THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEM RESPONSE ANALYSIS REPORT FOR DIPLOMA IN SECONDARY EDUCATION EXAMINATION (DSEE) 2019

732 CHEMISTRY

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FOREWORD

The National Examinations Council of Tanzania has a great pleasure to issue this report on Candidates' Items Response Analysis (CIRA) for the year 2019 Diploma in Secondary Education Examination (DSEE) in Chemistry. DSEE is a summative evaluation with the function of demonstrating the effectiveness of the educational system in general and the educational delivery system in particular. Statistics of examination results and analysis of candidates' responses to the examination questions serve as indicators of what the educational system was able or unable to provide to the student teachers in their two years of secondary teacher education programme.

This CIRA has been prepared in order to provide feedback to tutors, parents, students, policy makers, school quality assurers and other education stakeholders, on the candidates' performance in Chemistry subject.

Generally, the report aims at highlighting the factors behind the observed performance by the candidates. For those who scored high marks, the factors include adequate knowledge of concepts related to the subject, ability to identify the requirement of the questions and competence in applying formulae. Only few candidates scored low marks due to inefficient mastery of subject content.

It is expected that the feedback provided in this report will enable educational administrators, school managers, tutors, school quality assurers and students to identify proper measures to be taken in order to improve teaching and learning in colleges, and consequently improve the candidates' performance in future examinations administered by the Council.

Finally, the Council would like to thank all those 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 candidates' items response analysis aims at providing feedback about performance of candidates who sat for the Diploma in Secondary Education Examination (DSEE) in May, 2019 in Chemistry subject. The number of candidates who sat for the examination was 3,215, out of which 2,510 were using University of Dodoma (UDOM) curriculum and 704 were using the Tanzania Institute of Education (TIE) curriculum. The remaining 1 candidate sat for supplementary examination under the curriculum of the University of Dodoma (UDOM). The examination tested the candidates' competences in using knowledge and skills gained in chemistry to solve daily life challenges, use and manage chemistry laboratory and assess learners' achievement objectively. The performance of candidates is presented in Table 1.

Table 1: Candidates' performance in Chemistry Examination

Candidates Type	**Sat**	**Number of Candidates and Percentage**					
		Passed	**Grades**				
			A	B	C	D	F
All	3,215	3,211	533	1,030	1,433	215	4
		99.88	16.58	32.04	44.57	6.69	0.12
UDOM Curriculum	2,510	2,506	192	726	1,373	215	4
		99.84	7.65	28.92	54.70	8.57	0.16
TIE Curriculum	704	704	341	304	59	0	0
		100.00	48.44	43.18	8.38	0	0

Table 1 shows that all (100%) candidates under TIE curriculum passed the examination, whereas 99.84% of the candidates under the UDOM curriculum passed with only 4 (0.16%) candidates failing.

For the purpose of this report, analysis of the performance in each questions and their corresponding topics was done based on the candidates who sat for examination using TIE curriculum only. This is because the UDOM curriculum is not permanent.

In the TIE curriculum, the Chemistry paper consisted of 16 questions in three sections, namely A, B and C. Section A consisted of ten short answer questions carrying 4 marks each and all questions were compulsory. Sections B and C had three essay questions each and the candidates were required to answer only two questions from each section. Each question in section B and C carried 15 marks.

This report is divided into four sections, namely introduction, analysis of the candidates' performance in each question and analysis of performance in each topic. Conclusion and recommendations are given in the last section together with the Appendix indicating a summary of performance in each topic.

Throughout this report, the candidates' performance is categorized as *good*, *average* and *poor* based on the percentage ranges 70-100 , 40-69 and 0-30 respectively.

2.0 ANALYSIS OF CANDIDATES' RESPONSES IN EACH QUESTION

This part analyses the performance of candidates in each question and the results are presented in figures. Extracts have been used to exemplify correct and incorrect responses. Highlights of misconceptions observed and reasons behind the candidates' performance has been included.

In this analysis, the level of performance in each question has been categorized as good, average or weak as shown in table 2.

Table 2: Categories of Marks in Question 1-16

Question number and Total marks	Category	Marks	Colour in figures and appendix
1 – 10 (4 marks)	Good	3 - 4	Green
	Average	2 - 2.5	Yellow
	Weak/poor	0 - 1.5	Red
11 – 16 (15 marks)	Good	10.5 - 15	Green
	Average	6.0 - 10	Yellow
	Weak/poor	0 - 5.5	Red

2.1 Question 1: General Chemistry

The question had parts (a) and (b). In part (a), the candidates were required to define the principle quantum number and in part (b) they were asked to describe three principles that govern the arrangement of electrons in an atom.

The question was attempted by 691 (98.2%) candidates out of whom 40.2 percent scored from 3 to 4 marks including 12.4 percent who got a full score. Those who scored from 2 to 2.5 marks were 19.7 percent while 40.1 percent scored from 0 to 1.5 marks. Generally, performance in this question was average since 59.9 percent of the candidates scored from the average mark and above. Summary of the performance is shown in Figure 1.

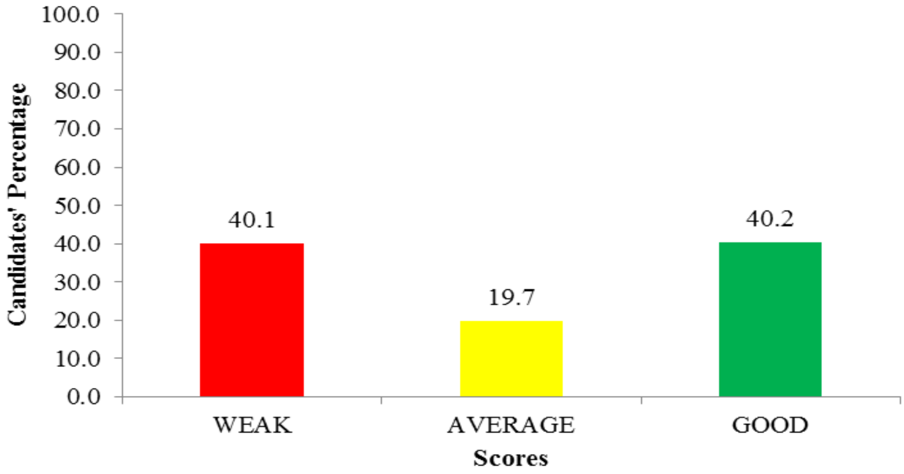


Figure 1: *Distribution of candidates' scores in question 1*

Findings from candidates' response analysis indicate that, those who scored from 3 to 4 marks had sufficient knowledge on the concept of quantum number and hence managed to attempt well both parts of the question. In part (a) for instance, they defined principle quantum number *as the main energy level to which electron belongs.* In part (b), the candidates in this category succeeded to describe correctly three principles governing arrangement electrons in an atom which are Hund's rule which states that *electrons are distributed among the orbitals in such a way to give maximum number of unpaired electrons* and *having the same direction of spin*. Pauli's exclusion principle states that *no two electrons in an atom can have all the four quantum numbers identical*. The third is the Aufbau principle which states that *in a ground state of an atom, the electron tends to occupy the available orbital in the increasing order of energy, the orbital of the lower energy being filled first.* The correct answers given indicate that the candidates had good mastery of the concepts of atomic structure. Extract 1.1 shows a sample of correct responses from one candidate.

1. (a) Principle quantum number,: Refers to the type of quantum number which show the amount of energy level in the atom. It donated by letter "n"

(b) Three principles that govern the arrangement of electrons in an atom

i) Hund's ruler "state that "The pairing of electron in atom is not allowed until all the same energy orbital level occupied by atleast one or two electron."

Example: $Cu = [Ar]\ 3d^9 4s^2$ is not correct. but $Cu = [A]\ 3d^{10} 4s^1$ is correct and obey the hund's rule.

(ii) Aufbau principle: State that "At the ground state the pairing of electron to the atom increase with increase of atomic number" That means the pairing of electrons in atom increase with increase energy level

(iii) Paul's exclusion: State that "No two electron can have four quantum number the same

Extract 1.1: An example of good responses in question 1

In Extract 1.1, the candidate correctly defined the principle quantum number and stated the three principles that govern the arrangement of electrons in an atom.

The candidates, who scored 2 to 2.5 marks managed to define correctly the principle quantum number in part (a) but could hardly state any of the three principles which were required in part (b). The partial responses reflected inadequate mastery of the concept of atomic structure.

On the contrary, candidates who scored from 0 to 1.5 marks provided irrelevant definition of principle quantum number and failed to describe the required principles. One of them for instance, cited irrelevant rules such as the *octet rule, duplet rule and the magnetic principle* in part (b). Such responses indicate that the candidates lacked proper knowledge of the atomic structure. Extract 1.2 shows an example of incorrect responses given by one of the candidates.

1. a	Principal quantum number is the
	type of quantum which show the
	energy and number of electron
	in an ~~ob~~ ~~ob~~ orbital.
b i	Azimutal quantum number It is
	involves in orientation of electron
	in an ~~ob~~ ~~of~~ orbital
ii	Magnetic quantum number It is
	used to show the shape of orbital
iii	Spin quantum number. It is used to
	show the spining of electrons in
	an orbit throug opposite direction
	that is clockwise and anti-clockwise
	electron.

Extract 1.2: An example of poor responses in question 1

Extract 1.2 is a sample of incorrect response given by a candidate in defining quantum number and describing the three principles that govern the arrangement of electrons in an atom.

2.2 Question 2: Chemical Kinetics, Energetics and Equilibrium

The question demanded candidates to find the solubility product constant (Ksp) of Bismuth sulphide whose solubility was 1.0×10^{-5} mol/L at 25^0C.

Statistics show that out of 587 (83.4%) candidates who attempted the question, 72.9 percent scored from 0 to 1.5 marks, 7.8 percent scored from 2 to 2.5 marks and 19.3 percent scored from 3 to 4 marks. The question attained poor performance with only 27.1 percent of the candidates scoring 2 marks and above. Figure 2 shows summary of the distribution of the candidates' scores.

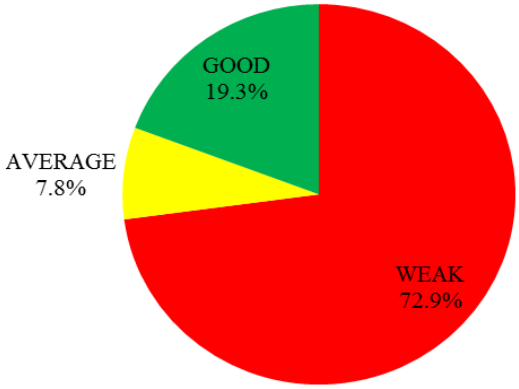
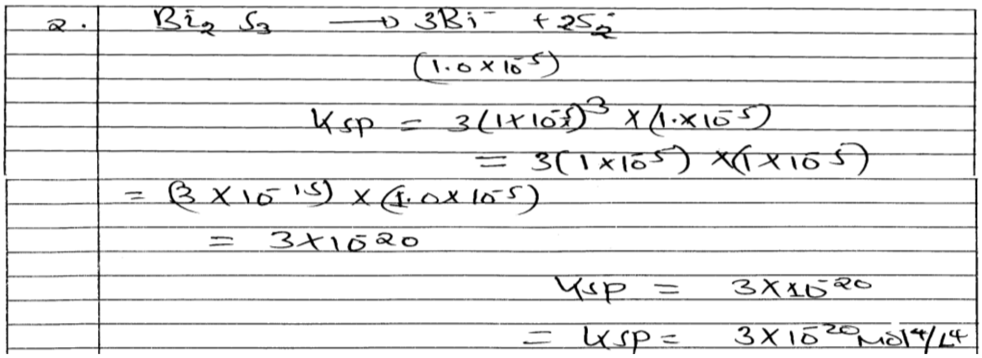


Figure 2: *Distribution of candidates' scores in question 2*

The analysis of candidates' responses shows that, most of those who scored from 0 to 1.5 marks attempted the question partially and some few messed up in the calculation procedure. For example, some candidates gave inappropriate ionization of bismuth sulphide as $B_2S_3 \longrightarrow Bi^{2+} + S^-$. Others did not manage to show the ionization equation at all. As a result they could not establish the correct formula of calculating the Ksp which was supposed to be $Ksp = 108x^5$. Failure to give correct answers depicts lack of enough knowledge of the concept of chemical equation. Extract 2.1 shows incorrect response by one of the candidates.



2. $Bi_2S_3 \longrightarrow 3Bi^- + 2S_2^-$

(1.0×10^{-5})

$Ksp = 3(1 \times 10^{-5})^3 \times (1. \times 10^{-5})$

$= 3(1 \times 10^{-5}) \times (1 \times 10^{-5})$

$= (3 \times 10^{-15}) \times (1.0 \times 10^{-5})$

$= 3 \times 10^{-20}$

$Ksp = 3 \times 10^{-20}$

$= Ksp = 3 \times 10^{-20} Mol^4/L^4$

Extract 2.1: An example of poor responses in question 2

In Extract 2.1, the candidate used incorrect approach to calculate Ksp without showing the formula.

Furthermore, candidates with scores from 3 to 4 marks showed the correct ionization equation of bismuth sulphide, $B_2S_3 \longrightarrow 2Bi^{3+} + 3S^{2-}$ and the calculation procedure thereafter to get the Ksp value of

$1.08 \times 10^{-23}\ mol^5 / L^5$. This is an indication that those candidates had enough knowledge of the concept of solubility product. Extract 2.2 shows an example of relevant responses given by one of the candidates.

2 soln.

Data given:

solubility of $Bi_2S_3 = 1.0 \times 10^{-5}\ mol/L \rightarrow 25°c$.

Required to find solubility product of $Bi_2S_3 = ?$

Consider:

$Bi_2S_3 \rightleftharpoons Bi^{3+} + S^{2-}$

$Bi_2S_3 \rightleftharpoons 2Bi^{3+} + 3S^{2-}$

$2X \quad 3X$

Hence; $Ksp = (2x)^2 \cdot (3x)^3$.

$Ksp = (4x^2)(27x^3)$

$Ksp = (4 \times 27)x^{2+3}$

$Ksp = 108x^5$

$Ksp = 108x^5$ ----- (i)

But its solubility $(x) = 1.0 \times 10^{-5}$.

Therefore.

$Ksp = 108 \times (1 \times 10^{-5})^5$

$Ksp = (108 \times 1 \times 10^{-25})$

$Ksp = 1.08 \times 10^{-23}\ mol^5 dm^{-15}$

Therefore the solubility product will be $1.08 \times 10^{-23}\ mol^5 \ldots$

Extract 2.2: An example of good responses in question 2

In Extract 2.2, the candidate derived the Ksp expression and calculated the solubility product of bismuth sulphide appropriately.

Likewise, candidates who scored from 2 to 2.5 marks managed to show some steps of calculation correctly but could not manage to proceed until they got the correct value of solubility product. For example, few candidates in this category ended up writing the formula $Ksp = 108x^5$ but failed to substitute the value of x.

2.3 Question 3: Organic Chemistry

The question required the candidates to explain why $CH_3CH(CH_3)CH(CH_3)CH_3$ and $CH_3(CH_2)_4CH_3$ have different boiling points regardless of their similarity in molecular mass.

This question was attempted by 693 (98.4%) candidates of which 82.0 percent scored from 0 to 1.5 marks, 17.9 percent scored from 2 to 2.5 marks, and only 0.1 percent scored from 3 to 4 marks. In general, the question attained poor performance with only 18.0 percent of the candidates managed to score 2 marks and above. Figure 3 shows a summary of the performance in question 3.

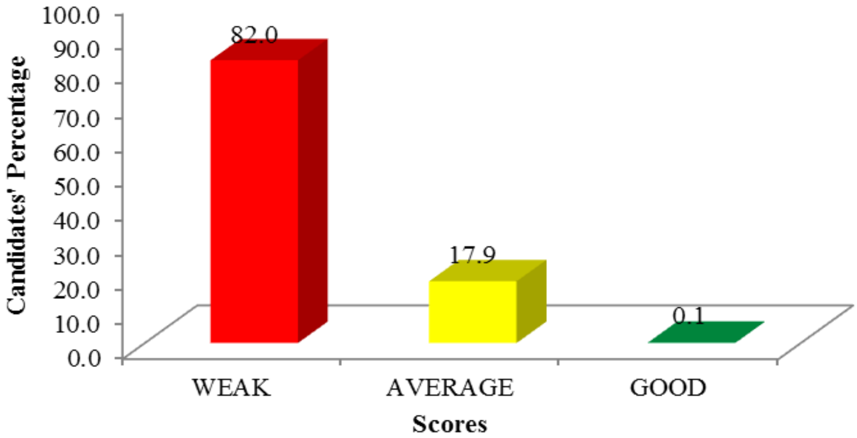
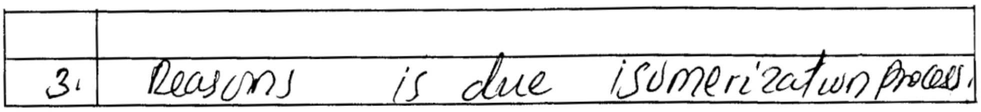


Figure 3: *Distribution of candidates' scores in question 3*

Most of the candidates who scored from 0 to 1.5 marks failed even to identify the difference between the two molecules. Others gave irrelevant responses including a certain candidate who wrote that *branched chain alkane has higher electronegative compared to straight chain*. Another candidate responded that *their difference in boiling points is caused by variation in number of carbon atoms*. Basically, the candidates lacked sufficient knowledge of the properties of organic compounds. Extract 3.1 shows a sample of incorrect responses from one of the candidates.



Extract 3.1: An example of poor responses in question 3

In Extract 3.1, the candidate identified the process through which isomers are formed, rather than accounting for the difference in boiling points.

Besides, candidates who scored from 2 to 2.5 marks gave partial account on the differences in boiling points between the branched and unbranched molecules. For instance, there was a candidate who wrote that *branched chain is condensed hence low temperature is needed compared to straight chain alkane which need high temperature.* Such response is incomplete because it does not specify which molecule is condensed and which one is a long chain between $CH_3CH(CH_3)CH(CH_3)CH_3$ and $CH_3(CH_2)_4CH_3$.

On the other hand, candidates who scored from 3 to 4 marks managed to point out the effect of surface area on the boiling points of the two molecules. They correctly explained the decrease in van der Waal's forces associated with branching in $CH_3CH(CH_3)CH(CH_3)CH_3$ and hence its subsequent lower boiling point. One of the candidates for example, explained that *the boiling point of branched chain of alkane is lower than the corresponding straight chain alkane of the same molecular mass due to the decrease in van der Waals forces in branched chain*. Another candidate wrote that: *branched chain have low surface area which results to low intermolecular attractive forces compared to straight chain. Hence the amount of energy required to break the bond is also lowered*. The relevant answers imply that the candidates had adequate knowledge of the physical properties of organic compounds. Extract 3.2 depicts a correct response from candidate.

3. $CH_3CH(CH_3)CH(CH_3)CH_3$ and $CH_3CH_2CH_2CH_2CH_2CH_3$

$CH_3CH_2CH_2CH_2CH_2CH_3$ hav higher boiling point than $CH_3CH(CH_3)CH(CH_3)CH_3$ due to fact That $CH_3CH_2CH_2CH_2CH_2CH_3$ hav large surface area than $CH_3CH(CH_3)CH(CH_3)CH_3$ due to its open structure hence increase in surface area increases van der waal forces and increases in van der waal forces increases boiling point to $CH_3CH_2CH_2CH_2CH_2CH_3$ than $CH_3CH(CH_3)CH(CH_3)CH_3$

Extract 3.2: An example of good responses in question 3

Extract 3.2 shows response of a candidate who correctly associated the difference in boiling points, surface area and Van der Waal's forces of the molecules.

2.4 Question 4: Planning and Preparation for Teaching

The question required candidates to outline four demerits of demonstration strategy in teaching and learning Chemistry. Statistics show that, out of 686 (97.4%) candidates who attempted the question, 27.0 percent scored from 3 to 4 marks, 29.6 percent scored from 2 to 2. 5 marks and 43.4 percent scored from 0 to 1.5 marks. Generally, performance in this question was average since 56.6 percent of the candidates scored 2 marks and above. The distribution of the candidates' performance is shown in Figure 4.

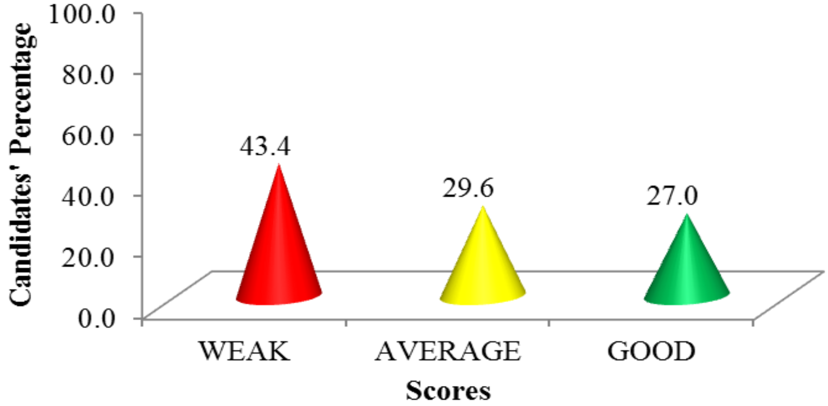


Figure 4: *Distribution of candidates' scores in question 4*

The analysis of responses shows that the majority of candidates who scored from 3 to 4 marks managed to outline at least three demerits of demonstration strategy in teaching and learning Chemistry. The following is a sample of responses given by one candidate who scored 4 marks in this question. *the strategy has limited chances for all students to perform the activities, it requires an expert or experienced person if it involves dangerous or complicated materials, it is not user friendly strategy for young children as it needs teachers' help all the time and lastly, it is time consuming strategy in preparation and presentation.* Such a correct response is an indication that candidates in this category were conversant with the shortcomings of the presentation strategy in teaching and learning. Extract 4.1 shows correct responses by one of the candidates who gave four demerits of demonstration strategy in teaching and learning Chemistry.

4. Demerits of demonstration strategy in teaching and learning

(i) learner become observer ie does not partici-pate.

- During demonstration learners become observer to the teacher, no interaction during demonstration this become as a gape btn learner and teacher.

(ii) lead to poor interaction btn teacher and learner.

- For better teaching and learning, there must be good interaction among teacher and learner for effective teaching and learning.

(iii) Reduce active attension of learner

- This is because most of learner can be tired to continue to observe to the teacher hence attension among them drop.

(iv) Consume time

- Through demonstration, teacher use much time to explain subject matter but by using other strategy such as brainstorming this can save time instead of being explains much him/herself.

Extract 4.1: An example of good responses in question 4

Extract 4.1 is a sample of correct responses from a candidate who managed to outline correctly the four demerits of demonstration strategy in teaching and learning Chemistry.

Responses of candidates who scored 2 to 2.5 marks included some correct and incorrect points on the demerits of demonstration strategy. For example some candidates managed to write only two instead of four points. This suggests that the candidates had partial understanding of the drawbacks of demonstration strategy in teaching and learning.

Besides, candidates who scored from 0 to 1.5 marks gave responses which ranged from vague statements to at least one correct disadvantage. For instance, one candidate wrote; *it is dangerous, selective in cognitive ability of the learners, the method wastes time as it is irrelevant strategy.* Another candidate responded by writing *it can demonstrate irrelevant things and it can lead to confusion to learners.* The inability of the candidates to give the correct answers is attributed to inadequate awareness on demonstration strategy. Extract 4.2 indicates an incorrect response from one of the candidates.

4 Demerity of demonstration method
(i) It help learner to remember important concept on the previous lesson.
(ii) It simplify teaching and learning process
(iii) It build everlasting memory to the learner.
(iv) It help to summarize the most difficult concept.

Extract 4.2: An example of poor responses in question 4

Extract 4.2 is an incorrect response in which the candidate gave merits instead of demerits of demonstration strategy in teaching and learning Chemistry.

2.5 Question 5: Chemistry Curriculum Materials

The question required candidates to briefly explain four uses of chemistry teachers' guide. The performance shows that out of 701 (99.6%) candidates who attempted this question, 86.7 percent scored from 3 to 4 marks, 10.3 percent scored from 2 to 2.5 marks while 3.0 percent scored from 0 to 1.5 marks. The overall performance in this question was good as 97.0 percent of the candidates scored 2 marks and above, with 48.8 percent scoring full marks. This information is captured in Figure 5.

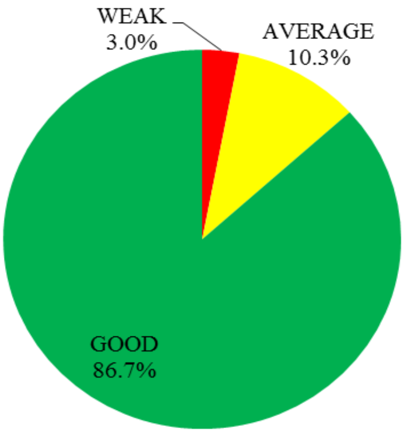


Figure 5: *Distribution of candidates' scores in question 5*

Candidates who scored from 3 to 4 marks managed to provide three to four uses of the chemistry teachers' guide but with minor grammatical errors in some cases. To mention the few, some of the responses which were given include: *It provides solution for exercises in text books; it updates and advances teachers' pedagogical competences, it provides teachers with suggested teaching and learning strategies, it suggests a teacher with a range of alternative suggestions on how to monitor the syllabus*. Candidates' ability to provide correct uses of the chemistry teachers' guide is an indication that they had adequate understanding of the curriculum materials in chemistry. Extract 5.1 displays correct responses of one of the candidates.

Qn5 i) It show teaching methodology which can be used in teaching and learning process. As it contain different methodology hence make easy to the teacher to select appropriate methodology.

ii) It is used to show teaching activities operation. This helps the teacher to identify his or her role especially during teaching and learning process.

iii) It is used to show answers which are not present in textbook. Due to some questions, which is not present in textbook, hence through teacher guide one identify ~~on~~ answers.

iv) It is used to show appropriate teaching and learning resources. It show resources such as textbook, teaching aids which teacher employ during teaching and learning process.

Extract 5.1: An example of good responses in question 5

Extract 5.1 is a response of a candidate who managed to explain well the four uses of chemistry teachers' guide.

Candidates who scored from 0 to 1.5 marks, gave incorrect responses resulting from misconception and guessing. There were few cases in which candidates provided uses of the teacher's manual instead of uses of the teacher's guide. For example, one of the candidates wrote; *chemistry teacher's guide helps to use scheme of work, lesson plan and lesson notes appropriately.* Another candidate wrote: *it is best used by students for personal preparation studies.* Cases of repetition of points were also found in scripts of several candidates in this category. The incorrect responses given by the candidates imply that they had partial knowledge about the curriculum materials. Extract 5.2 shows responses of a candidate who failed to give four uses of the chemistry teachers' guide.

05. Uses of Chemistry teacher's guide.

(i) Used by a teacher to know what should required to teach and what is not required.

(ii) Used to direct teacher on preparation to his or her lesson

(iii) ~~Its~~ Used to provide more information than what is usually in text book

(iv) ~~Used~~ It assist a teacher to stand as facilitator.

Extract 5.2: An example of good responses in question 5

Extract 5.2 is a sample of correct responses in which a candidate described correctly the four uses of chemistry teachers' guide.

Furthermore, the analysis indicates that, candidates who scored from 2 to 2.5 marks either gave partial responses or had misconceptions on their responses. For example, one candidate explained that *it shows the content that the teacher is required to teach at a particular level.* Another candidate gave the uses of subject logbook instead of teachers' guide, by writing that, *it arouse critical thinking and it also assist another teacher to take charge in case of absence.* Similarly, some of the candidates gave incorrect responses pertaining to the uses of lesson plan. The incorrect responses indicate that the candidates had insufficient knowledge of the curriculum materials.

2.6 Question 6: Planning and Preparation for Teaching

The question required candidates to outline four problems faced by a chemistry teacher with inadequate preparation. Statistics show that out of 700 (99.4%) candidates who attempted the question, 90.4 percent scored 3 to 4 marks, 3.6 percent scored 2 to 2.5 marks and 6.0 percent scored 0 to 1.5 marks. The general performance in this question was good with 94.0

percent scoring 2 marks and above. Distribution of candidates' scores in question 6 is presented in Figure 6.

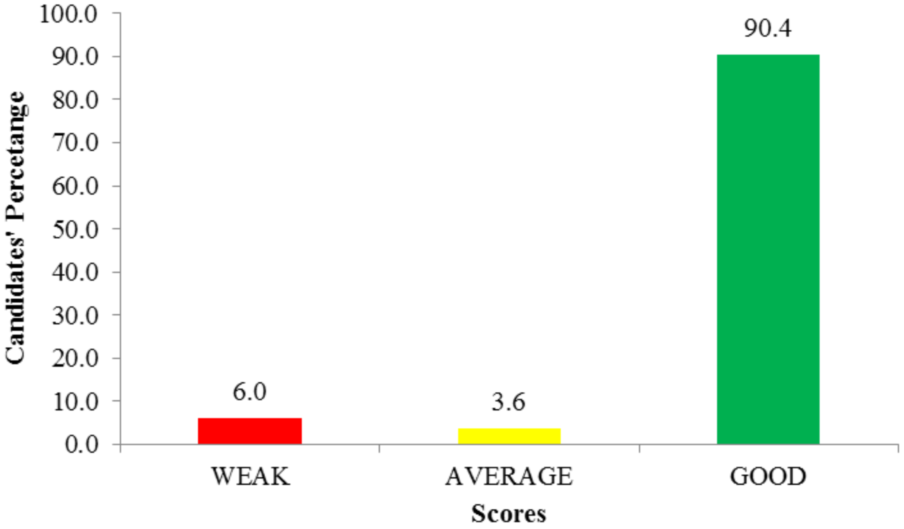


Figure 6: *Distribution of candidates' scores in question 6*

Analysis of candidates' responses showed that, those who scored from 3 to 4 marks managed to give relevant answers such as: *the teacher lack confidence, failure to meet lesson objectives, failure to use the teaching and learning resources and lack of class control.* Most of the candidates (22%) gave all four points correctly while the rest provided three points. Candidates in this category demonstrated good mastery of knowledge about the disadvantages of a teacher not getting prepared prior to classroom teaching. Extract 6.1 is an example of correct responses.

6 (i) Bad organization of content / lesson. because
Inadequate preparation a teacher can teach from
Complex to simple.

(ii) Poor Methods of teaching. Inadequate pre
paration teacher can loose the Ideas of using
the Method of teaching.

(iii) Poor teaching ~~te~~ aid. Inadequate preparatio
n can cause teacher to fail to prepa
re the best teaching aid he/she can
use the older which is not ~~pr~~ represented
well the ideas.

iv) Lack of confidence - Inadequate prep
aration can cause a teacher to loose co
nfidence be he/she is not aware about w-
hat is teach.

Extract 6.1: An example of good responses in question 6

In Extract 6.1, the candidate correctly indicated four problems that may face a chemistry teacher with inadequate preparation.

In the category of candidates who scored from 2 to 2.5 marks, analysis of responses reveals presence of many partial and few correct answers. Some responses had sentences which lacked appropriate grammar for instance *fell objective teaching the lesson ok.* Candidates' insufficient knowledge of the significance of preparation by the teacher before conducting a lesson accounts for candidates' failure to score high marks.

On the other hand, candidates who scored from 0 to 1.5 marks failed to give all or most of the correct answers. Some of them provided erroneous responses such as *failure to meet lesson objectives, some teachers become angry, language problem and shortage of practical apparatus*. Others failed to identify the demands of the question as they wrote irrelevant responses like *contamination of solution, measuring errors, instrumental error and environmental errors.* It seems that some of the candidates misunderstood the question by employing the word "preparation" from the context of classroom teaching to the context of working in the laboratory as most of their answers relied on experimental activities. Obviously, the candidates had insufficient knowledge oF planning for a lesson. An example of responses which did not meet the demand of the question is shown in Extract 6.2.

6.	(i). ~~Avai~~ large number of students.
	(ii). Materials are not available
	(iii). Uneffecient Laboratory
	(iv). Absence of teacher's guide.

Extract 6.2: An example of poor responses in question 6

In Extract 6.2, the candidate gave factors hindering effective teaching instead of problems faced by chemistry teacher with poor preparation.

2.7 Question 7: Electrochemistry

The question was as follows:

(a) Provide the meanings of the following terms

(i) Electrochemistry

(ii) Conduction.

(b) Differentiate electronic from electrolytic conductors.

Data analysis shows that, out of 678 (96.3%) candidates who attempted the question, 78.0 percent scored from 0 to 1.5 marks, 17.8 percent scored from 2 to 2.5 marks and 4.7 percent scored from 3 to 4 marks. Generally, candidates' performance in this question was poor in which only 22.0 percent scored 2 marks and above. Figure 7 illustrates the distribution of the candidates' scores in question 7.

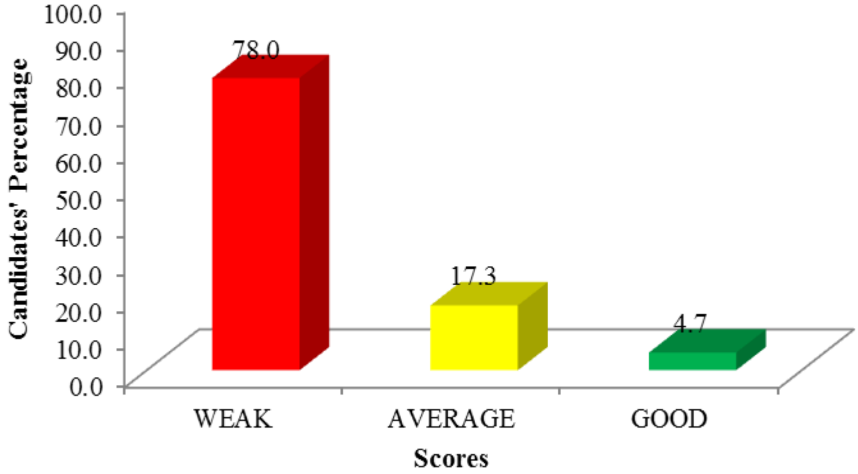


Figure 7: *Distribution of candidates' scores in question 7*

Most of the candidates who scored from 0 to 1.5 marks failed to define electrochemistry and conduction in part (a). Their definitions were either vague or explanations that addressed irrelevant concepts. Others confused the concept of electrolysis with electrochemistry. For example, one candidate defined electrochemistry as *the study of the electric current passed through different chemicals to decompose them* instead of the transfer of electrons in connection to the electrical current generated or used in the process. Likewise, some candidates defined conduction as the transfer of heat instead of defining it as the process of transfer of charge, heat or sound through a conductor.

Similarly, in part (b) some of the responses indicate that the candidates did not comprehend the carriers of charge in electronic and electrolytic conductors. For instance, despite the fact that electrons and ions are the major charge carriers in electronic and electrolytic conductors respectively, one candidate wrote that *both electronic and electrolytic conductor involve passage of electric current by protons*. Several other candidates that attempted this part gave the general definition of conductors. Basically, the candidates were supposed to distinguish the two conductors based on the nature (type) of the particles which flow to create electric current. In electronic conductor, the transfer of charge is by flow of electrons, whereas in electrolytic conductor transfer of charge is by movement of ions in electrolyte. Other candidates attempted the question by giving incomplete differences between the two conductors. For example, one of the candidates wrote that *electronic conductor is an equipment of the electric current that* *allows the passage of electric current while electrolytic conductor is a conductor that allow passage of electric current*. Candidates in this category lacked thorough knowledge of electrochemistry. Extract 7.1 shows an example of incorrect responses given by candidates.

7 a(i) Electrochemistry is the branch of chemistry which deal with dissocation of weak electrolyte and strong electrolyte.

(ii) Conduction is the process where object conduct electricity. or fail to conduct electricity.

b) i) Electronic is the device which allow electric current to pass through While Electrolytic conductor is the device which conduct electricity.

Extract 7.1: An example of poor responses in question 7

Extract 7.1 is a response by a candidate who gave definition of electrolysis instead of electrochemistry and the other definitions given were incorrect as well.

Moreover, candidates who scored from 3 to 4 marks demonstrated sufficient knowledge of electrochemistry as most of them managed to give the definitions of the terms in part (a), and the difference between the two conductors in part (b). For instance, in part (a), one candidate defined electrolysis as *the study which concern with transfer of electrons from one chemical species to another and their relationship between the electrons transferred and electrical currents that are generated or used during this process.* In part (b), another candidate correctly distinguished the conductors as *electronic conductor involves flow of charges by transfer of electrons like copper while electrolytic conductor involves the flow of the charge due to movement of ions like in electrolyte.* Extract 7.2 shows a sample of correct responses given by one of the candidates.

07. (a) (i) Electrochemistry is the branch of physical chemistry which deals with the production of electric current from spontenous chemical reactions and production of chemical reaction from electric current.

(ii) Conduction is the way or method through which heat or ~~elect~~ is transfered from one point to another

(b) Electronic conductors are solid substance which allow the passage of electric current through moving electron charge

While

Electrolytic conductors are solution or molten substance which allow the passage of electric current through moving and free ions.

Extract 7.2: An example of good responses in question 7

Extract 7.2 shows response from a candidate who answered both part (a) and (b) correctly.

Further analysis on the responses of candidates who scored from 2 to 2.5 marks shows that most of them gave partial definitions of the two terms in part (a). Other candidates managed to answer at most part (a) but gave incorrect answers in part (b).

2.8 Question 8: Environmental Chemistry

The question had two parts, (a) and (b). In part (a), candidates were required to give the meaning of acidic rain and in part (b) to differentiate primary from secondary air pollutants.

The performance indicated that out of 683 (98.3%) candidates who attempted the question, 7.0 percent scored 3 to 4 marks, 59.0 percent scored 2 to 2.5 marks and the remaining 34.0 percent scored 0 to 1.5 marks. Generally, the performance in this question was good since 66.0 percent scored 2 marks and above.

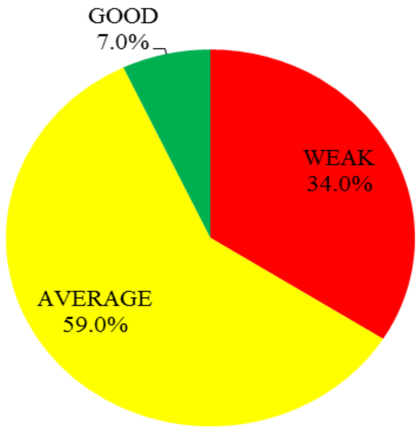


Figure 8: *Distribution of candidates' scores in question 8*

Analysis of candidates' responses shows that, those who scored from 3 to 4 marks managed to define acidic rain and some of them differentiated primary from secondary air pollutants appropriately. One candidate for instance, gave acceptable definition of acidic rain as *the type of rain formed when water combines with the acidic oxides (carbon dioxide, sulphur dioxide or nitrogen oxides) in the atmosphere forming weak acids like carbonic acids* H_2CO_3. Another candidate attempted part (b) correctly writing that: *a primary air pollutant is the pollutant that is passed directly to the air from a given source, while a secondary air pollutant is the one formed in the atmosphere through chemical reactions such as formation of ozone in the photochemical smog.* Such correct responses indicate that candidates had adequate knowledge of environmental issues. Extract 8.1 shows an example of correct responses in question 8.

8a) aacdic rain this is the types of rain formed when H_2O combines with the carboni dioxide ~~forming~~ forming carbonic acid

$$H_2O + CO_2 \rightarrow \underbrace{H_2CO_3}_{\text{aacdic rain}}$$

b) Primary pollutant this are the types of pollutant that are originated directly from the sources while secondary pollutant are those types of pollutant that occurs due to the combination of primary pollutant

Extract 8.1: An example of good responses in question 8

In Extract 8.1, the candidate correctly defined acidic rain and differentiated primary from secondary air pollutants.

On the other hand, candidates whose scores ranged from 2 to 2.5 marks attempted either of the two parts of the question appropriately. In most cases, part (a) was well performed by candidates relative to part (b).

Nonetheless, candidates who scored from 0 to 1.5 marks incorrectly, attributed the sources of pollutants to homebased and industrial activities. For example, one candidate wrote that primary air pollutant *results from human activities such as burning of forests while secondary air pollutant results from industrial activities*. There were several cases in which candidates skipped either part (a) or part (b). In the same way, a few candidates had a misconception that primary air pollutants are substances which cause much less harm to the environment than the secondary air pollutants. Extract 8.2 shows an example of incorrect responses in question 8.

Q8 a) Acid rain

Is the rain which contain some Impurities or chemicals such as iron.

b). Primary air pollution: Are pollution from natural sorrounding such as burning charcoal, smell from dust white

while

Secondary air pollution: Are air pollution from industrial, or any other machine which has chemicals

Extract 8.2: An example of poor responses in question 8

In Extract 8.2, the candidate gave incorrect response in both part (a) and (b). Iron does not contribute to formation of acidic rain.

2.9 Question 9: Laboratory Management

The question was as follows:

(a) List two supply systems in a chemistry laboratory

(b) Why is it recommended to;

(i) add acid into water and not vice versa.

(ii) cover a container holding sodium hydroxide pellets.

Statistics of candidates' performance indicate that, out of 703 (99.9%) candidates who attempted the question, 41.3 percent scored from 3 to 4 marks, 37.8 percent scored from 2 to 2.5 marks and 20.9 percent scored from 0 to 1.5 marks. Generally, candidates' performance in this question was good with 79.1 percent scoring 2 marks and above. Summary of the distribution of the candidates' scores is shown in figure 9.

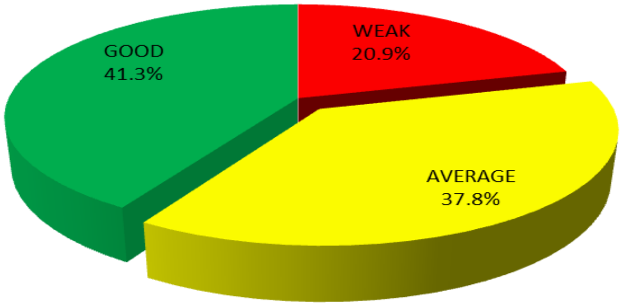


Figure 9: *Distribution of candidates' scores in question 9*

Candidates who scored from 3 to 4 marks demonstrated good mastery of the subject matter and they understood the requirement of the question. The majority of the candidates listed correctly the supply systems in a chemistry laboratory which were any two among *water, gas* and *electric supply systems.* In part (b)(i) most of the candidates managed to explain the likely risk upon addition of acid into water by stating that *concentrated acids react vigorously and violently with water to the extent that explosion can occur*. In item (b)(ii), most of candidates correctly commented on the scientific fact beyond covering a container of sodium hydroxide pellets. Sodium hydroxide tends to absorb moisture from the atmosphere and dissolve in it forming a solution (deliquescent property). Hence its container must be well stoppered. Extract 9.1 is an example of correct responses.

9 (a) (i) Water Supply system
(ii) Power supply system

(b) (i) It is recommended to add acid into water so as to avoid the explosion which may occur when water will be added to acid.

(ii) It is recommeded to cover The container holding Sodium hydroxide pellets because sodium hydroxide pellets is hygroscopic substance which absorb water from the atmosphere to form solution. Thus when container is left uncovered sodium hydroxide will absorb water

Extract 9.1: An example of good responses in question 9

In Extract 9.1, the candidate gave correct laboratory systems and accounted for the addition of acid into water and not vice versa.

Further analysis revealed that, candidates who scored from 2 to 2.5 marks gave some correct and incorrect responses. A considerable number of candidates in this category provided partial responses. One candidate for example, answered part (a) by writing *drainage system, mechanical system and water systems.* Mechanical system is not a system associated with laboratories. Others wrote irrelevant answers like *inwards systems and outwards systems* which signifies insufficient knowledge about laboratory management.

On the other hand, candidates who scored from 0 to 1.5 marks, in part (a) they failed to name the systems available in the chemistry laboratory. For example, one of them wrote *wiring supply system* instead of electric supply system. In some cases, candidates mentioned *computer system* and *heat sources* such as stove and the Bunsen burner. In part (b), some candidates had a misconception that sodium hydroxide tends to react with air when exposed. For instance, one candidate wrote *This is because sodium hydroxide it react with air (oxygen) to give water and sodium*. Another candidate wrote that *cover a container holding sodium hydroxide pellets because sodium hydroxide is flammable catch fire easily*. There were few cases in which candidates asserted that *sodium hydroxide pellets can evaporate away* which is not the case. The incorrect responses imply that the candidates had insufficient knowledge of laboratory management. Extract 9.2 shows an example of incorrect responses in question 9.

09 List two supply system in chemistry laboratory.
i) Gas supply system.
ii) Liquid supply system.

b) Why is recommended to.
i) add acid into water and not vice versa?
Because water is neutral thus why ~~have~~ to ~~reaction~~ you add ~~[illegible]~~ acid into water

ii) Cover a container holding Sodium hydroxide pellets.?
Because sodium atom contain in a compound of sodium hydroxide pellets are most reactive metal when exposed to air thus why it is covered when it is outside the container.

Extract 9.2: An example of good responses in question 9

In Extract 9.2 the candidate responded to all parts of the question by giving incorrect responses.

2.10 Question 10: Chemical Kinetics, Energetics and Equilibrium

Candidates were provided with the information that;
The industrial formation of ammonia is represented in the chemical equation: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -ve$
They were then required to give four strategies of increasing the speed of the formation of ammonia.

According to statistics, 688 (97.7%) candidates attempted this question of whom 55.2 percent scored from 3 to 4 marks, 23.0 percent scored from 2 to 2.5 marks and 21.8 percent scored from 0 to 1.5 marks. The overall performance in this question was good since 78.2 percent of the candidates scored 2 marks and above. The distribution of the candidates' scores in question 10 is shown in figure 10.

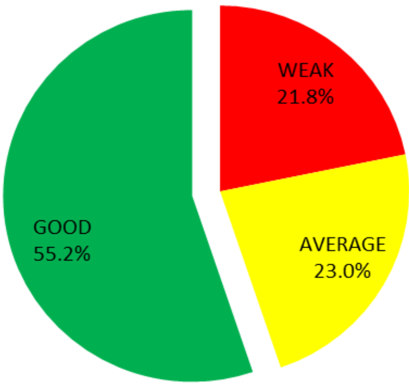


Figure 10: *Distribution of candidates' scores in question 10*

The analysis revealed that, most of the candidates who scored from 3 to 4 marks, managed to mention correctly three or four strategies of increasing the yield of ammonia gas. One candidate for example, wrote *an increase in concentration of reactants (N_2 and H_2), increase the pressure of the reactants, decrease in temperature of the reactants, addition of a catalyst, or removal of ammonia so produced.* Extract 10.1 shows an example of correct responses in question 10.

10.	
(i).	Decrease in temperature will in the system will lead to the speed of formation of ammonia.
(ii).	Increase in concentration of the reactact will lead to formation of ammonia.
iii	Increase in pressure to the reactant side will increase speed of formation of ammonia.
iv	Decrease the concentration of ammonia, in the system.

Extract 10.1: An example of good responses in question 10

In Extract 10.1, the candidate correctly stated the strategies of increasing the yield of ammonia in the system.

Moreover, most of the candidates who scored 2 to 2.5 marks managed to provide two correct strategies that favour forward reaction. For example, one of the candidates gave the following strategies, *removing ammonia, decreasing the concentration of the reactants, increasing the temperature of the systems and decreasing the pressure of the system.* The first two strategies are correct while the remaining are incorrect. Increasing the temperature and decreasing the pressure favour the backward process (formation of the reactants) because the forward process (formation of ammonia) is exothermic.

On the contrary, candidates who scored from 0 to 1.5 marks, were able to give clearly only one correct strategy. The other strategies given were either incomplete or inappropriate. For example, there was a candidate who wrote *increase in pressure of the reactant, decrease concentration of the reactants will favour backward reaction, increase in ammonia favours backward reaction and increase in temperature favours production of* N_2 *and* H_2. Only the first strategy which was increasing pressure is correct. The rest of the strategies do not facilitate the formation of ammonia gas with respect to Le Chateliers' principle. Most of the candidates in this category confused the modality of varying temperature and pressure in order to speed up the yield in an equilibrium reaction. Principally, the candidates lacked adequate skills in applying the factors affecting chemical equilibrium to predict the outcomes. Extract 10.2 is an example of candidates' incorrect answer in question 10.

10 i) To convert Ammonium into ammonia
ii) combination of different reagents in order to get ammonia.
iii) chemical reaction in order to get ammonia.
iv) Combining organiz materials to the industry.

Extract 10.2: An example of poor responses in question 10

In Extract 10.2, the candidate gave some ways of manufacturing ammonia instead of giving adjustment of factors to produce ammonia in the given reaction.

2.11 Question 11: Transition Metals

The question was as follows:

(a) Given the complex compound $[CoCl(H_2O)_2(NH_3)_3]Cl$*:*

(i) What is the coordination number of the central metal ion?

(ii) What is the oxidation state of the central metal ion?

(iii) Give the IUPAC name of the compound.

(b) Why transition elements;

(i) have variable oxidation states?

(ii) forms of complex ions?

(iii) exhibit paramagnetism?

The candidates' performance indicated that out of 359 (51.0%) who attempted the question, 7.2 percent scored from 10.5 to 15 marks, 32.6 percent scored from 6 to 10 marks, and 60.2 percent scored from 0 to 5.5 marks. Generally, the performance in this question was average as 39.8 percent of the candidates scored 6 marks and above. The distribution of candidates' scores is shown in figure 11.

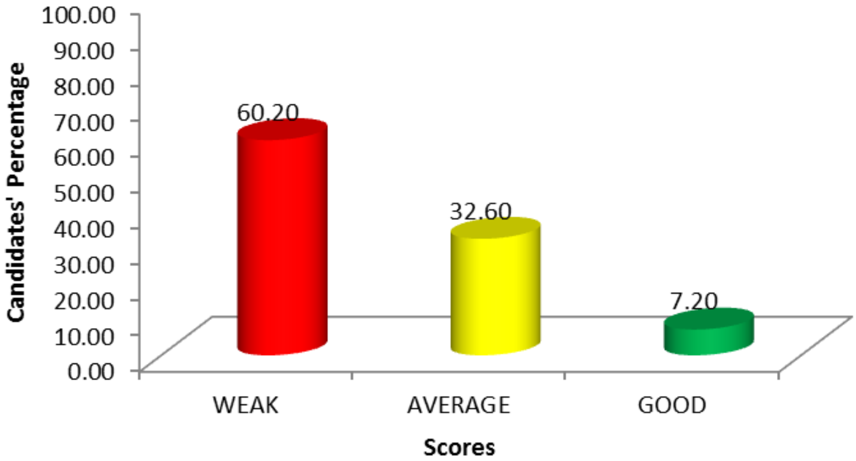


Figure 11: *Distribution of candidates' scores in question 11*

The analysis of the candidates' responses revealed that, those who scored from 10.5 to 15 marks had good mastery of the subject matter. In part (a), the candidates identified correctly the coordination number of the complex compound $[CoCl(H_2O)_2(NH_3)_3]Cl$ which is 6. Similarly, they calculated accurately the oxidation state of the central metal atom (Cobalt) which is +2. They also named the complex compound $[CoCl(H_2O)_2(NH_3)_3]Cl$ correctly as $\text{diamminetriaquachlorocobalt}\left(\text{II}\right)\text{ chloride}$. In part (b), most of the candidates gave proper reasons to account for the tendency of transition elements to have variable oxidation states, form complex compounds and exhibit paramagnetism. For instance, one of the candidates wrote that *transitional metals elements have variable oxidation states because their outermost electronic configuration is* $\left(n-1\right)d^{1\text{-}10}ns^2$. *Since the energy levels of (n-1)d and ns-orbitals are quite close to each other, hence both the ns and (n-1)d electrons are available for bonding purposes.* Another candidate responded that *transition metal elements form complex compounds because of have small size and high nuclear charge of the metal cations due to the presence of vacant d- orbitals available of suitable energy.* Majority of the candidates attempted part (b)(iii) correctly by writing that *most transition elements exhibit paramagetism due to the presence of unpaired electron in atoms, ions or molecules.* Extract 11.1 illustrates an example of correct responses in question 11.

11(a) Given $[Co\,Cl(H_2O)_2(NH_3)_3]Cl$

(i) Coordination number of central atom : is number of bonds of ligand attached to the central metal,

$\therefore$ Coordination number = 6 .

(ii) Oxidation state of central metal ions

$Co + (-1) + (0 \times 2) + (0 \times 3) = +1.$

Charge of $H_2O = 0$

$NH_3 = 0$

$Co + -1 = +1$

$Co = 1 + 1 = +2.$

$\therefore$ Oxidation state of Co is +2

(iii) Required IUPAC name of compound.

$[Co\,Cl(H_2O)_2(NH_3)_3]Cl$

Name ; Triammine diaqua chloro colbat II chloride.

(b)(i) Transition metal elements have variable oxidation state because they have ability to expand d-orbital, d-orbital on transition element can be expanded and accomodate various electrons which can be used in compound formation

(vi) Transition element have ability to form complex ions because they have empty orbital which can accept lone pair from ligands, they have strong nuclear force which can attract electrons, and also they have small atomic size due to strong nuclear force.

Extract 11.1: An example of good responses in question 11

In Extract 11.1, the candidate gave correct details about the complex compound. He/ she also provided appropriate reasons concerning transition elements.

Candidates whose scores ranged from 6 to 10 marks responded correctly in some parts while giving incorrect answers in other parts. For example, in part (a) some candidates identified correctly the coordination number of the central metal atom. However, they failed to give the oxidation state of the compound. Likewise, in part (b) some candidates accounted correctly for the presence of variable oxidation states of transitional metals, but they gave incorrect responses in items (ii) and (iii).

Furthermore, most of the candidates who scored 0 to 5.5 marks calculated the coordination number incorrectly, getting different values rather than +6, which was the correct answer. In naming the complex compound, others introduced chlorine before ammonia (this violates the alphabetical preference). In the same way, some of the candidates did not indicate the number of the ligands, or the oxidation state of cobalt. For example, one candidate named $[CoCl(H_2O)_2(NH_3)_3]Cl$ as *triamminemonochloro Cobalt diaquachloride* instead of *triamminediaquachlorocobalt (II) chloride*. This indicates that the candidates lacked sufficient skills in naming complex compounds according to the IUPAC system. In part (b), some candidates had a misconception that transition metals have variable oxidation state because they have neutral metal atom and central metal atom instead of the presence of outermost electronic configuration of $(n\text{-}1)d^{1\text{-}10}\ ns^2$. Since the energy levels of (n-1)d and ns-orbitals are quite close to each other, hence both the ns and (n-1)d electrons are available for bonding purposes. Extract 11.2 shows a sample of incorrect responses in question 11.

11. (a) Complex compound.

$[CoCL(H_2O)_2(NH_3)_3]Cl$.

(i) The coordination number of the central metal ion is 7.

(ii) The oxidation state of the central metal ion is 3^+.

(iii) IUPAC name of the compound is diaquo tri amino chloro cobat (II) Chloride.

(b) (i) have variable oxidation states because there central metal compound.

(ii) They form complex ~~compound~~ ions because they have high attractive force.

(iii) transition metal elements have exhibit paramagnetism because they have magnetic field which attract electron towards.

Extract 11.2: An example of poor responses in question 11

Extract 11.2 is an incorrect response given by one of the candidates who failed to interpret the molecular formula in part (a) and thus gave incorrect reasons in part (b).

2.12 Question 12: General Chemistry

The question was as follows;

(a) *Give the meaning of the following terms:*

(i) *sp^3 hybridization.*

(ii) *sp^2 hybridization.*

(iii) *sp hybridization.*

(b) *Calculate the wavelength in A of line in a Balmer series that is associated with a drop of electron from the fourth orbit. (R_H = 1.09676×10^6 cm^{-1}).*

The candidates' performance indicates that out of 519 (73.7%) candidates who attempted the question, 23.3 percent scored 10.5 to 15 marks, 50.3 percent scored 6 to 10 marks and 26.4 percent scored 0 to 5.5 marks. Generally, performance in this question was good, with 73.6 percent scoring 6 marks and above. Summary of the distribution of the candidates' scores is shown in figure 12.

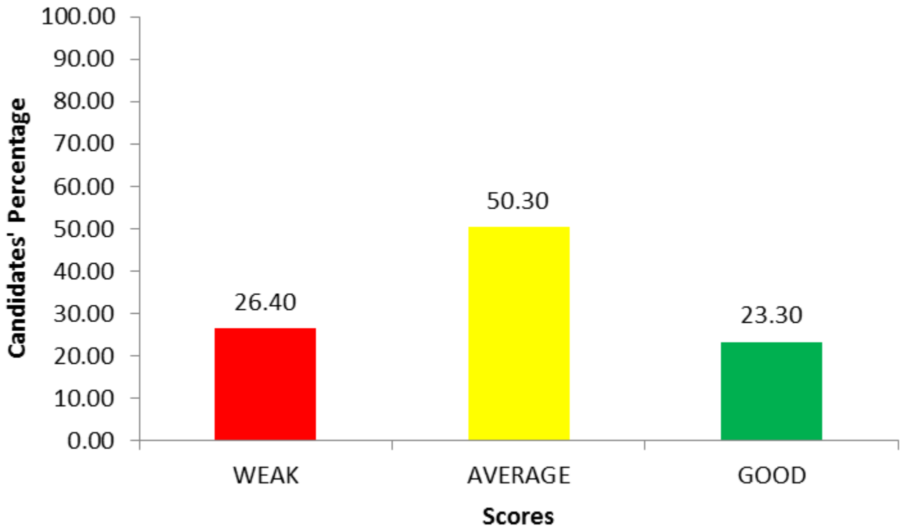


Figure 12: *Distribution of candidates' scores in question 12*

Analysis of candidates' responses shows that those who scored 10.5 to 15 marks managed to attempt both parts (a) and (b) satisfactorily. In part (a), the candidates defined sp^3, sp^2 and sp hybridizations properly. This can be justified from a response of one candidate who defined sp^3 hybridization as *the type of hybridization formed by mixing one s-orbital and three p-*

orbitals. Another candidate defined sp^2 hybridization as *a type of hybridization formed by mixing one s-orbital and two p-orbitals*. Similarly, in part (b), most of the candidates managed to calculate the required wavelength of line in Balmer series by applying the Rydberg's equation. They successfully indicated that the transition of the electron involved the 2nd and the 4th energy levels. This implies that the candidates had sufficient knowledge of the topic of *General Chemistry*. Extract 12.1 depicts an example of correct responses in question 12.

12 (a) i SP^3 hybridization; Is the type of hybridization which involve the mixing up of one S-orbital and Three (3) P-orbitals to form an hybrid orbital of ~~sp^3~~. SP^3. This kind of hybridization it has a structure called tetrahedral structure. Example CH_4

ii) SP^2 hybridization; is The type of hybridization which involve the mixing up of one s-orbital and two (2) P-orbitals to form a hybrid orbital of SP^2. This hybridization forms as structure called ~~te~~ trigonalplaner structure. Example $AlCl_3$

iii) SP hybridization; is the type of hybridization which involve the mixing up of one S-orbital and one P-orbital to form ~~a~~ a hybrid orbital of SP. This kind of hybridization has the structure of Linear structure. Example CO_2.

(b) solution

from

$$\frac{1}{\lambda} = RH\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

Given

$RH = 1.09676 \times 10^6 cm^{-1}$

$n_1 = 2$.

$n_2 = 4$.

λ(wavelength) = Required.

12 (b) Then

$$\frac{1}{\lambda} = 1.09676\times10^{6}cm^{-1}\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$1/\lambda = 1.09676\times10^{6}cm^{-1}\left[3/16\right]$$

$$1/\lambda = 1.09676\times10^{6}cm^{-1} \times 0.1875.$$

$$1/\lambda = 205,642.5\ cm^{-1}.$$

$$\lambda = \frac{1}{205,642.5\ cm^{-1}}$$

$$\lambda = 4.86\times10^{-6}\ cm.$$

Then.

Recall

$1m \equiv 100cm$

$m? \equiv 4.86\times10^{-6}cm$

$= 4.86\times10^{-8}m.$

Also

$1A \equiv 10^{-10}m.$

$A? \equiv 4.86\times10^{-8}m$

$= 486.28A.$

$\therefore$ The wavelength is $486.28A$.

Extract 12.1: An example of good responses in question 12

Extract 12.1 is a response of a candidate who gave correct explanation of concepts of hybridization and appropriate computation of wave length.

For those candidates who scored from 6 to 10 marks, they gave correct definitions of sp^3, sp^2 and sp hybridizations. However, in part (b) most of them interchanged parameters in the Rydberg's equation, and got incorrect values of wavelength. Only few candidates in this category managed to write the Rydberg's equation correctly although they made mistakes during calculation of wavelength.

Conversely, majority of the candidates who scored from 0 to 5.5 marks failed to define sp^3, sp^2 and sp hybridizations. For example, one candidate defined sp^3 hybridization as *the type of hybridization that involves the attachment of the tri atoms.* In the definition, the candidate did not specify the kind of orbitals involved. In part (b), most candidates failed to convert 'cm' into Å, an elementary stage towards calculating the required wavelength. Some of the candidates failed to identify the energy levels involved in the transition of the electron in Balmer series ($n_1 = 2$, and $n_2 = 4$). Subsequently, the energy levels $n_2 = 5$ and $n_2 = 6$ were mistakenly used by candidates as well as the equation ʎ = $R_H\ [n_4^2 - n_2^2]$ instead of $1/\lambda = R_H\left[1/n_4^2 - 1/n_2^2\right]$. Extract 12.2 shows an example of incorrect responses in question 12.

12 (b) $\lambda = \frac{1}{R_H}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$$= \frac{1}{1.09676\times10^{6}}\left[\frac{1}{2^2} - \frac{1}{1^2}\right)$$

$$= \frac{1}{1.09676\times10^{6}}\left(\frac{1}{4}\right).$$

$$= 2.279441263\times10^{-7}\ \text{cm.}$$

$$\approx 2.3\times10^{-7}\ \text{cm}$$

∴ Wavelength in Å of line in a balmer series $= 2.3\times10^{-7}$ cm.

$$= 2.3\times10^{-7}\ \text{cm.}$$

Extract 12.2: An example of poor responses in question 12

Extract 12.2 is an incorrect response of one of the candidates who used incorrect equation and failed to convert centimetres into Anstron unit.

2.13 Question 13: Volumetric Analysis

The question was as follows:

As a chemistry teacher, the 24 hours advance instructions requires you to prepare 0.119 M sulphuric acid to be used by 120 students for titration. Each student needs 100 cm^3. The commercially available acid has the following specifications: 96% purity, density = 1.82 g/cm^3 and molecular weight = 98 g.

(a) *Mention two precautions you will take while handling suphuric acid.*

(b) *Show how you will prepare the required solution.*

(c) *Determine the volume of the dilute acid that will neutralize 25 cm3 of a 0.125 M sodium carbonate.*

Statistics of performance indicate that out of 528 (75.0%) candidates who attempted the question, 44.7 percent scored 10.5 to 15 marks, 38.6 percent scored 6 to 10 marks, and 16.7 percent scored 0 to 5.5 marks. The performance in this question was generally good with 83.3 percent of the candidates scoring 6 marks and above. A summary of the distribution of candidates' scores is shown in figure 13.

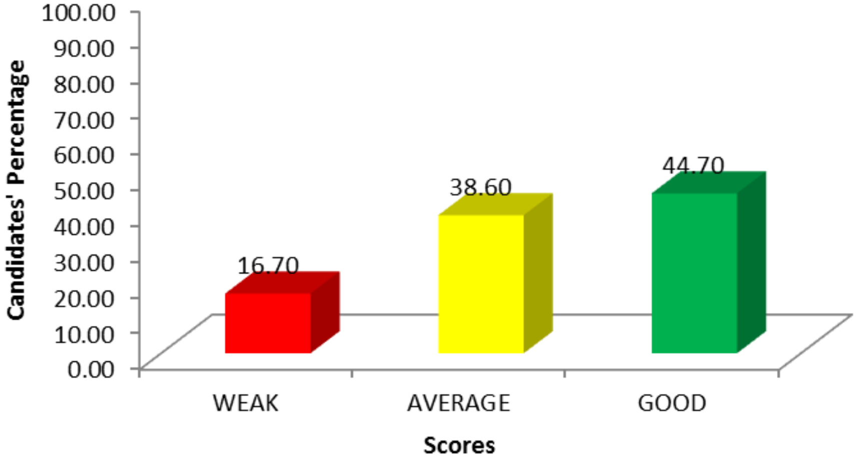


Figure 13: *Distribution of candidates' scores in question 13*

The candidates who scored from 10.5 to 15 marks demonstrated good mastery of the subject matter, as majority managed to mention the required precautions in part (a). For instance, one candidate gave the following precautions in part (a): *Wearing of safety goggle and gloves required during handling sulphuric acid since it is corrosive. Add the acid into water slowly while stirring the mixture to prevent the formation of a layer of acid*. They also showed all the necessary stages required for preparation of the solution including the calculations involved. The most capable candidates in this category answered part (c) appropriately as they calculated the exact volume of the acid. Extract 13.1 is an example of correct responses in question 13.

13	Solution
	Data given
	Chemical given
	(i) Sulphuric acid
	Molarity = 0.119M
	% purity = 96%
	Molecular weight = 98g
	Density = 1.82cm^3
	Number of students = 120. @ 100cm^3
	ii) Base given: Na_2Co_3
	molarity = 0.125M and volume = 25cm^3

13	(a) Two precautions for handling acid. (H_2SO_4)
	(i) Ware gloves when handling bottle because
	its is corrosive can cause burning avoid
	to hand with bare hand
	(ii) Avoid to add water into acid because
	it can cause fire outbreak.
	(b) Preparation of solutions
	- solution
	(i) to find molarity of concentrated acid
	from
	$\text{Molarity} = \frac{\text{density} \times \%\text{purity} \times 1000}{\text{molar weight} \times 100}$
	$\text{Molarity} = \frac{1.82 g/cm^3 \times 96\% \times 1000}{98 \times 100}$
	Molarity = 17.82 mol/dm^3
	Molarity of concentrated acid = 17.82mol'
	ii) To find volume of concentrated acid
	from dilution law
	$M_c V_c = M_d V_d$
	where
	M_c = molarity of concentrated acid
	V_c = Volume of concentrated acid
	M_d = molarity of dilute acid
	V_d = Molarity of dilute acid
	$M_c = 17.82$
	$M_d = 0.119M$
	V_d = number of students × volume of each students'
	= 120 × 100 = 12000 cm^3.

13 C	from the formulae
	$\frac{MaVa}{na} = \frac{MbVb}{nb}$
	$\frac{Mbvbna}{Manb} = Va$
	$= \frac{0.125 \times 25 \times 1}{0.119 \times 1} = Va = 26 cm^3$
	∴ Volume of dilute acid that will neutrali
	ze $25 cm^3$ of a $0.125m$ of sodium carbonate =
	$26 cm^3$

Extract 13.1: An example of good responses in question 13

In Extract 13.1, the candidate gave proper precautions and carried out the required calculations correctly.

In the category of those who scored 6 to 10 marks, many candidates gave either partial or incomplete answers. Others gave correct responses in parts (a) and (b) but they responded incorrectly to part (c). In the calculation, majority used incorrect formulae, and finally got an incorrect volume of the acid. This implies that the candidates had insufficient knowledge of how to prepare standard solutions.

On the other hand, majority of the candidates whose scores ranged from 0 to 5.5 marks failed to give proper precautions in part (a). Others gave unrelated laboratory rules instead of the specific precautions concerned with handling H_2SO_4. One candidate for example, wrote: *wash your hands before leaving the laboratory*. Only a few candidates managed to give proper precautions. Basically, the candidates lacked the knowledge for handling of chemicals based on their physical and chemical properties.

In part (b), the majority managed to write the formula for calculating the volume of concentrated H_2SO_4 but failed to apply it. Similarly, they wrote the dilution formula, $M_1V_I = M_2V_2$ correctly. However, they substituted the given data incorrectly. Similarly, part (c) was poorly attempted by most of the candidates. The incorrect responses indicate that the candidates had insufficient knowledge of volumetric analysis. Extract 13.2 shows an example of incorrect responses in question 13.

13 a) i) Don't pipette acid by sucking with

ii) If suck drop on your hand wash with water immediately

b) i) Find the morality of the solution

ii) Calculate the volume of the solution

iii) The divide the solution to the each student required

iv) Then distribute the solution to a place where each student

v) Determine the relative atomic mass of the solution

vi) Find the concentration of the solution.

c) $C = \frac{M}{V}$

$M = \frac{C}{Mr}$

$M = \frac{M}{V \times Mr}$

Data

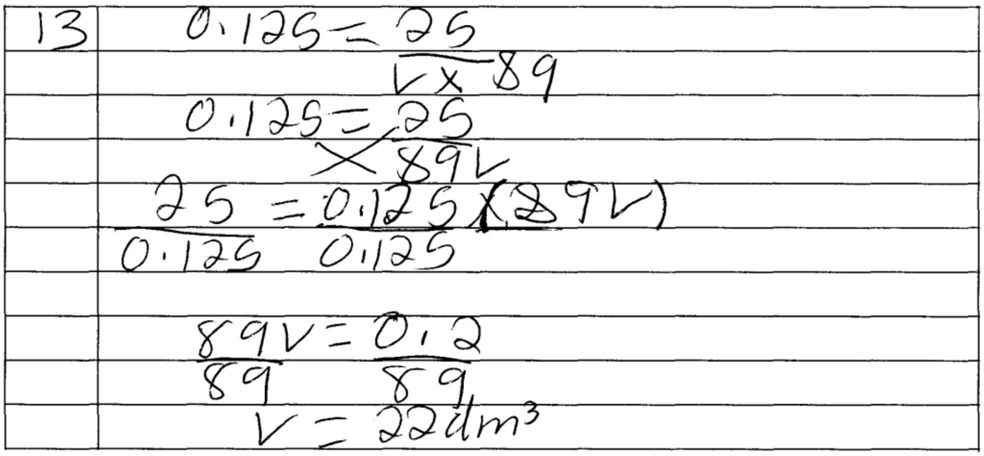
Volume = ?

Molarity = 0.125

$Mr\ (H_2SO_4) = (1\times2+23\times1+16\times4) = 89$

$M = 25cm^3$

$M = \frac{M}{V \times Mr}$


13
$0.125 = \frac{25}{V \times 89}$
$0.125 = \frac{25}{89V}$
$\frac{25}{0.125} = \frac{0.125(89V)}{0.125}$
$\frac{89V}{89} = \frac{0.2}{89}$
$V = 22dm^3$

Extract 13.2: An example of poor responses in question 13

Extract 13.2 is a response of a candidate who gave incorrect precautions and used unclear formula in the calculation of volume.

2.14 Question 14: Chemistry Curriculum Materials

The question instructed candidates to explain six points on the importance of teaching and learning resources in Chemistry.

The analysis of candidates' performance indicates that, out of 695 (98.7%) candidates who attempted the question, 47.6 percent scored 10.5 to 15 marks, 44.5 percent scored from 6 to 10 marks, and 7.9 percent candidates scored 0 to 5.5 marks. Generally, the question attained good performance with 92.1 percent of the candidates scoring 6 marks and above. The distribution of candidates' scores is displayed in figure 14.

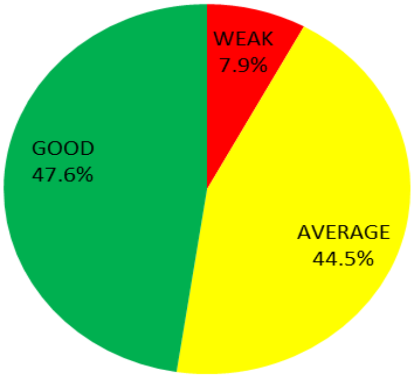


Figure 14: *Distribution of candidates' scores in question 14*

The candidates who scored 10.5 to 15 marks, properly gave six points on the importance of resources in teaching and learning of chemistry. The correct responses include the following*: Resources help teachers in preparation of chemistry notes and selection of best teaching strategies to be employed. They also arouse critical thinking and creativity to both teachers and students, and facilitate the preparation and performance of practical activities.* However, the explanations given by some candidates covered a narrow scope of teaching resources as they addressed teaching aids only. Teaching resources such as library, internet and laboratories among others were not cited. Basically, teaching aids are a subset of teaching resources. Extract 14.1 indicates an example of correct responses in question 14.

14. Teaching and learning resources refers to the matterials used for teaching and learning process. These matterials where by teacher use during teaching and learner for learning. Example text-book, models, pictures, Draws,

The following are the importance of using teaching and learning process.

Gains and hold attention of learners; through textbook, picture the learner should be attention and actively participation.

Compensation of language deficiency; through television, computer, text boole are led to raise the interest of learner and improve more language.

Save time during teaching and learning process; the resources like chalk projector, picture it can ensure the save of time and enhance more interesting for learning.

Encourage active participation; through projector, picture and computer it can lead the active participation between teacher and learners or land matterials.

Arouse interest and motivation for learners; through demostration of different content like Reproduction; the students should be interested since become more motivated and interest to the lesson.

Enhance creativity and innovative for both teacher and learner during learning or lesson. Through models and photograph it can led the inquiry mind to the learner

Reinforcing learning; The resource uses should reinforce more learning so as to learn well and accurate either by using video, textbook, syllabus and picture.

The Education institution should required to improve more teaching and learning resource since it led the more performance and good academic institution to archieve the goal.

Extract 14.1: An example of good responses in question 14

In Extract 14.1, the candidate described correctly the importance of resources in teaching and learning Chemistry.

Further analysis revealed that, candidates who scored from 6 to 10 marks, wrote three to four correct points. Others provided six points including partial ones which were not clearly stated. One candidate for example, responded that: *resources help in preparation of chemistry notes and selection of chemistry strategies as best.* The first point is correct but the second point does specify the type of strategies involved (in this case it should be teaching strategies). Another candidate gave an incorrect response that *they help teacher to attend school.* A few candidates responded that resources *help teachers to deliver the lesson systematically* while systematic teaching is guided by the lesson plan. The incorrect responses signify partial mastery of the topic of chemistry curriculum materials.

Conversely, candidates who scored from 0 to 5.5 marks, provided inappropriate responses in most part of the question. One example of responses given was: *they help in logical flow of the content*. Another candidate responded that, *teaching materials help a teacher to select* *teaching and learning materials.* The candidate lacked the understanding that teaching and learning materials refer to teaching and learning resources. Few others claimed that the teaching resources: *help to maintain uniformity in chemistry teaching* without knowing that uniformity in teaching chemistry countrywide is maintained by the chemistry curriculum (syllabus). Candidates in this category had a problem in differentiating teaching materials from curriculum materials. Extract 14.2 represents an example of incorrect responses in question 14.

14 Six points are explained the importance of teaching and learning resource in the teaching and learning of chemistry

1 Teaching and learning resource should be relevant with the level of the learner in the teaching and learning chemistry and motivate students

Teaching and learning resource should contain the different strategies which capture the learner interest in teaching and learning the chemistry

Teaching and learning resources should have specific objectives which enhance teacher to facilitate teaching and learning in the chemistry

Teaching and learning resources should be relevant with the subject matter in teaching and learning of chemistry encourage participation to the students

Teaching and learning resource should be relevant with the society need in teaching and learning of chemistry which improve performance to students

Extract 14.1: An example of poor responses in question 14

In Extract 14.2, the candidate gave features of teaching and learning resources instead of explaining their importance.

2.15 Question 15: Assessment in Chemistry

The question required candidates to explain five procedures for moderating a Chemistry test.

The question was attempted by 195 (27.7%) candidates in which 13.8 percent scored from 0 to 5.5 marks, 45.1 percent scored from 6 to 10 marks and 41.0 percent scored from 10.5 to 15. Candidates who scored 6 marks and above were 59.0 percent, indicating that the performance was average in this question. Summary of the distribution of candidates' scores is shown in figure 15.

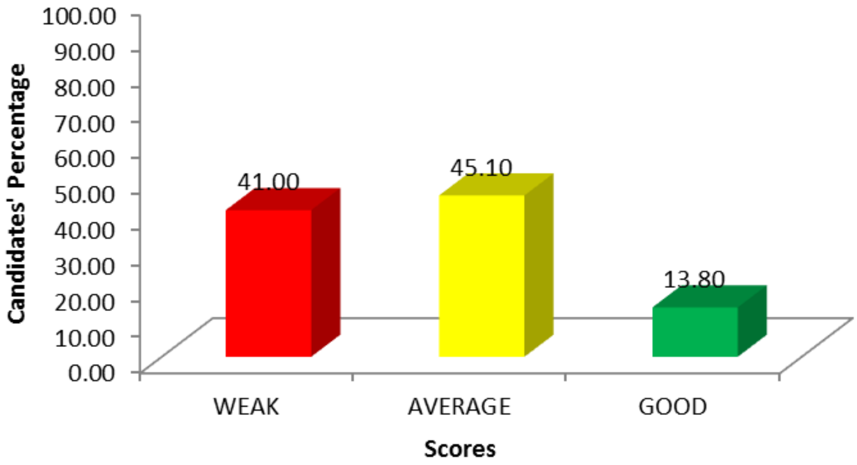


Figure 15: *Distribution of candidates' scores in question 15*

The candidates who scored from 10.5 to 15 marks, properly gave the five procedures for moderating chemistry test. Some of the candidates gave precise explanation while others just mentioned the points. The expected procedures were as follows: C*onstruct a chemistry test by using table of specification. Administer the test (of equivalent academic level to the candidates to be tested) to the students. Mark and score the test using the constructed marking scheme. Carry out item analysis* and *replace all poor items with good ones*. Most of the candidates gave the procedures, although some were not awarded a full mark because they were not presented in chronological order. Generally, the candidates showed adequate knowledge of assessment in Chemistry. Extract 15.1 presents a sample of correct responses in question 15.

15. Moderating a chemistry test is the Process or method of making a chemistry test average or fair by removing all diffult or very easy item from the test according to the level of learner. This will be done either by a Teacher concerned or a Cabinet of Chemistry experties.

The following are the procedure for moderating Chemistry test :-

Determining of purpose of test; before doing moderation of chemistry test teacher he/she supposed to determine purpose of the test, which purpose is a test is intended to measure is it a knowledge, or Application, Comprehension, Analysis or test need to evaluate ?.

Determining number of test item; But also teacher before doing moderation of chemistry test he/she is supposed to determine number of test item constructed which is intended to measure certain domain or number of item in whole test from table of specification according to the nature and level of the learner.

Construction of relevant Chemistry test; After determining number of test item teacher he/she supposed to construct a test item which is relevant to the nature of the learner and level of the learner.

Item analysis; after Constructing test item a teacher he/she supposed to make analysis of item by administering to his/her fellow chemistry - teachers or experties even he/she can administer the item / test to the student of near school of the same level before administering to the intended class.

Eliminating / discriminating of very - difficult and very easy test item; After all chemistry teacher he/she supposed to eliminate or discriminate all chemistry test Item which is very difficult and very easy so as to make the chemistry test Item moderate / average

All in all moderating of a chemistry test Item is very important because it help teacher to measure what is intended to be measured - and also help a teacher to determine different skills of ~~his~~ and ability in performance of his/her learner, therefore it's advisable that chemistry teacher must moderate test before administering to student.

Extract 15.1: An example of good responses in question 15

Extract 15.1 shows response of a candidate who managed to explain the appropriate procedures for moderating a chemistry test.

For the candidates who scored from 6 to 10 marks, analysis of responses shows that the majority gave correct procedures with incomplete explanations. There were few candidates who managed to explain at most two points, but did not explain the rest of the points properly. Thus, candidates in this group were to some extent knowledgeable on assessment in Chemistry.

Furthermore, candidates who scored from 0 to 5.5 marks misunderstood the demand of the question. Many of them wrote the instructions which are normally given in question papers such as *the test has three sections A, B and C. Answer all questions in section A, and two questions from each of sections B and C. Cellular phones and any other unauthorized materials are not allowed in the examination room*.

Others mixed up moderation and standardization of a test as they wrote *find the average mean, deviation, variance, standard deviation and then find Z-scores and T- scores.*. Likewise, there were few candidates who provided incorrect responses as a result of guessing. One of the candidates for instance, wrote that: *do not mark the test when your sick, tired or stressed; determine the ability of the learners for effective testing.* Another candidate responded that *the teacher to announce the test coverage and the day of conducting a test.* Failure by the candidates to give the correct answers implies that they had inadequate knowledge of the topic of *assessment in chemistry*. Extract 15.2 is a sample of incorrect responses in question 15.

15	Moderating - is the process of
	Supervision of the test during the
	test time"
	The following are the
	procedure of moderating a Chemistry
	test.
	Arrangement of the class:
	During the moderating the Chemistry
	test the class should be arrange
	into the proper way which
	can help the moderator to pass among
	in in both direction horizontally and

vertically during modarating.
Make the inspection to the Student before the they inter in the examination room. Also another procedure of moderating the Chemistry test is to inspect the Student so as to avoid them to inter in the examination room with the materal which are not allowed.
Distributing of the answer sheet to the Student and to allow them to write their infomation. Also when moderating the Chemistry test the moderater should distribute the answer shee to the Studet and to tell them to write their infomation
Taking the roll cal of the Student; Also when moderating the Chemistry test you have to take the roll cal of the Student who present in the test room which can help to determine the Student who attend on test and those who didnot atten.
At the end of time collect the answer sheet of the Student; Also Lastly when moderating a Chemistry test when the time end you have to collect the answer sheet from the Student and to count them to prove if they are similer to the number of the Student.
Generally the above are the procedure of modarating chemisty test.

Extract 15.1: An example of poor responses in question 15

Extract 15.2 is a sample of incorrect responses in which the candidate wrote how to invigilate a test instead of how to moderate it.

2.16 Question 16: Planning and Preparation for Teaching

The question required candidates to explain five advantages of using role play in the teaching and learning of the concept of 'States of Matter'.

The analysis indicates that the question was attempted by 511 (72.6%) candidates, and thus being the least attempted one. Moreover, 16.6 percent scored from 10.5 to 15 marks, 45.2 percent scored from 6 to 10 marks and 38.2 percent scored 0 to 5.5 marks. In general, the performance in this question was average since 61.8 percent of the candidates scored 6 marks and above. The distribution of the candidates' scores is shown in figure 16.

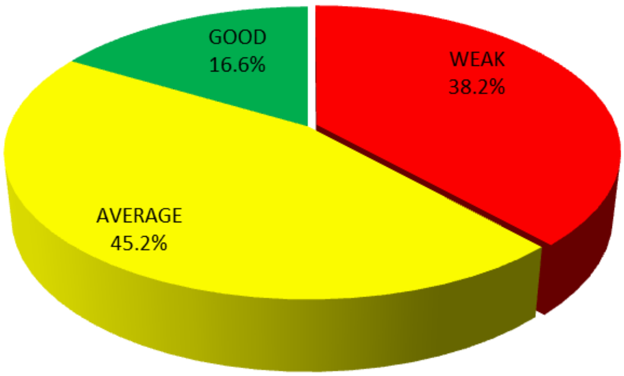


Figure 16: *Distribution of candidates' scores in question 16.*

The candidates who scored from 10.5 to 15 marks demonstrated good ability in explaining the advantages of role play in teaching and learning the concept of states of matter. Here is an example of responses given by one of the candidates in this category. *Role play helps to clarify and demonstrate attitude and concepts of solid state. For example, students can hold each other tightly to role play the package of particles in a solid substance like a stone*. Similarly, another candidate wrote that: *role play is used to teach abstract concept that could possibly be difficult to be understood by using verbal description for example students can role play on how liquid molecules move randomly in liquid states*.

Others asserted that role play entertains and holds the attention of the learners if the actors hold realities like demonstrating how particles and molecules behave in different states. Extract 16.1 shows an example of correct responses.

16 Also role play encourages students active participation in the process of teaching and learning. Active participation enables learners to think critically and construct meaning. For example when different students act as having features of all states of matter this makes them think logically to identify what real are the features of solids, liquids and gases.

Creativity and discovery may also be promoted by role play. This is due to the fact that role play is an art that stimulates sense of discovering new skills. About states of matter role play can lead students to discover the differences between these states as well as similarities among them and go as far as discover what are the usefulness of these three states of matter.

Role play also promotes cooperation in teaching and learning. This is because when students are performing role play to deliver knowledge they work together and as a result they develop love of cooperative learning which is very important component of learning chemistry.

Extract 16.1: An example of good responses in question 16.

Extract 16.1 shows a portion of correct explanations provided by one of the candidates about the advantages of role play.

Further analysis of candidates' responses indicates that, those who scored from 6 to 10 marks provided relevant advantages of role play in general, but failed to relate them with the states of matter. For example, one candidate wrote: *role play prepares for real situation, it arouse interest of the students in learning, helps in retention and memories of the concept* *demonstrated.* Others hardly gave two to three advantages out of five which were needed. A few candidates included points which were totally irrelevant to the demand of the question.

On the contrary, candidates who scored from 0 to 5.5 marks, lacked sufficient knowledge of role play in teaching and learning. Many had misconceptions due to failure to understand the demands of the question. For example, one candidate wrote *it helps students to differentiate states of matter like solid, liquid and gaseous substances*. Another candidate wrote that: *role play helps in evaluating the lesson and identifying learning diversities of learners.* The answers imply that the candidates had insufficient knowledge about planning and preparation for teaching.

Similarly, some candidates confused role play strategy for jigsaw and gallery walk. For example one candidate wrote *in role play, chemistry teacher designs a number of groups depending on the tasks prepared.* On the contrary, another candidate responded incorrectly by claiming that role play enables students to move from one group to another to learn what others have discussed. Such failure by the candidates to appropriately answer the question is an indication that they had insufficient knowledge about teaching and learning strategies. Extract 16.2 is a sample of incorrect responses in question 16.

16. Teaching and learning of the concept :- Refer to the process of transfering new knowledge from teachers to learners during the process of teaching and learnin learning. The following are the advantages of using role-play in the teaching and learning of the concept "States of matter"

Role-play helps learners to identify solid materials in the teaching and learning of the concept "States of matter" which commonly found to the environment.

Use of role-play helps lear learners to know the importances of solid state, liquid state and gaseous states of matter to the environment and how they are used in the teaching and learning of the concept "states of matter"

Use of role-play helps learners to know differences of solid state, liquid state and gaseous states in nature of materials, uses and areas where they can be found.

Use of role-play helps the teachers to understanding the thinking abili ability of each students, during explaining the concept of "States of matter" which are found to the environment. Hence learners can make competition in giving-out their explanation.

Use of role-play helps the learners to reflect the concept of "states of

16.	Use of role-play helps the learners
	to reflect the concept of "states of matter"
	to real life situation due to solid state,
	liquid state and gaseous state are found
	to the environment.
	Generally:- Role-play of the
	concept "States of matter" in the teaching
	and learning helps to make easy brainstorm
	brainstorming of new knowledge, due to
	the materials found in the "states of
	matter" are familiar to the environment

Extract 16.2: An example of poor responses in question 16

Extract 16.2 is a response of a candidate who mixed up role play with jigsaw and gallery work.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH TOPIC

The Chemistry examination had a total of 16 questions covering 11 out of 13 topics. The topics are *Principles of Teaching and learning Chemistry, Volumetric Analysis, Laboratory Management, Assessment in Chemistry, Electrochemistry, General Chemistry, Chemistry Curriculum Materials* and *Organic Chemistry.* Other topics were *Chemical Kinetics, Energetics and Equilibrium, Environmental Chemistry* and *Transition Metals.*

In terms of the performance, the analysis indicated that, four topics attained good performance, five topics had average performance, while two topics had poor performance. Topics which attained good performance were: *Chemistry Curriculum Materials* (94.6%), *Volumetric Analysis* (83.3%), *Laboratory Management* (79.1%), and *Planning and Preparation for Teaching* (70.8%).

The topics which attained average performance were, *General Chemistry* (66.8%), *Environmental Chemistry* (66.0%), *Transition Metals* (62.5%), *Assessment in Chemistry* (59.0%) and *Chemical Kinetics, Energetics and Equilibrium* (52.7%).

The poorly performed topics were *Electrochemistry* (22.0%) and *Organic Chemistry* (18.0%). A summary of the performance in each topic is shown in the **Appendix**.

4.0 CONCLUSION

The candidates' general performance in Chemistry subject was average. This is demonstrated by both statistics and candidates' responses. Despite the fact that the majority of the candidates scored average marks and above, few others performed poorly. The major challenges which were identified through this analysis are as follows:

(a) Lack of competence in numerical skills in which some candidates failed to use appropriate formulae and procedures in calculations.

(b) Inappropriate knowledge on the properties of chemical species and their subsequent treatment or handling in Chemistry. For instance, some candidates could not account for the difference in boiling points of the isomers presented in question 3.

(c) Failure of some candidates to understand the demands of questions and respond accordingly.

(d) Inability to interpret chemical formulae and obtain scientific information in various aspects pertaining to the formulae; and

(e) Lack of understanding of principles and inability to associate the principles / theories with a number of scientific observations.

5.0 RECOMMENDATIONS

Based on the observation made through the Candidates' Item Response Analysis, the following recommendations are given in order to improve the performance of prospective candidates in Chemistry subject:

(a) More emphasis should be put on the use of pictures and models of organic and inorganic compounds during teaching and learning. In this way performance in the topic of *Organic Chemistry* will be improved.

(b) Students are advised to undertake more exercises on practical questions requiring numerical skills. This will enable to improve performance of candidates in topics such as *Electrochemistry* and *Chemical Kinetics, Energetics* and *Equilibrium*.

APPENDIX

ANALYSIS OF CANDIDATES' PERFORMANCE PER TOPIC

S/n	Topic	Question Number	Percentage Pass		Remarks
			Candidates who scored 40% or above	Average	
1	Chemistry Curriculum Materials	5	97.0	94.6	Good
		14	92.1		
2	Volumetric Analysis	13	83.3	83.3	Good
3	Laboratory Management	9	79.1	79.1	Good
4	Planning and Preparation for teaching	4	56.6	70.8	Good
		6	94.0		
		16	61.8		
5	General Chemistry	1	59.9	66.8	Average
		12	73.6		
6	Environmental Chemistry	8	66.0	66.0	Average
7	Transition Metals	11	39.8	62.5	Average
8	Assessment in Chemistry	15	59.0	59.0	Average
9	Chemical Kinetics, Energetics and Equilibrium	2	27.1	52.7	Average
		10	78.2		
10	Electrochemistry	7	22.0	22.0	Poor
11	Organic Chemistry	3	18.0	18.0	Poor