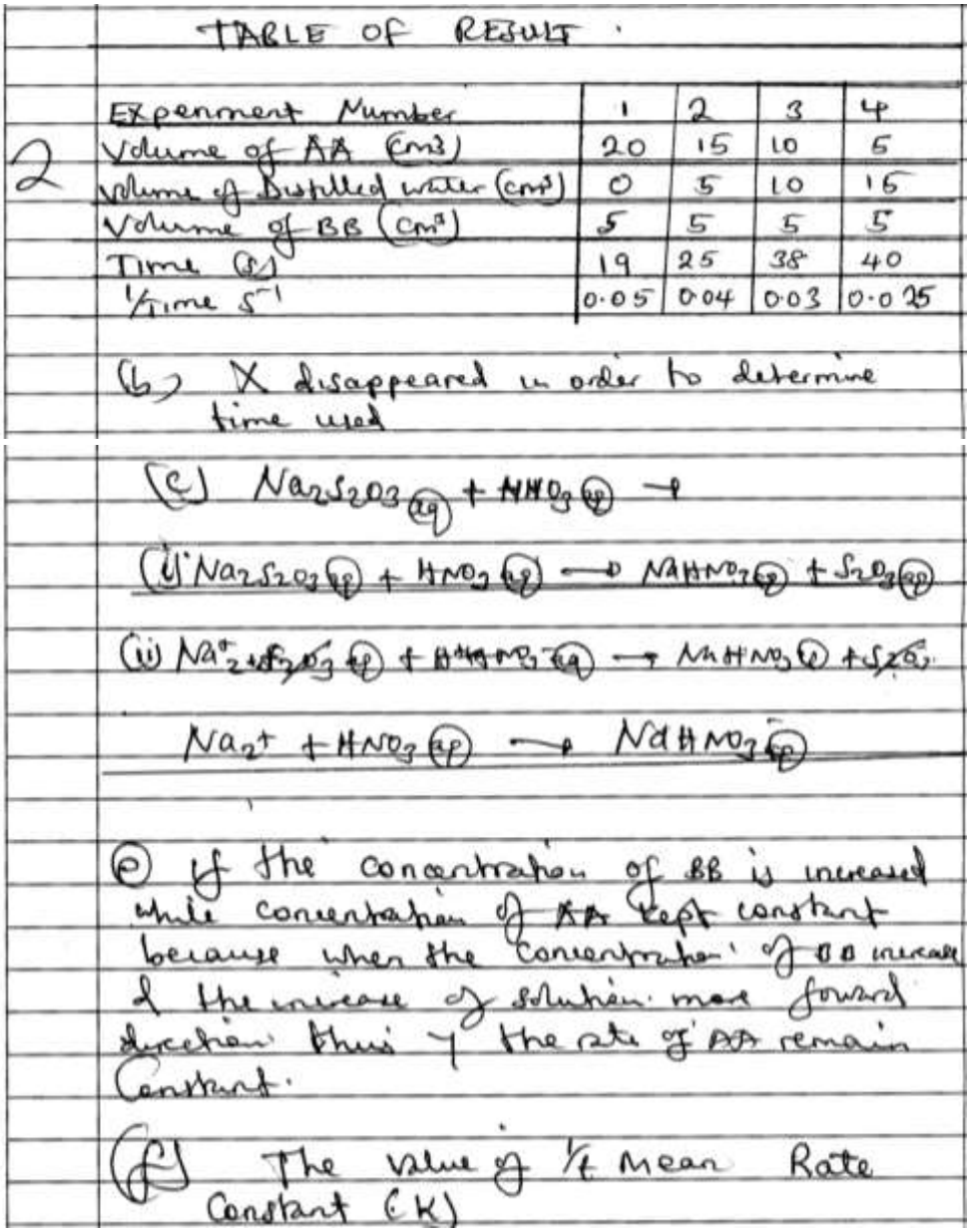


TABLE OF RESULT

Experiment Number	1	2	3	4
Volume of AA (cm^3)	20	15	10	5
Volume of Distilled water (cm^3)	0	5	10	15
Volume of BB (cm^3)	5	5	5	5
Time (s)	19	25	38	40
1/Time s^{-1}	0.05	0.04	0.03	0.025

(b) X disappeared in order to determine time used

(c) $Na_2S_2O_3(aq) + HNO_3(aq) \rightarrow$

(i) $Na_2S_2O_3(aq) + HNO_3(aq) \rightarrow NaHNO_2(aq) + S_2O_3(aq)$

(ii) $Na^+_2S_2O_3(aq) + HNO_3(aq) \rightarrow NaHNO_3(l) + S_2O_3$

$Na_2^+ + HNO_3(aq) \rightarrow NaHNO_3(aq)$

(e) If the concentration of BB is increased while concentration of AA kept constant because when the concentration of BB increase the increase of solution move foward direction thus the rate of AA remain Constant.

(f) The value of 1/t mean Rate Constant (K)

Extract 22.2: A sample of incorrect responses to question 2 Chemistry 2C.

In Extract 22.2, the candidate was able to get a correct solution in part (a) only and failed to get correct responses in the rest parts.

2.2.3 Question 3: Qualitative Analysis

Qualitative analysis assessed the competence of the candidates in carrying out practical activities to make informed observations and inferences of the

salts under investigation. The sample salts given were: lead (II) nitrate ($Pb(NO_3)_2$ in alternative paper 2A, zinc nitrate ($Zn(NO_3)_2$ in paper 2B and sodium chloride (NaCl) in paper 2C. In all the three alternative papers, the experiments to be performed were guided.

The analysis of the data shows that, 646 (94.0%) candidates passed, whereas only 41 (3.6%) candidates failed, implying good performance. The distribution of these data is given in Figure 19.

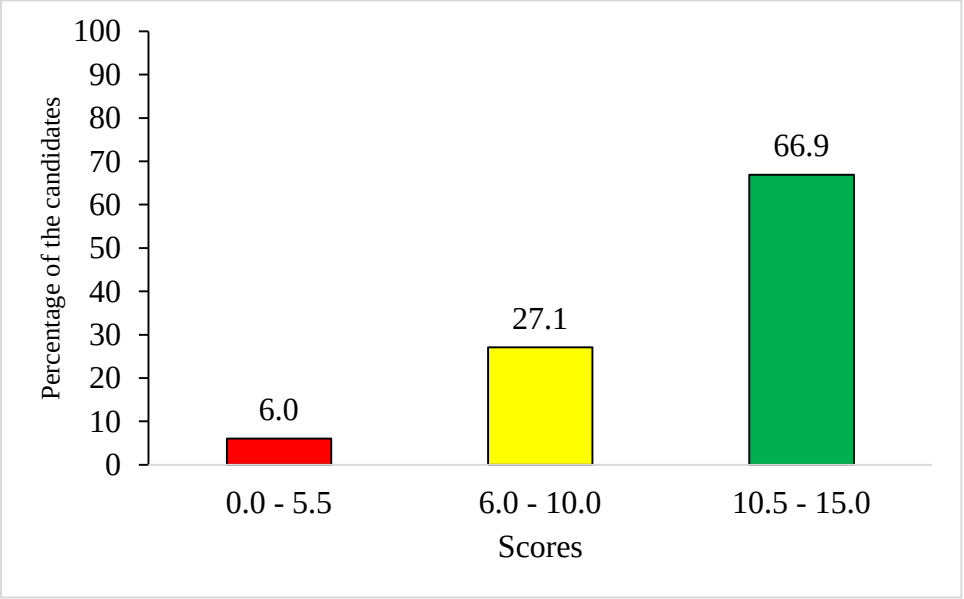


Figure 19: Distribution of the candidates' scores on Chemistry 2 question 3

The data in Figure 19 show that 66.9.0 per cent scored 10.5 to 15 marks, 27.1 per cent scored 6 to 10 marks and the ones who scored 0 to 5.5 marks were only 3.6 per cent. Figure 18 is the distribution of these performance data.

The tasks in all the alternative papers were as follows:

2.2.3.1 732/2A Chemistry 2A

In alternative 2A question was as follows:

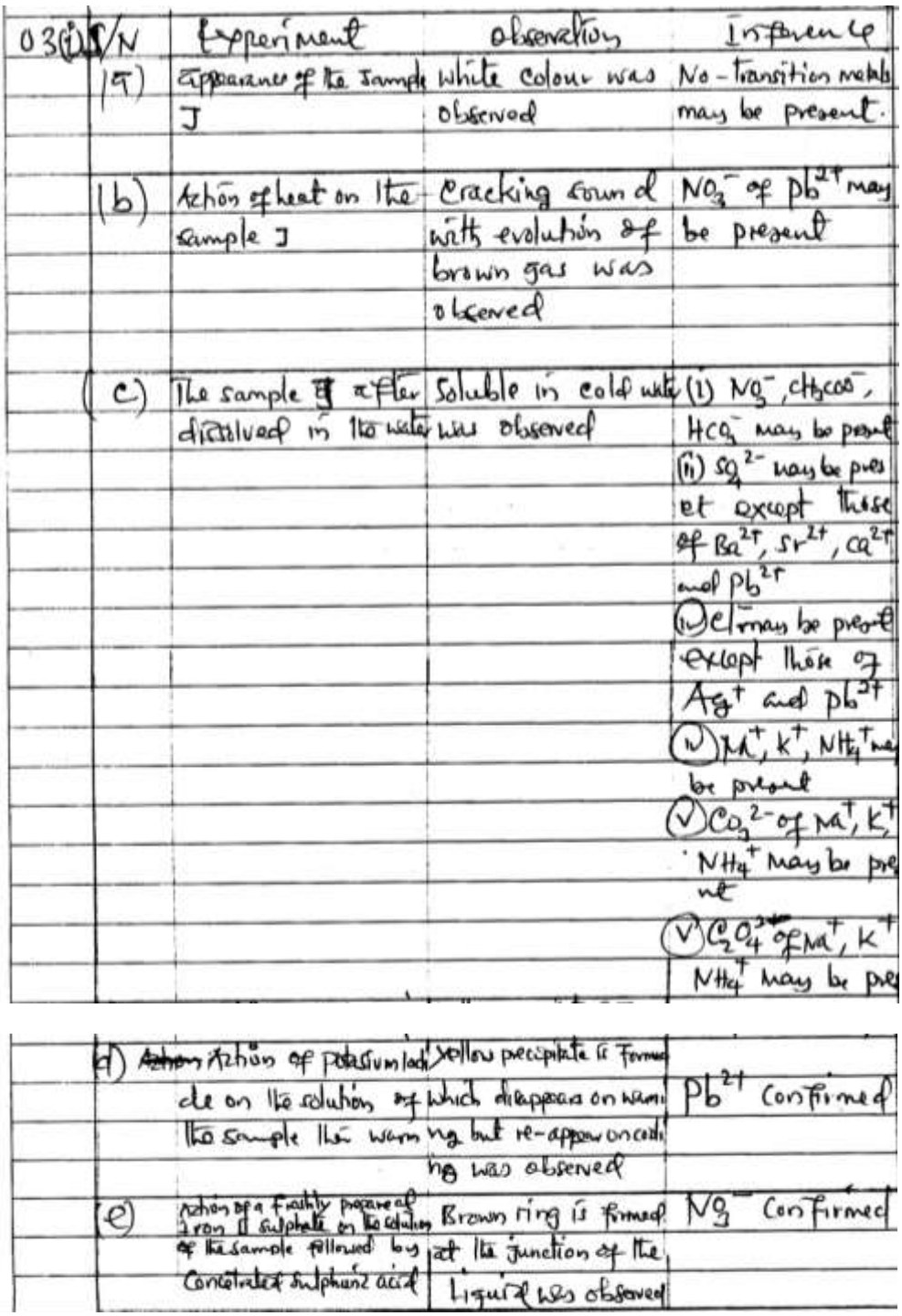
*Sample **J** is a simple salt containing one cation and one anion. Carefully, carry out qualitative analysis experiment to identify the ions present in the salt based on the following tests:*
(a) Appearance of the sample.

(b) Action of heat on the sample.
(c) The sample dissolved in the water.
(d) Action of potassium iodide on the solution of the sample then warm.
(e) Action of a freshly prepared iron(II) sulphate on the solution of the sample followed by concentrated sulphuric acid

Questions

(i) Prepare a relevant Table showing the qualitative analysis results.
(ii) Write a balanced chemical equation (with state symbols) for the reaction that took place in experimental test (b).

The analysis of the candidates' responses showed that, those who scored 10.5 to 15 marks were able to perform the experiments and made accurate observation. These candidates had adequate knowledge of the physical properties of different chemical reactions as they made correct observable physical changes. They were also able to make correct inference on the cation and anion of the sample provided though such physical and chemical reactions. Another quality on these candidates was their ability to deduce the nature of the sample and give the correct chemical reactions assigned. Extract 23.1 is an example of correct responses.

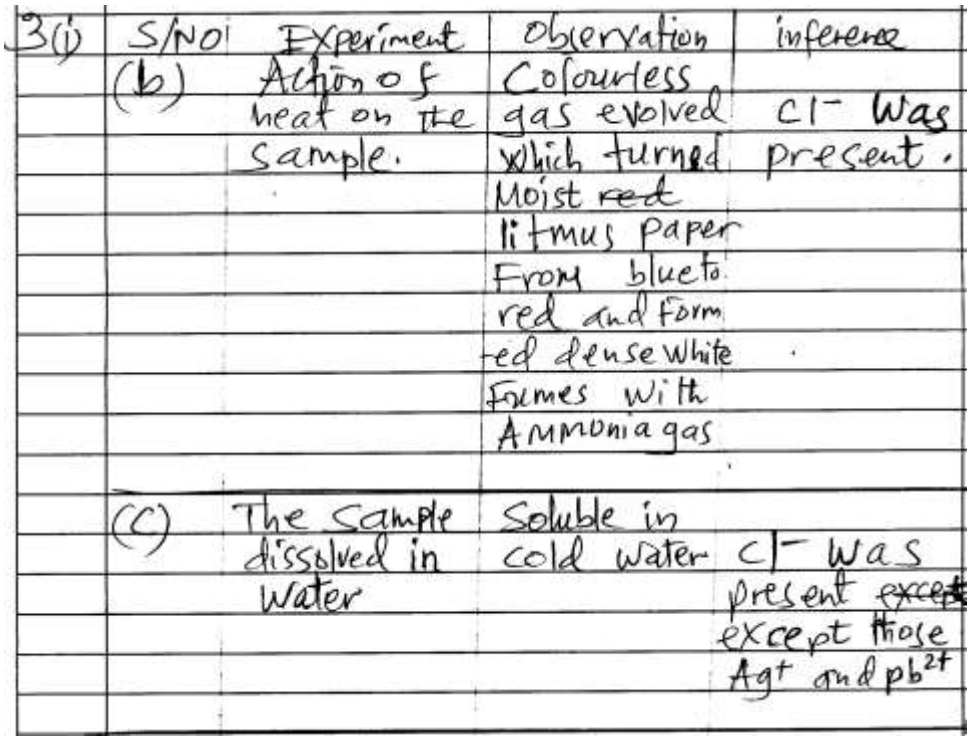


03 (i)	S/N	Experiment	observation	Inference
	(a)	Appearance of the sample J	White colour was observed	No - transition metals may be present.
	(b)	Action of heat on the sample J	Cracking sound with evolution of brown gas was observed	NO_3^- of Pb^{2+} may be present
	(c)	The sample after dissolved in the water	Soluble in cold water was observed	(i) NO_3^-, CH_3COO^-, HCO_3^- may be present (ii) SO_4^{2-} may be present except those of Ba^{2+}, Sr^{2+}, Ca^{2+} and Pb^{2+} (iii) Cl^- may be present except those of Ag^+ and Pb^{2+} (iv) NH_4^+, K^+, NH_4^+ may be present (v) CO_3^{2-} of NH_4^+, K^+, NH_4^+ may be present (vi) $C_2O_4^{2-}$ of NH_4^+, K^+ NH_4^+ may be present
	(d)	Action of potassium iodide on the solution of the sample the warming	Yellow precipitate is formed which disappears on warming but re-appear on cooling was observed	Pb^{2+} confirmed
	(e)	Action of a freshly prepared Iron II Sulphate on the solution of the sample followed by Concentrated sulphuric acid	Brown ring is formed at the junction of the Liquid was observed	NO_3^- confirmed

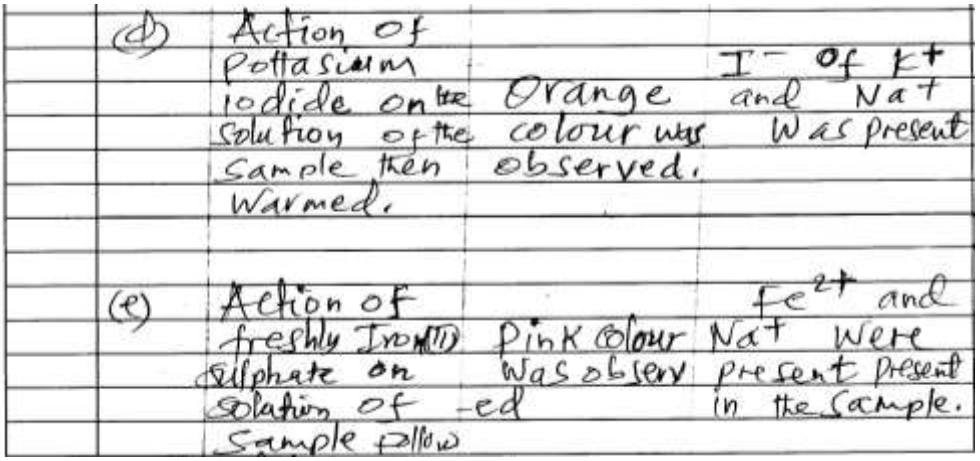
Extract 23.1: A sample of correct responses to question 3 Chemistry 2A

Further analysis revealed that some of the candidates who scored 6 to 10 marks failed to give responses in items that require writing reaction equations. However, few of them gave either incorrect observation or wrong inferences. This implies that they have inadequate knowledge on physical and chemical properties of some salts.

On the other hand, the candidates who from 0 to 5.5 marks apart from failing to give responses in items that require writing reaction equation, they were to complete the table of results. In addition, others left the table with unfilled gaps in both observation and inference columns. Extract 23.2 provides a sample of incorrect responses.



3(i)	S/NO	Experiment	observation	inference
	(b)	Action of heat on the sample.	Colourless gas evolved which turned Moist ~~red~~ litmus paper From blue to red and formed dense white fumes with Ammonia gas	Cl^- was present.
	(c)	The sample dissolved in water	Soluble in cold water	Cl^- was present ~~except~~ except those Ag^+ and Pb^{2+}



Extract 23.2: A sample of incorrect responses to question 3 Chemistry 2A

In Extract 23.2, the candidate inferred the anion as chloride ion (Cl-) instead of nitrate ion (NO_3^-), and cation as sodium ion (Na^+ instead of lead (Pb^{2+}).

2.2.3.2 732/2B Chemistry 2B

The question was as follows:

*Sample **O** is a simple salt containing one cation and one anion. Carefully, carry out qualitative analysis experiment to identify the ions present in the salt based on the following tests:*

(a) Appearance of the sample.
(b) Action of heat on the sample.
(c) Action of concentrated sulphuric acid on the sample then warm.
(d) The sample dissolved in the water.
(e) Action of aqueous sodium hydroxide on the solution of the sample.
(f) Action of potassium hexacyanoferrate(II) solution on the solution of the sample followed by dilute HCl.
(g) Action of ferrous sulphate solution on the solution of the sample followed by concentrated H_2SO_4 along the side of test tube.

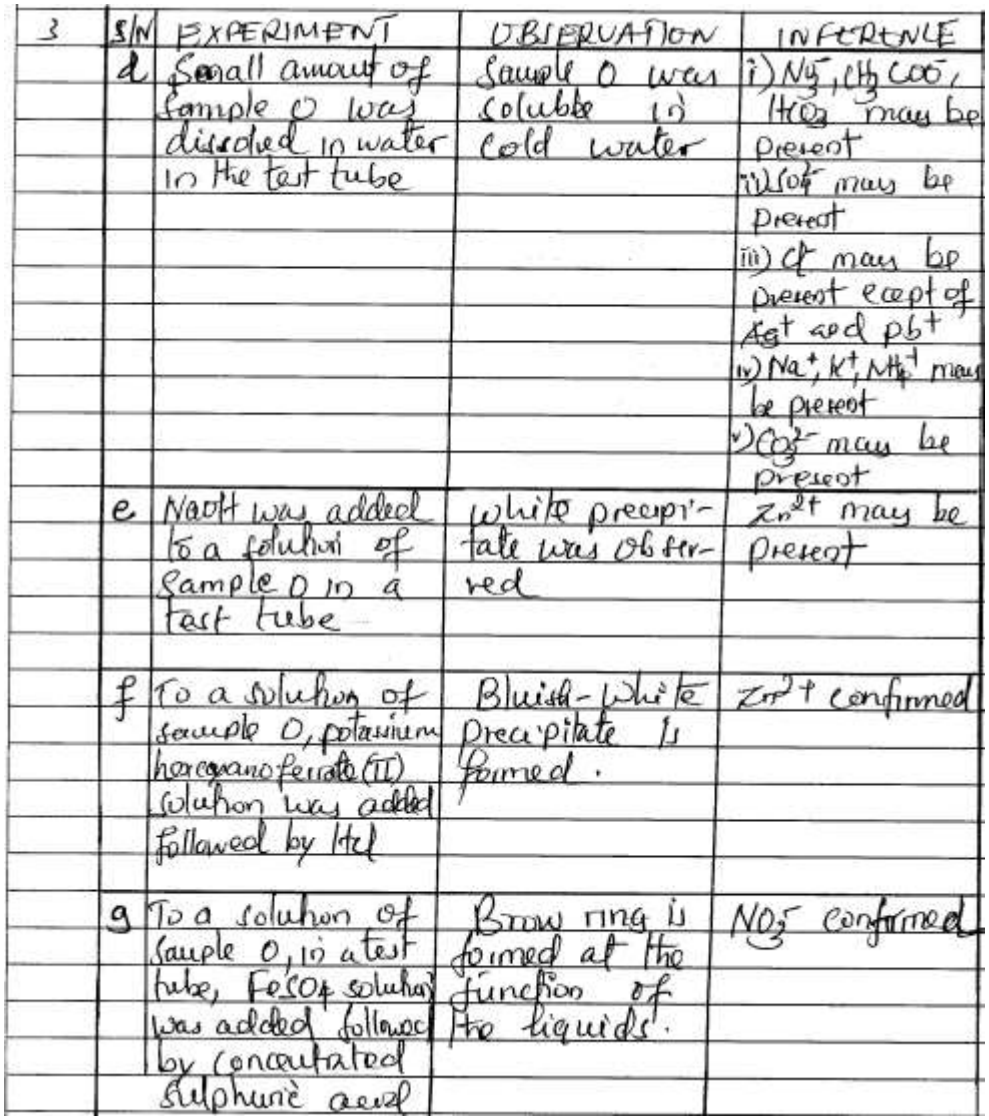
Questions

(i) Prepare a relevant Table showing the qualitative analysis results.
(ii) Write a balanced chemical equation for the test at experimental test (b).
(iii) Write a balanced chemical equation between the sample and sodium carbonate.

The analysis of the candidates' responses showed that, those who scored 10.5 to 15 marks managed to carry out all the seven tests (a) – (g) and report the observation and inferences in a standard table of results. Also, most of the candidates showed correct reaction equations and products from the tests given. For example, they gave thermal decomposition in experiment (b) as:

$$2Zn(NO_3)_2 \xrightarrow{\Delta} 2ZnO + 4NO_2 + O_2$$

These candidates had adequate knowledge of the concept of chemical equations. An example Extract 24.1 is illustrative.

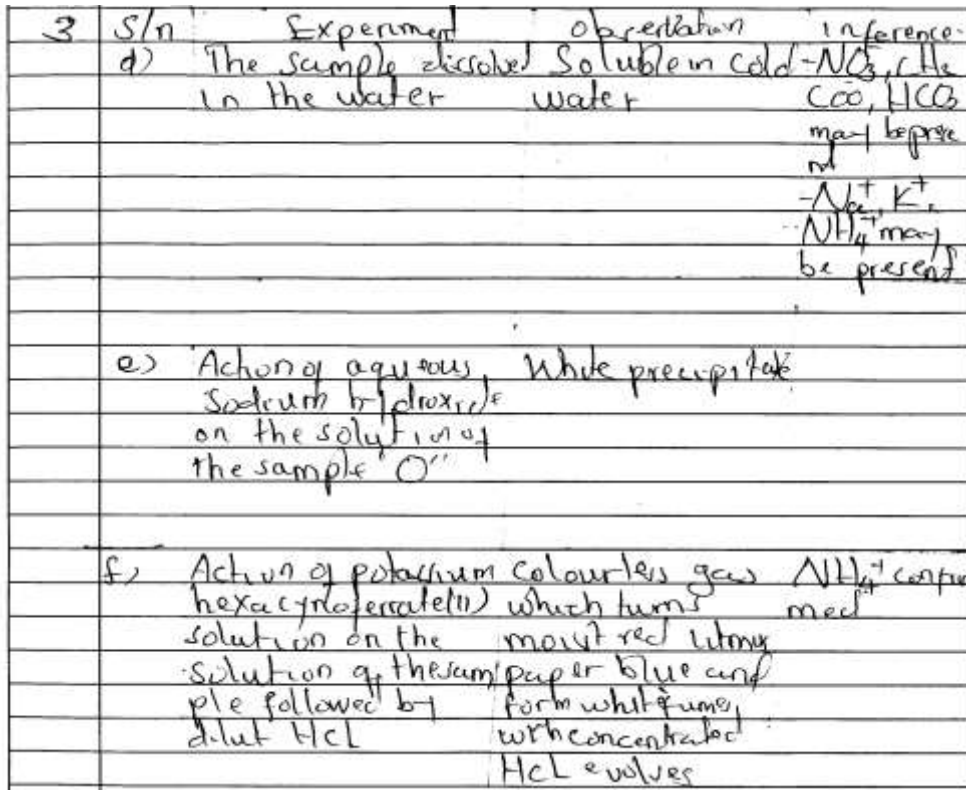


3	S/N	EXPERIMENT	OBSERVATION	INFERENCE
	a	Small amount of sample O was dissolved in water in the test tube	Sample O was soluble in cold water	i) NO_3^-, CH_3COO^-, HCO_3^- may be present ii) SO_4^{2-} may be present iii) Cl^- may be present except of Ag^+ and Pb^{2+} iv) Na^+, K^+, NH_4^+ may be present v) CO_3^{2-} may be present
	e	NaOH was added to a solution of sample O in a test tube	white precipitate was observed	Zn^{2+} may be present
	f	To a solution of sample O, potassium hexacyanoferrate(II) solution was added followed by HCl	Bluish-white precipitate is formed.	Zn^{2+} confirmed
	g	To a solution of sample O, in a test tube, $FeSO_4$ solution was added followed by concentrated Sulphuric acid	Brown ring is formed at the function of the liquids.	NO_3^- confirmed

Extract 24.1: A sample of correct responses to question 3 Chemistry 2B

Further analysis revealed that some of the candidates who scored 6 to 10 marks could not distinguish inferences of the preliminary tests and that of confirmatory tests. This implies that those candidates have inadequate knowledge on physical and chemical properties of some salts.

In contrast, the candidates whose scores ranged from 0 to 5.5 marks they faced similar challenges like the ones reported in alternative paper 2A, Others used trial and error since they was unable to derive such inferences from the observation. Additionally, others left the table with unfilled gaps in both observation and inference columns. Extract 24.2 provides a sample of incorrect responses.


3

S/n	Experiment	observation	inference
d)	The sample dissolve in the water	Soluble in cold water	NO_3^-, CO_3^{2-}, HCO_3^- may be present Na^+, K^+, NH_4^+ may be present
e)	Action of aqueous Sodium hydroxide on the solution of the sample "O"	White precipitate	
f)	Action of potassium hexacyanoferrate(II) solution on the solution of the sample followed by dilut HCl	Colourless gas which turns moist red litmus paper blue and form white fumes with concentrated HCl evolves	NH_4^+ confirmed

Extract 24.2: A sample of incorrect responses to question 3 Chemistry 2B

In Extract 24.2, the candidate was able to report only on experiment (d) which involves solubility property. The rest of the responses were incorrect.

2.2.3.3 732/2C Chemistry 2C

The question in alternative paper 2C was as follows:

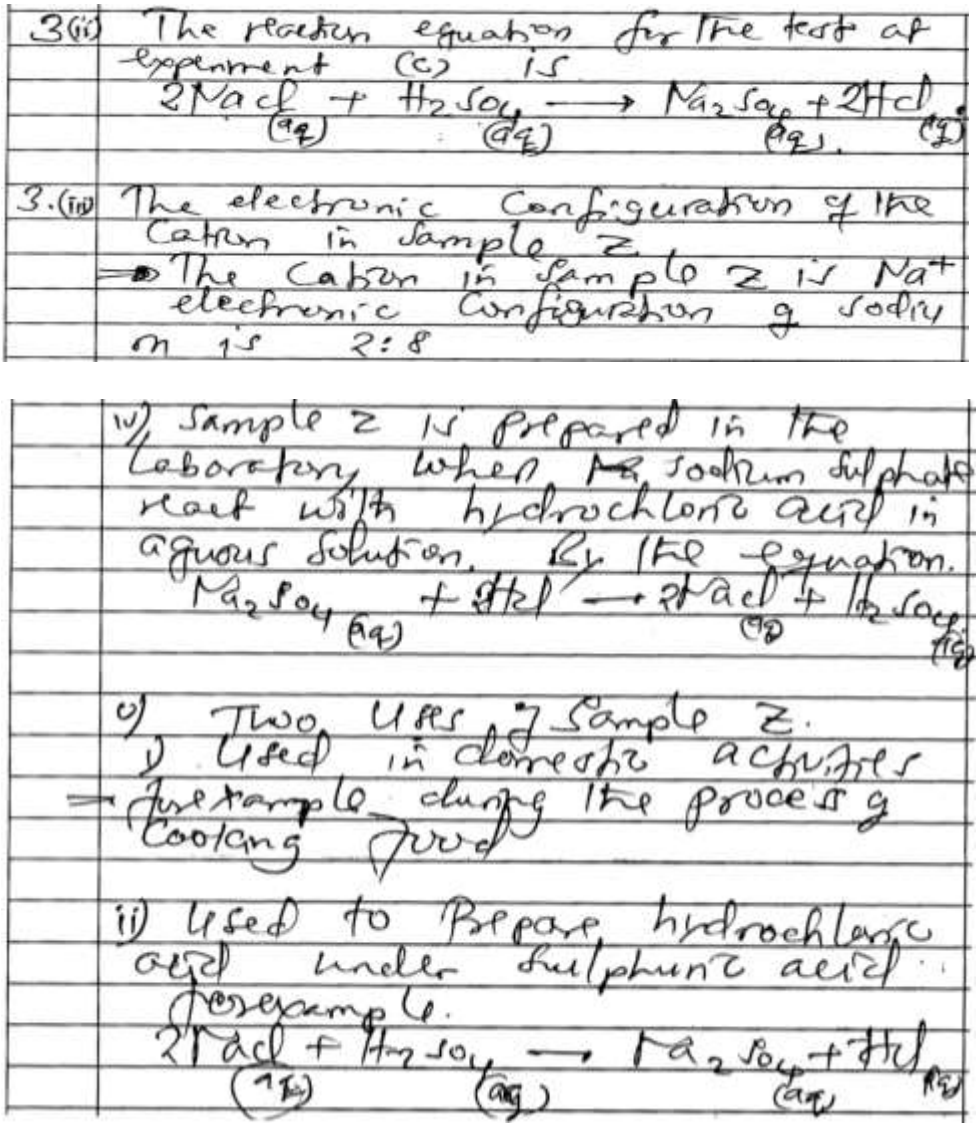
*Sample **Z** is a simple salt containing one cation and one anion. Carefully, carry out qualitative analysis experiment to identify the ions present in the salt based on the following tests:*

(a) Appearance of the sample.
(b) Action of heat on the sample.
(c) Action of concentrated sulphuric acid on the sample.
(d) Solubility.
(e) Action of aqueous sodium hydroxide on solution of sample Z.
(f) Flame test on sample Z.
*(g) Action of dilute nitric acid on solution of sample **Z** followed by silver nitrate solution.*

After the experiment, they were required to answer these questions:

(i) Prepare a relevant Table showing the qualitative analysis results.
(ii) Write the reaction equation for the test at experiment (c).
(iii) Write the electronic configuration of the cation in sample Z.
(iv) How is Z prepared in the laboratory? Support your answer with chemical reaction.
*(v) What are the two uses of sample **Z**? Briefly, explain.*

The analysis from the candidates' responses showed that, those who scored 10.5 to 15 marks were able to undertake all the experiments and made accurate observation. From the observed physical and chemical changes, they were able to determine the cation and anion of the sample salt provided was sodium chloride (NaCl). This enabled them to write the correct electronic configuration of the cation, (sodium Na = 2:8) implying that they understood the cation to be Na^+. This implies that they understood the properties of the sample salt when in solution. Extract 25.1 provides an example.



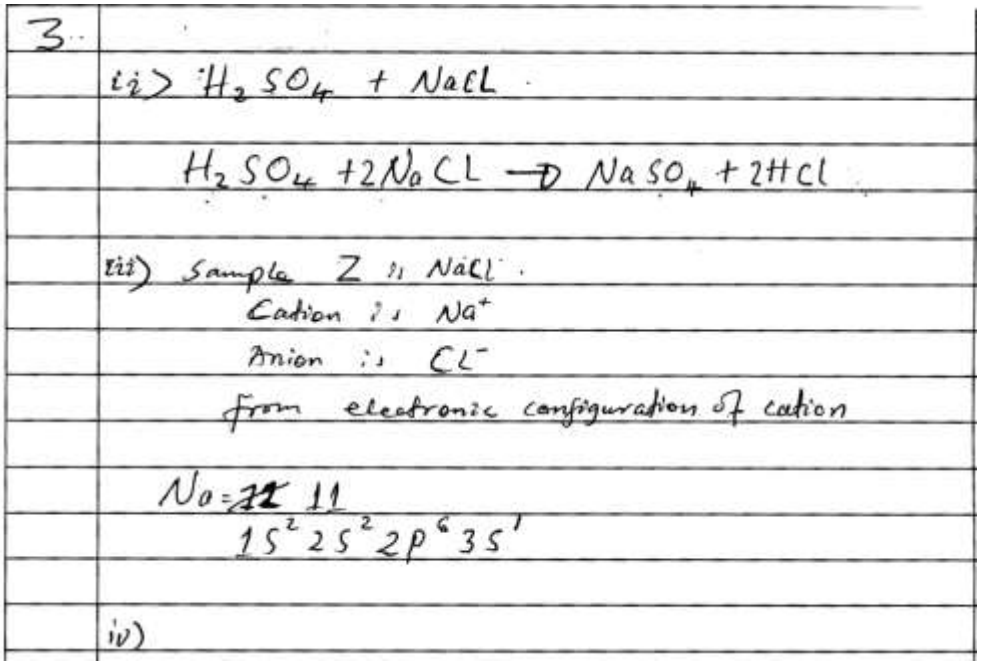
Extract 25.1: A sample of correct responses to question 3 Chemistry 2C

Extract 25.1 is a part of the response in which the candidate managed to show the reaction took place in experiment (c), wrote a correct configuration of Na^+ and stated the use of sodium chloride.

Further analysis revealed that some of the candidates who scored 6 to 10 marks wrote incorrect chemical equations due to low knowledge of the chemical symbols. For instance, one candidate wrote the reaction in part (iv) as: $Na_2 + Cl \rightarrow Na_2Cl$. Another candidate who did not read the question properly wrote in part (ii) that the reaction took pace at experiment (c) was

$Na^+(aq) + Cl^-(aq) \rightarrow NaCl$ instead of $H_2SO_4(l) + 2NaCl(s) \rightarrow Na_2SO_4(aq) + 2HCl(g)$.

In contrast, many of the candidates who scored 0 to 5.5 marks to were able to respond to few areas in parts (i) which involved the table of results. This was due to their inability to recognize the nature of the sample salt, hence gave incorrect conclusion. These candidates however, failed to answer the rest parts of the questions. It was also noted that some of the candidates. Others used trial and error to write the inferences as the included the correct ions with others that are related with neither observation report nor the sample given. Extract 25.2 provides a sample of incorrect responses.


3.

ii) $H_2SO_4 + NaCl$

$H_2SO_4 + 2NaCl \rightarrow NaSO_4 + 2HCl$

iii) Sample Z is NaCl.

Cation is Na^+

Anion is Cl^-

from electronic configuration of cation

No = ~~11~~ 11

$1s^2 2s^2 2p^6 3s^1$

iv)

Extract 25.2: A sample of incorrect responses to question 3 Chemistry 2C

Extract 25.2 shows that in part (i) the candidate failed to write the product of reaction between sodium chloride and sodium sulphate and to write electronic configuration of Na^+. Part (iv) and (v) were skipped.

3.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH TOPIC

The analysis of data revealed that, 9 out of 12 topics had good performance. The topics include: *Laboratory Management* (95.7%), *Principles of Teaching and Learning Chemistry* (94.4%), *Analysis of Ordinary Level Chemistry Curriculum Materials* (94.2%), *Chemical Kinetics, Energetics*

and Equilibrium (91.7%), *Planning and Preparation for Teaching* (90.6%), *Assessment in Chemistry* (87.0%), *Transition Metal Chemistry* (84.2%), *General Chemistry* (81.2%) and *Volumetric Analysis* (72.2%). The topics that showed average performance were *Environmental Chemistry* (65.7%) and *Organic Chemistry* (54.5%) while the weakly performed topic was *Electrochemistry* (30.4%). The summary of the candidates' performance in each topic is shown in **Appendix I**.

Comparison of performance in 2021 and 2020 shows that performance in six topics increased by the percentage between 1.6 and 11.2. Out of them, *Laboratory Management* increased by 11.2 per cent, followed by *Assessment Procedure in Chemistry* (8.7%) and *Transition Metals Chemistry* (8.6%). Conversely, the performance of three topics declined at a range of 4.9 to 7.6 per cent, whereby *Environmental Chemistry* dropped by 7.6 per cent and *Planning and Preparation for Teaching* by 4.9 per cent. However, the topic on *Analysis of Ordinary Level Chemistry Curriculum Materials* and *General Chemistry* were not assessed in 2020. This comparative analysis is summarized in **Appendix II**.

4.0 CONCLUSION

The analysis in this report has shown that the performance of the candidates was good. This performance has increased by 0.2 per cent compared to the year 2020 in which the candidates passed were 99.8 per cent. The good performance was attributed to candidates' ability, adequate knowledge and skills on performing theory and practical questions. However, one topic was weakly performed because some of the candidates lacked such qualities.

In comparison, the performance in practical paper was better than in theory paper. Similarly, the performance in topics like *Chemical Kinetics, Energetics and equilibrium* which were assessed in both papers, were consistently high, suggesting high competence of the candidates in solving practical questions. Besides, although the performance in academic topics which were assessed in theory paper was good, the performance in pedagogic topics was relatively better when the two contents are compared. Those topics were assessed in questions 1, 2, 3, 5, 10, 11, 12, 14 na 15.

5.0 RECOMMENDATION

In order to improve the performance of prospective candidates in the chemistry examination, it is recommended that:

(a) Teaching and learning should be more practical and frequent exercises academic visits should be encouraged in topics like *Environmental Chemistry*, *Organic Chemistry and Electrochemistry*.

(b) The teaching and learning of all chemistry topics should be made practical. Use of this interactive teaching and learning methods is suggested since it enables learners to retain the learned materials and will enhance learners' critical thinking, discovery and innovation.

(c) Student teachers are advised to practice solving questions related to the use of graphs especially in topics about experiments in rates of chemical reaction.

APPENDIX I

ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH TOPIC

S/N	Topic	Question Number	The % of the candidates who Scored 40 Per cent or Above	Average of % score per Topic	Remarks
1.	Laboratory Management	14	95.7	95.7	Good
2.	Principles of Teaching and Learning Chemistry	15	94.4	94.4	Good
3.	Analysis of Ordinary level Chemistry Curriculum Materials	1	94.2	94.2	Good
4.	Chemical Kinetics, Energetics and Equilibrium	3	91.7	91.7	Good
5.	Planning and Preparation for Teaching	2	82.3	90.6	Good
		10	98.8		
6.	Assessment Procedure in Chemistry	5	99.0	87.0	Good
		16	75.9		
7.	Transition Metal Chemistry	9	84.2	84.2	Good
8.	General Chemistry	8	65.0	81.2	Good
		12	97.4		
9.	Volumetric Analysis	11	72.2	72.2	Good
10.	Environmental Chemistry	6	65.7	65.7	Average
11.	Organic Chemistry	4	44.0	54.5	Average
		13	65.9		
12.	Electrochemistry	7	30.4	30.4	Weak

APPENDIX II

COMPARATIVE ANALYSIS OF THE CANDIDATES' PERFORMANCE BETWEEN 2020 AND 2021 IN EACH TOPIC