

**THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA**



**CANDIDATES' ITEM RESPONSE ANALYSIS  
REPORT FOR THE CERTIFICATE OF SECONDARY  
EDUCATION EXAMINATION (CSEE) 2019**

**032 CHEMISTRY**

**NATIONAL EXAMINATIONS COUNCIL OF TANZANIA**



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## FOREWORD

This Candidates' Items Response Analysis Report in Chemistry subject for the Certificate of Secondary Education Examination (CSEE) 2019 has been prepared in order to deliver feedback to students, teachers, school quality assurers, parents, policy makers and the public in general about the performance of the candidates and the challenges they encountered in attempting the examination.

The Certificate of Secondary Education Examination (CSEE) marks the end of four years of ordinary level secondary education. It is a summative evaluation which among other things, shows the effectiveness of education system in general and education 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 students in their four years of secondary education.

The analysis presented in this report is envisioned to contribute towards understanding some of the reasons behind the performance of candidates in Chemistry subject. The report highlights some of the aspects that made some of the candidates unable to score high marks in this paper. Such aspects include; inadequate knowledge on various topics, failure to understand the requirement of the questions, failure to present appropriate chemical equations and inadequate numerical skills. The feedback provided will enable the educational administrators, school managers, teachers, school quality assurers, students and other educational stakeholders to propose measures to be taken in order to improve candidates' performance in future examinations administered by the National Examinations Council of Tanzania.

The National Examinations Council of Tanzania will appreciate comments and suggestions from teachers, students and the public in general that can be used for improving future Analysis Reports.

The Council would like to thank the examination officers, examiners and all others who participated in the preparation of this report.



Dr. Charles E. Msonde  
**EXECUTIVE SECRETARY**

## 1.0 INTRODUCTION

This report analyses the performance of school candidates who sat for the Certificate of Secondary Education Examination (CSEE) 2019 in Chemistry subject. The examination was set according to the revised version of the 2008 CSEE format which was developed from the 2010 Chemistry syllabus for Secondary School Education.

The paper consisted of sections A, B and C. Section A consisted of two objective questions. Question 1 had ten multiple choice items which weighed 10 marks. Question 2 had five matching items which carried 05 marks. Section B had ten (10) short answer questions, each carrying 07 marks while section C comprised two (2) essay questions each carrying 15 marks. The candidates were required to answer only one question from section C.

A total of 162,777 candidates sat for the examination and the performance was good as 124,952 candidates, equivalent to 76.76 percent passed at grade A to D. The distribution of grades is shown in Table 1.

**Table 1: Candidates' Grades in CSEE 2019 Chemistry Examination**

Grades	A	B	C	D	F
% of Candidates	1,673	8,192	53,259	61,828	37,825

The performance in CSEE 2019 has increased by 14.61% relative to the performance in 2018 where 62.15% of the candidates passed the examination.

This report is divided into four sections: introduction, analysis of the candidates' performance in each question and analysis of performance in each topic followed by conclusion and recommendations.

The analysis of the performance in each question indicates the demand of the question, figures (graphs, charts) and samples of candidates' responses (extracts) have been used for more clarification in the analysis.

## 2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH QUESTION

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 each Question 1-14**

Question number	Category	Marks	Colour in figures
1	Good	7.0 - 10	Green
	Average	3.0 - 6.0	Yellow
	Weak/poor	0 - 2.0	Red
2	Good	3.5 - 5.0	Green
	Average	1.5 - 3.0	Yellow
	Weak/poor	0 - 1.0	Red
3 - 12	Good	5.0 - 7.0	Green
	Average	2.5 - 4.5	Yellow
	Weak/poor	0 - 2.0	Red
13 - 14	Good	10 - 15	Green
	Average	5.0 - 9.0	Yellow
	Weak/poor	0 - 4.0	Red

### 2.1 Section A: Objective Questions

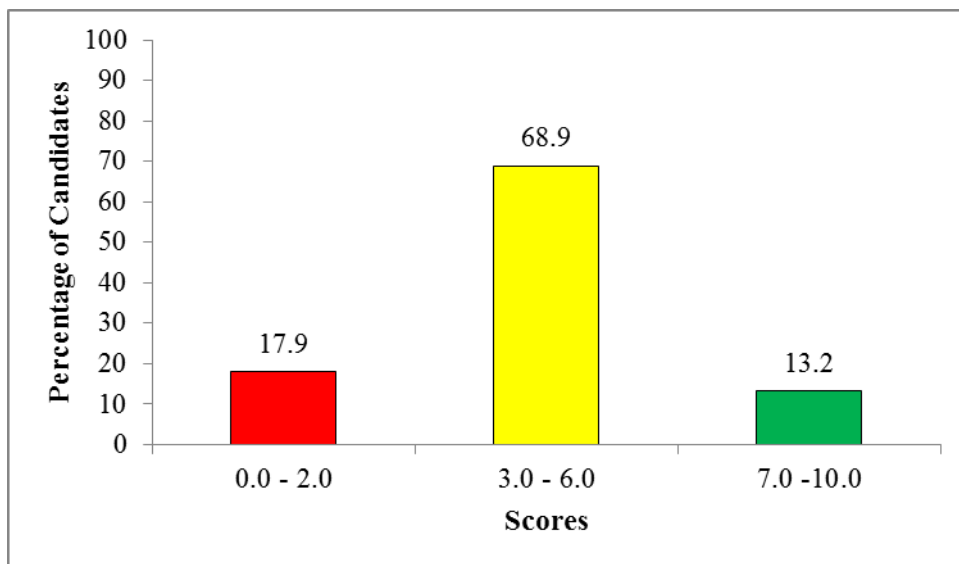
This section consisted of two objective questions. Question 1 had 10 multiple choice items while question 2 had 5 matching items. Each item in both questions carried 1 mark.

#### 2.1.1 Question 1: Multiple Choice Items

The items in this question were composed from eight topics. The topics are *Organic Chemistry; Water; Hydrogen; Fuels and Energy; Matter; Laboratory techniques and Safety; Oxygen and Soil Chemistry*. The candidates were required to choose the correct answer from five alternatives (A to E) and write its letter beside the item number in the answer booklet provided.

The statistics show that 163,741 (99.9%) candidates attempted this question. The analysis of candidates' performance indicates that 17.9

percent of the candidates scored 0 to 2 marks, 68.9 percent scored 3 to 6 marks while 13.2 percent scored 7 to 10 marks. These statistics are displayed in Figure 1.



**Figure 1:** *Performance of candidates in question 1.*

Figure 1 shows that 82.1 percent of the candidates scored 3 to 10 marks, an indication of good performance in this question.

Item (i) required the candidates to choose a response which provides an answer why water is referred to as the universal solvent. Analysis of the responses indicates that most of the candidates were able to choose the correct response E, *Water dissolves more substances than any other known liquid*. Those candidates had enough knowledge on the properties of water, that it dissolves more substances than any other liquid, hence a universal solvent.

On the other hand, few candidates who chose other options had limited knowledge on the properties of water as most of them selected distractor C, *water dissolves both organic and inorganic solutes*. Those candidates were attracted by the terms *organic* and *inorganic* without knowing that the only organic solutes that are dissolved by water are polar ones but not all solutes.

In item (ii), the question required the candidates to identify the final product given when methane undergoes substitutional reaction with excess chlorine. Majority of the candidates were able to choose the correct response D, *Tetrachloromethane*. These candidates had adequate knowledge on the free radical substitution reaction of alkanes, hence they were able to realize the correct response. They understood that other products like monochloromethane, dichloromethane, and trichloromethane were the intermediates. The candidates who opted for the distractors had inadequate knowledge on the free radical substitution reaction of methane. For example, the candidates who opted for distractor A, *Chloromethane* could not realize that with excess chlorine, the reaction would go to completion where all hydrogen atoms get substituted by free radical chlorine.

Item (iii) required candidates to select the correct response for why hydrogen gas is collected over water and by upward delivery method. A considerable number of candidates chose the correct option, A, *It is insoluble in water and less denser than air*. Those candidates had practical knowledge on the concept of laboratory preparation of hydrogen gas and its properties. Most of those who selected wrong options chose option D, *it is soluble in water and less denser than air*. These candidate had poor knowledge on the physical properties of hydrogen, hence they could not know that being soluble in water, hydrogen gas could not be collected over water.

Item (iv) of the question provided candidates with fuels 1 *Coal*, 2 *Fire wood*, 3 *Petrol*, 4 *Charcoal* and were required to identify those which originate from fossils. The correct response was A, 1 and 3. Most candidates managed to choose the correct answer, an indication that they had sufficient knowledge on classification of fuels basing on their sources. The few candidates who chose the distractors lacked adequate knowledge on classification of fuels basing on their sources.

Item (v) asked the candidates to select an option which was not the use of chromatography. The correct response was D (*To bleach dye/colour*). The candidates who gave incorrect responses did not recognize the concept of chromatography as a method of separation of mixtures. They were also not aware of the uses of chromatography.

Item (vi) asked candidates to choose an answer which had a proper set of apparatuses to be used in grinding granules of a solid substance into fine

powder in a laboratory. The correct response was D, *Pestle and mortar*. Majority of candidates managed to choose the correct response. Those candidates had appropriate knowledge on the laboratory apparatuses and their uses. On the contrary, a few candidates who failed to choose the correct response, lacked sufficient knowledge on the basic chemistry-laboratory apparatuses and their uses.

Item (vii) asked candidates to choose the method used in production of oxygen gas in large scale. The correct response was D, *Fractional distillation of liquefied air*. Most of the candidates chose incorrect alternatives, indicating that they had insufficient knowledge on the industrial preparation of oxygen gas.

Item (viii) required candidates to choose a set of processes which uses a gas that ignites with a pop sound, when a lighted splint is passed through it. The correct response was B, *Hardening oil, balloon filling and welding*. This question was scored correctly by an average number of candidates who had adequate knowledge on the properties, uses and test for hydrogen gas.

For item (ix), the candidates were required to choose the most correct statement about chemistry laboratory. The correct answer was A, *Is a special room designed for conducting chemical tests*. Most candidates chose the correct answer, indicating that they had adequate knowledge on the concept of chemistry laboratory. Some few candidates who opted for distractors failed to associate the term ‘chemical tests’ with a chemistry laboratory.

In the last item (x), the candidates were required to choose the correct answer about the role of organic matter in the soil. The correct response was C, *Reserving nutrients thus providing soil fertility*. This item was averagely scored by the candidates. Conversely, some candidates who were not able to choose the correct option, had inadequate knowledge about the role of organic matter in the soil.

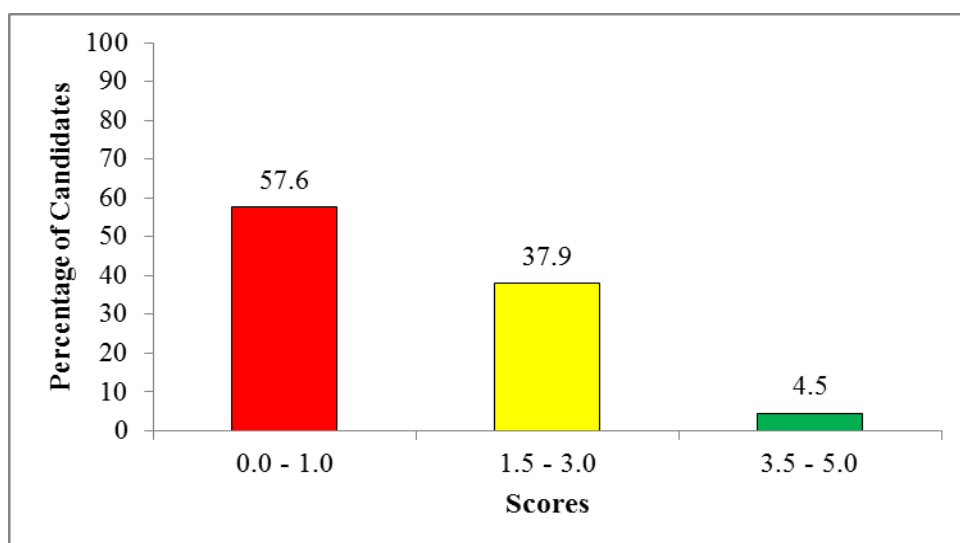
The correct responses given by most of the candidates to items from different topics, indicated that they had adequate knowledge on the content examined.

However, items (iii), (v) and (vii) appeared to be more difficult to most candidates including the high scoring candidates.

### 2.1.2 Question 2: Matching Items

This question was comprised of items from only one topic, *The Scientific Procedures*. The question consisted of 5 items in List A which were to be matched with 7 responses from List B.

The question was attempted by 163,684 candidates. The general performance was average as 42.4 percent of the candidates scored 2 marks and above. Candidates who scored 0 to 1.0 mark were 57.6 percent while 37.9 percent scored 2.0 to 3.0 marks, and 4.5 percent scored 3.0 to 5.0 marks. Further statistics of performance are shown in Figure 2.



**Figure 2:** Performance of the candidates in question 2.

Candidates who scored high marks in this question managed to match correctly most of the items. This indicates that the candidates were competent in relating the statements in List A with the steps of the scientific procedure in List B.

Candidates who scored low marks related the statements in List A with the terms in List B incorrectly, especially items (i) and (v). Item (i) required the candidates to choose from List B, a terminology that shows how the results relate to hypothesis. Most of the candidates responded incorrectly by writing B, *Data analysis*, instead of A, *Conclusion*. The candidates were

not conversant with the meaning of data analysis. In data analysis, the researcher explains the results but does not give a statement of how the results relate to hypothesis.

Item (v) required the candidates to choose a correct scientific step from List B in which a researcher explains the results. The correct match was B, *Data analysis* but some responded by writing A, *conclusion*. Those candidates were not knowledgeable enough about the steps of *The scientific procedure*.

## **2.2 Section B: Short Answer Questions**

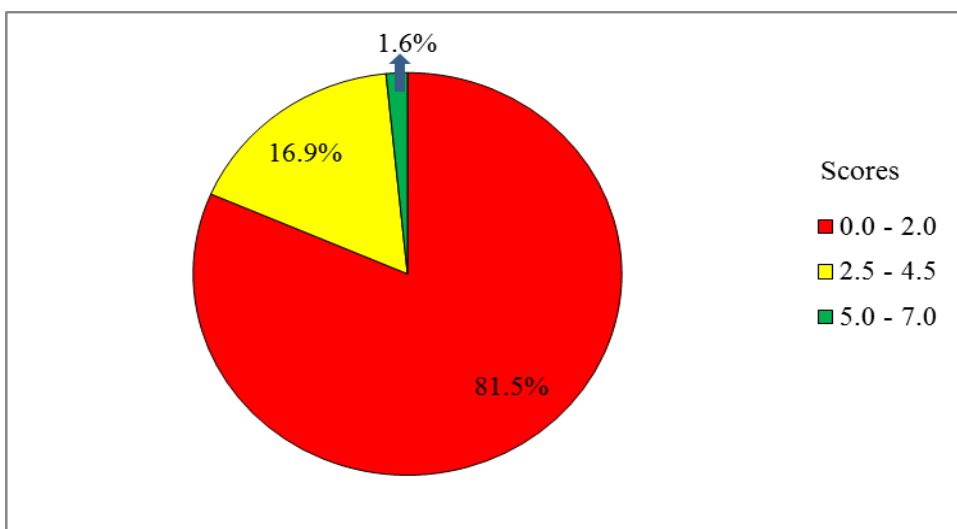
This section consisted of ten (10) short answer questions each carrying a total of 7.0 marks. The pass score in this section was 3.0 marks.

### **2.2.1 Question 3: The Mole Concept and Related Calculations**

The question comprised parts (a) and (b). In part (a), candidates were asked to determine the number of chlorine molecules which are in  $20\text{ cm}^3$  of chlorine gas at s.t.p. In part (b), candidates were required to compute the number of ions present in 5 g of Copper (II) nitrate.

The question was answered by 149,635 (91.3%) candidates, out of whom 18.5 percent scored 2.5 marks and above indicating a general poor performance. Further statistics are displayed in Figure 3.





**Figure 3:** *Performance of the candidates in question 3.*

As shown in Figure 3, 1.6 percent of the candidates scored 5.0 to 7.0 marks, 16.9 percent scored 2.5 to 4.5 marks whereas the majority (81.5 percent) scored from 0 to 2.0 marks.

Some of the candidates who scored low marks gave incorrect responses as they used incorrect formulae while others made inappropriate calculations. For example, in answering part (a), some candidates were unable to convert the given data to relevant units, that would lead them to carry out required calculations. For instance, they did not convert  $20 \text{ cm}^3$  into  $\text{dm}^3$  or  $22.4 \text{ dm}^3$  into  $\text{cm}^3$  units when dividing the volume given by the gram molar volume.

In part (b), most of the candidates failed to arrive to the correct answer, because they could not work out the total number of moles of ions present in one mole of  $\text{Cu}(\text{NO}_3)_2$  salt. They could not write a dissociation equation of the  $\text{Cu}(\text{NO}_3)_2$  salt that gives one mole of  $\text{Cu}^{2+}$  and two moles of  $\text{NO}_3^-$  making a total of three moles of ions. For example, one candidate calculated the number of moles of copper (II) nitrate in 5 g instead of the number of moles of ions present. To get the number of ions, the candidate was supposed to multiply the total number of moles of ions present in that amount of  $\text{Cu}(\text{NO}_3)_2$  salt by the Avogadro's number. Basically, the low scoring candidates in this question were not good at mathematical manipulation and had inadequate knowledge on the mole concept and related calculations. Extract 3.1 represents an example of candidates' poor responses.

3.	(a)	solution
		Molecule are $20\text{cm}^3$
		Chlorine gas = $35.5$
		s.t.p $22.4$
		$1\text{mole} = \frac{22.4\text{ s.t.p.}}{20\text{cm}^3} \times ?$
		$= \frac{1\text{mole}}{1\text{mole}} = \frac{22.4\text{ s.t.p.} \times 20\text{cm}^3}{1\text{mole}}$
		$= 44.8\text{ molecules.}$
		$\therefore \text{The chlorine molecules} = 44.8\text{ molecules.}$
	(B)	
		$n = \frac{\text{Molecules}}{\text{s.t.p.}}$
		$n = \frac{5}{22.4}$
		$n = 0.22\text{ moles.}$
		$\therefore \text{The number of mole} = 0.22\text{ moles}$

Extract 3.1: An example of poor responses in question 3.

In Extract 3.1 part (a), the candidate multiplied the volume of chlorine with the molar volume instead of dividing the volume of chlorine by the gram molar volume. In part (b), he/she divided the mass of copper (II) nitrate by gram molar volume instead of dividing the given mass by the molar mass of copper (II) nitrate.

On the other hand, candidates who performed well managed to determine correctly, the number of molecules present in  $20\text{ cm}^3$  of chlorine gas at s.t.p. They also calculated the number of ions present in 5 g of copper (II) nitrate salt. This showed that those candidates were knowledgeable on the mole concept and related calculations, mathematical manipulation *i.e*

presentation of formulae, plugging data in formula and giving the final answer. Extract 3.2 shows an example of good responses.

3. a)	
	Given $20\text{cm}^3$ of $\text{Cl}_2$ at s.t.p
	from
	GMV at s.t.p
	$1\text{mole of gas} = 22.4\text{dm}^3 = 22400\text{cm}^3$
	$1\text{mol} = 22400\text{cm}^3$
	$x\text{mol} = 20\text{cm}^3$
	$x = \frac{20\text{cm}^3 \times 1\text{mol}}{22400\text{cm}^3} = 8.93 \times 10^{-4}\text{ moles}$
	from
	$N = n \times L_A$ , where $N = \text{Number of molecules}$
	$n = \text{no of moles}$
	$L_A = \text{Avogadro's constant}$
	$N = 8.93 \times 10^{-4}\text{ moles} \times 6.02 \times 10^{23}$
	$= 5.376 \times 10^{20}\text{ molecules}$
	<u><math>\therefore</math> There are <math>5.376 \times 10^{20}</math> molecules of Chlorine gas</u>

3.	b)	Given
		5g of $\text{Cu}(\text{NO}_3)_2$
		$\text{Cu}(\text{NO}_3)_2 \longrightarrow \text{Cu}^{2+} + 2\text{NO}_3^-$
		1 mole produces three moles of ions
		$\text{Cu}(\text{NO}_3)_2 \approx \text{Cu} + 2(\text{NO}_3) \approx \text{Cu} + 2(\text{N} + 3\text{O})$
		$\approx 64 + 2(14 + 48) \approx 64 + 2(62)$
		$\approx 188\text{g/mol}$
		$188\text{g} \rightarrow 3\text{ moles of ions}$
		$5\text{g} \rightarrow X\text{ moles}$
		$X = \frac{5 \times 3}{188} \approx 0.07979\text{ moles}$
		From
		$N \approx n \times L_A$ , where $N \approx \text{no of ions}$
		$n \approx \text{no of moles}$
		$L_A \approx \text{Avogadro's constant}$
		$N \approx 0.07979\text{ moles} \times 6.02 \times 10^{23}$
		$\approx 4.8 \times 10^{22}\text{ ions}$
		$N \approx 4.8 \times 10^{22}\text{ ions}$
		$\therefore$ There are $4.8 \times 10^{22}\text{ ions}$

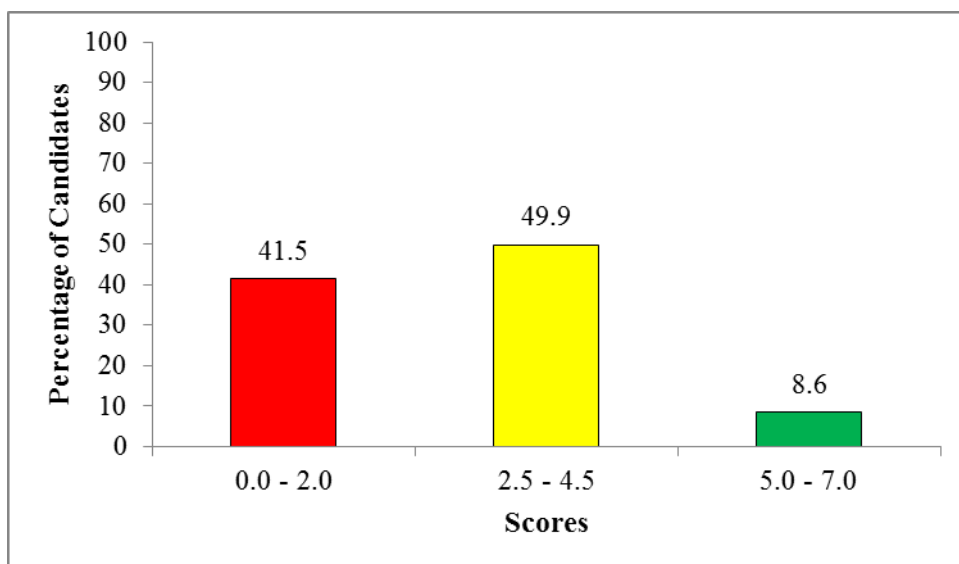
Extract 3.2: An example of good responses in question 3.

In Extract 3.2, the candidate determined correctly the number of chlorine molecules which are in  $20\text{ cm}^3$  of chlorine gas at s.t.p, and calculated correctly the number of ions present in 5 g of copper(II) nitrate salt.

### 2.2.2 Question 4: Acids, Bases and Salts

The question consisted of two parts, (a) and (b). In part (a), candidates were required to distinguish normal salts from acidic salts based on their methods of preparation. In part (b), the candidates were tasked to give four uses of salts in daily life.

The statistics show that this question was attempted by 161,318 (98.5%) candidates. The performance was average as 58.5 percent of the candidates scored 2.5 marks or above. Statistics further indicate that, 41.5 percent scored from 0 to 2.0 marks, 49.9 percent 2.5 to 4.5 marks and 8.6 percent 5.0 to 7.0 marks. Figure 4 shows the summary of these statistics.



**Figure 4:** *Performance of the candidates in question 4.*

Analysis of candidates' responses shows that the candidates who scored 3.0 to 7.0 marks, managed to distinguish normal salts from acidic salts based on the methods of preparation. They also gave four correct uses of salt in daily life such as in controlling soil pH and preservation of foods. For instance, one candidate wrote that ammonium chloride is used as an electrolyte in dry cells. The correct answers given by the candidates indicated that they had sufficient knowledge on salts. Extract 4.1 shows an example of correct responses.

4a)	Normal salt	Acidic Salt
	- Is a type of salt which is formed when hydrogen ion are replaced by metal or ammonium ion	- Is a type of salt which is formed when part of hydrogen ion are replaced by metal or ammonium ion
4b)	i) It is used as fertilizer ii) It increase Food Flavour iii) It is used in softening hard water iv) It is used in hospital for joining broken bones	

Extract 4.1: An example of good responses in question 4.

In Extract 4.1, the candidate distinguished correctly the normal salts from acidic salts basing on their methods of preparation, despite the grammatical errors. The candidate also gave four correct uses of salt in daily life.

On the other hand, candidates who scored low marks were unable to differentiate normal salts from acidic salts based on the methods of preparation. In part (a) for instance, one candidate wrote; *normal salt is the salt with all water removed while acidic salt is the one which contain water of crystallization*. The statement shows that the candidate had a misconception that water of cystallization makes a particular salt acidic. Similarly, some of the candidates incorrectly regarded normal salts as the common salt. For instance, a candidate wrote that; *the normal salt can be used when cooking while the acidic you can not use it for cooking because it have chemical which can lead to problem of health of man or woman*. Such responses indicated that the candidates had insufficient knowledge about normal and acidic salts.

In part (b), the candidates gave incorrect responses on the uses of salts in daily life. For example, one candidate wrote that salt is *used in making food* instead of being used to preserve food and adding food taste. Another candidate wrote that salt is *used to make soil* instead of specifying that salts are used as fertilizers to improve soil fertility. The incorrect responses

given by the candidates implied that, they had inadequate knowledge on the concept of salts. Extract 4.2 indicates a sample of poor responses.

4	(a) normal salt - is the type of salt who are used in biological experiment <del>who</del> in the laboratory while <del>basic</del> acidic salt - is the type of salt who are by human in the vegetable (green vegetable and all vegetables used in home)
	b) i) used in biological experiment in the laboratory
	ii) used in <del>some</del> for people who dead <del>under</del> death
	iii) used in home
	iv) used to helps the person in cutting for some parts of the body

Extract 4.2: An example of poor responses in question 4.

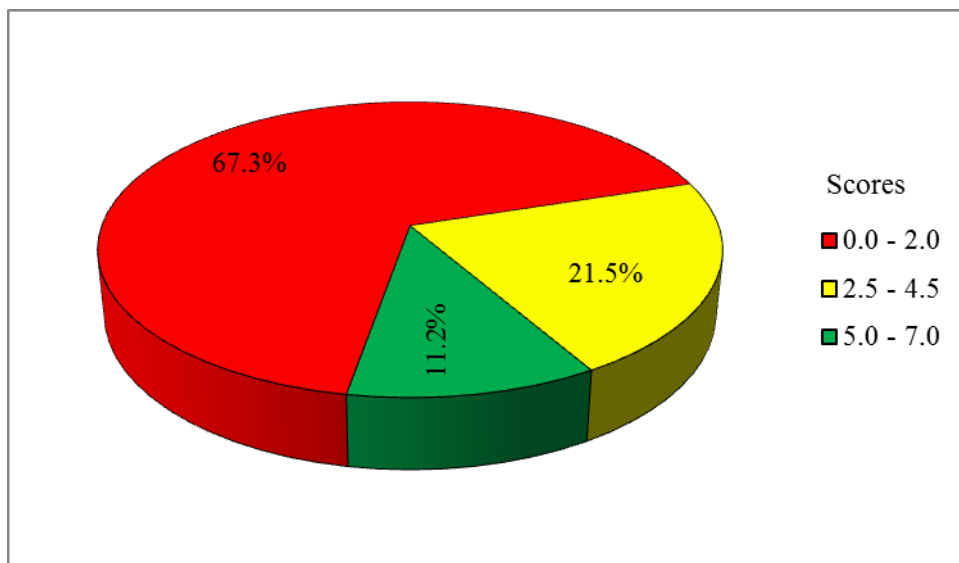
In Extract 4.2 part (a), the candidate differentiated incorrectly, the salts in connection with performance 'biological experiment' and usage in 'green vegetables'. In part (b), the responses given were incorrect and had grammatical errors.

### 2.2.3 Question 5: Hardness of Water

The question consisted of two parts (a) and (b). In part (a), the candidates were required to distinguish temporary from permanent hardness of water. In part (b), the candidates were required to explain how to remove temporary and permanent hardness of water with the help of chemical equations.

Statistics show that, 157,481 (96.1%) candidates attempted this question, out of which 11.2% scored 5.0 to 7.0 marks with 5.2% scoring full marks. Candidates who scored 2.5 to 4.5 marks were 21.5% while those who scored 0 to 2.0 marks were 67.3%. Generally, the performance was average

as 32.7% of the candidates scored 2.5 marks and above. Figure 5 summarizes the performance in question 5.



**Figure 5:** *Performance of the candidates in question 5.*

Analysis of the candidates' responses showed that, those who performed well in this question managed to distinguish between temporary hardness from permanent hardness of water. They wrote answers like; temporary hardness of water can be removed by boiling which is not the case for permanent hardness of water. They also explained correctly how to remove each type of hardness of water with the help of balanced chemical equations. This indicated that those candidates were conversant with the causes and means of removing the hardness of water. Extract 5.1 shows good responses from one of the candidates.



5:	<p>① Temporary hardness of water is the hardness of water which can be removed by boiling and its caused by hydrogen carbonates of calcium or magnesium, WHILE, Permanent hardness of water is the hardness of water which can not be removed by boiling and its caused by sulphates of calcium and magnesium.</p> <p>② (i) Temporary hardness of water can be removed by boiling.</p> $\text{Ca}(\text{HCO}_3)_2(\text{aq}) \xrightarrow{\Delta} \text{CaCO}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ <p>(ii) Permanent hardness of water can be removed by addition of washing soda.</p> $\text{CaSO}_4(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{CaCO}_3(\text{s}) + \text{Na}_2\text{SO}_4(\text{aq})$
----	--

Extract 5.1: An example of good responses in question 5.

In Extract 5.1, the candidate distinguished correctly, temporary from permanent hardness of water and gave ways of removing hardness of water, while supporting the explanations with the help of chemical equations.

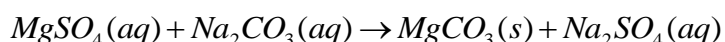
On the other hand, some candidates failed to distinguish between temporary and permanent hardness of water in part (a). For example, one candidate responded; *Temporary hardness it is removed by add soap and permanent hardness it does not form lather of the soap*. Apart from the grammatical errors, this response is not correct with respect to the concept of hardness of water. In part (b), most of the candidates gave incorrect responses regarding the removal of temporary and permanent hardness of water. For example, one candidate wrote; *temporary hardness of water- this is the type of hardness water which is remove by chemical in the dail life*. Similarly, another candidate wrote that *permanent hardness of water can be removed by heating the vessel in use*. Such incorrect responses indicated poor English language proficiency. In some cases, few candidates gave either

incomplete or inappropriate chemical equations in this part. For example, in an attempt to explain the softening of hard water by using washing soda, one candidate gave the following chemical equation:



In the chemical equation, the reactant and products were not correct.

The correct equation was supposed to be;



Further examples of inappropriate chemical equations provided by candidates were  $\text{Ca}(\text{OH})_{2(aq)} \rightarrow \text{CaO} + \text{H}_2\text{O}_{(l)}$  and  $\text{Mgco}_{3aq} \rightarrow \text{Mgo} + \text{co}_{2g}$

The incorrect chemical equations written by the candidates implied that they had inadequate knowledge in writing chemical equations. Extract 5.2 illustrates one of the incorrect responses.

5.	a)
	Temporary hardness of water.
	Is the temporary water which can help to dissolve in many soap to form <sup>temporary</sup> <del>different</del> That water is need to boiled to dissolved so when we used the temporary hardness of water without boiling it can not to use the many soap for other than permanent water.
	Permanent hardness of water.
	Is the water which does not increase any substance like boiled that water is the soft water does not increase any temperature or heat to form the <del>reference</del> . It can combine the <del>so</del> Sodium Calcium Magnesium <del>etc</del> and also so that water are the soft water which many people are used because it does not deal any substance but it need few soap to form <del>reference</del> .

5	(b)
	by starting with temporary hardness of water
	Equation:
	$\text{Na}_2\text{SO}_4 + \text{MgCl} \rightarrow \text{NaCl} + \text{MgSO}_4$
	That are the first equation
	$\text{CaCl} + \text{MgOH} \rightarrow \text{CaOH} + \text{MgCl}$
	That are the second equation of temporary
	hardness of water.
	by complete with permanent hardness of water.
	$\text{CaCl} + \text{MgOH} \rightarrow \text{CaOH} + \text{MgCl}$
	First equation of the permanent hardness of
	water.

Extract 5.2: An example of poor responses in question 5.

In Extract 5.2 part (a), the candidate gave incorrect explanations for each of the two types of hardness of water. Likewise, the candidate gave inappropriate chemical equations in part (b).

## 2.2.4 Question 6: Chemical Kinetics, Equilibrium and Energetics.

This question comprised parts (a) and (b). Candidates were provided with the equation for contact process at equilibrium as follows:

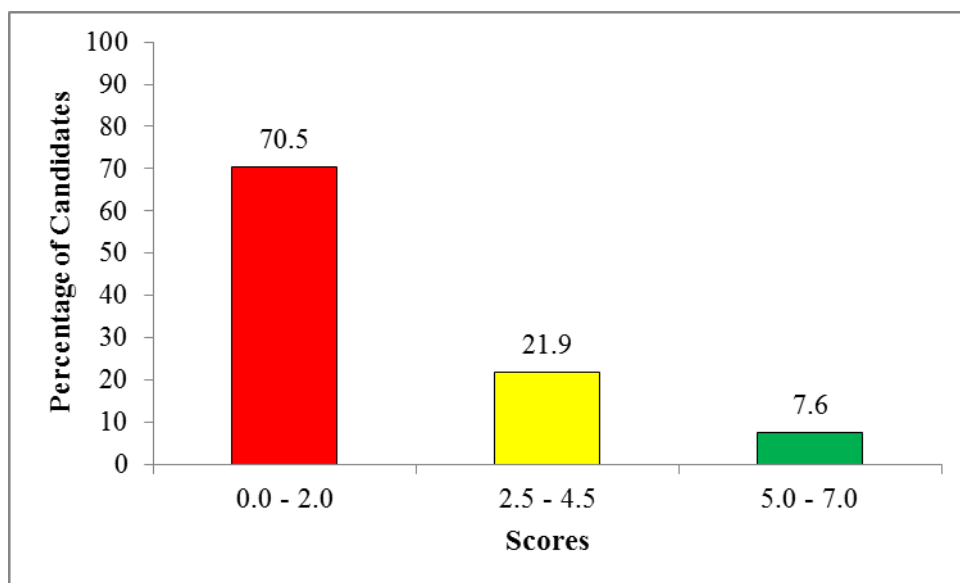


In part (a) (i), the candidates were required to justify whether the forward reaction is an exothermic or endothermic reaction. In part (a) (ii), they were required to explain the suitable adjustment of temperature and pressure in order to maximize the proportion of the product.

In part (b) (i), the candidates were required to explain the possible defect of subjecting the contact process into very high pressure and very low

temperature. In the last item, (b) (ii), the candidates were required to name the catalyst used to speed up the rate of formation of sulphur trioxide before attaining the equilibrium.

The question was attempted by 147,961 (90.3%) candidates of which 70.5% scored 0 to 2.0 marks, 21.9% scored 2.5 to 4.5 marks and 7.6% scored 5.0 to 7.0 marks. Generally, the performance in this question was poor as only 29.5% of the candidates scored 3.0 marks and above. Figure 6 shows the distribution of candidates' scores in question 6.



**Figure 6:** Performance of the candidates in question 6.

The candidates who scored 0 to 2.0 marks were not able to produce the correct responses to fulfill the requirement of the question. In part (a) (i) for instance, some of the candidates failed to justify that the forward reaction is an exothermic process. In answering the question, one candidate incorrectly wrote, *Endothermic reaction, because the endothermic reaction it absorb the heat from the surrounding*. This candidate was not aware that the negative value of enthalpy change designates an exothermic reaction rather than endothermic one. Other candidates identified the reaction as exothermic process, but they failed to give logical justification. For example one candidate wrote; *The reaction is exothermic because in the exothermic the reaction is forward and backward reaction due to reversible reaction*. This candidate could not interpret the role of the negative sign in the enthalpy change.

In part (a) (ii), some of the candidates failed to explain the way to adjust temperature and pressure in order to maximize the proportion of the product at equilibrium. For example, one candidate wrongly explained that; *when temperature increase from the product the reaction will favour backward; when the pressure increase there are no effect*. This candidate was unaware that decreasing the temperature and increasing the pressure could increase the yield of the product simply because the reactants will collide much often to form the products. In part (b) (i), candidates' responses show that most of them did not understand the demand of the question as they gave responses contrary to the expected ones. For instance, one candidate wrote: *Very high pressure and very low temperature favour the contact process because it led to the formation of the sulphuric acid*. Another candidate responded by writing; *Because contact process is the manufacturing industry of sulphuric acid*.

In part (b) (ii), some candidates mentioned other chemical substances apart from the usual catalyst, which is vanadium pentoxide ( $V_2O_5$ ). An example was from a candidate who mentioned potassium permanganate. Yet another candidate cited incorrectly, iron manganese(IV) oxide. These incorrect responses given indicated that those candidates had inadequate knowledge about the contact process. Extract 6.1 shows a sample of poor responses.

6	a. (i) It is endothermic process because it is oxidation reaction.
	(ii) In temperature when it increase it would be equilibrium when to remain constant and also in pressure must remain constant and the use of catalyst.
	b. (i) Because our body is depending on the equilibrium of temperature and pressure.

Extract 6.1: An example of poor responses in question 6.

In extract 6.1, the candidate named the forward reaction as an endothermic instead of exothermic, and gave inappropriate adjustment of temperature and pressure. Lastly, the candidate gave a reason instead of naming the catalyst required in the contact process.

On the contrary, some candidates managed to identify the forward reaction as an exothermic. They explained the strategy of decreasing temperature and increasing pressure to maximize the yield of sulphur trioxide at equilibrium. Some of them managed to state the disadvantages of subjecting the contact process to high pressure and low temperature. Similarly, the candidates identified the appropriate catalyst which is vanadium pentoxide. Extract 6.2 portrays an example of good responses from one of the candidates.

6.	a) i) Forward reaction is exothermic due to negative heat change. This means the reaction liberate heat energy to the surroundings.
	ii) - I will decrease the temperature so as to increase the production of $\text{SO}_3$ . This is because decrease in temperature will cause forward reaction to be dominant. All this is because the reaction is exothermic.

6.	a) ii) - I will increase the pressure so as to maximize proportions of product. This is because increase in pressure favours the reaction forming fewer molecules. Hence, due to increase in pressure, forward reaction will be favoured.
	b) i) It is because using very high pressure is very expensive. Also, using low temperature will cause the reaction to take a long period of time.
	ii) Catalyst used is Vanadium Pentoxide ( $\text{V}_2\text{O}_5$ ).

Extract 6.2: An example of good responses in question 6.

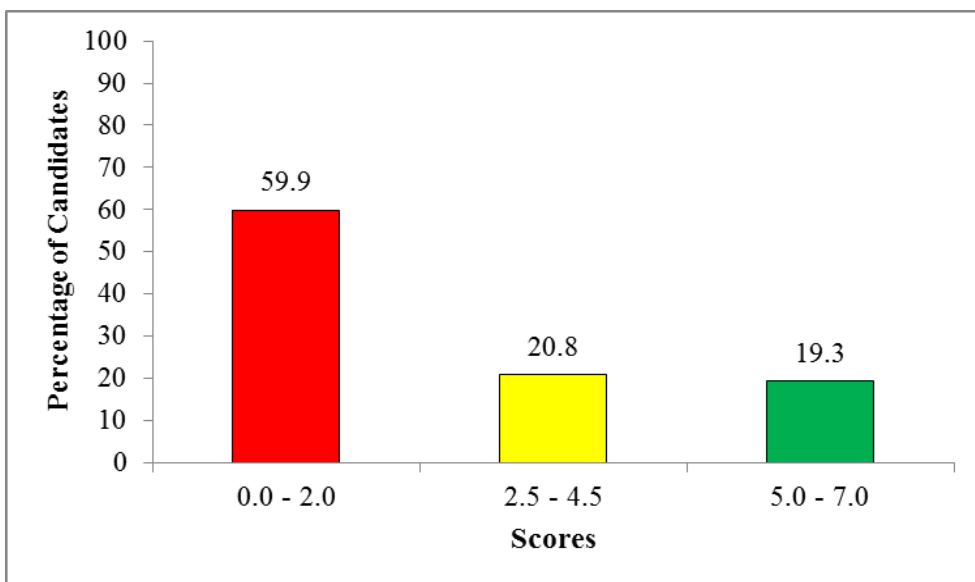
In Extract 6.2 part (a), the candidate identified correctly the forward reaction as exothermic with appropriate justification. The candidate also explained how temperature and pressure can be adjusted to maximize the proportion of the products in the equilibrium mixture. In part (b), the candidate gave

correct impact of applying with high pressure and low temperature; and named the catalyst required in the contact process.

### 2.2.5 Question 7: Formula, Bonding and Nomenclature

The question consisted of two parts (a) and (b). In the stem of the question, the candidates were provided with the information about an atom of element X (having atomic number 11) combining with an atom of element Y (having atomic number 9) to form a compound. Part (a) required the candidates to write the formula of the compound formed and state the type of bond formed in it. In part (b), the candidates were required to give four properties of the compound represented in part (a).

The question was attempted by 153,359 (93.6%) candidates of whom 59.9% scored 0 to 2.0 marks, 20.8% scored 2.5 to 4.5 marks and those who scored from 5.0 to 7.0 marks were 19.3%. The general performance in this question was average as 40.1% of the candidates scored 2.5 marks and above. Summary of candidates' performance is represented in Figure 7.



**Figure 7:** *Performance of candidates in question 7.*

Candidates who scored high marks, wrote the correct formula of the compound XY and stated correctly the type of bond as an ionic. The

candidates also gave four correct properties of the compound XY. This indicated that the candidates had adequate knowledge on the concept of chemical bonding. Extract 7.1 shows a sample of good responses.

7.	a) XY
	Bond - ionic bond, the bond that is formed due to transfer of electrons from a metal to a non-metal which is more electronegative.
	b) i) It is soluble in water and insoluble in organic solvents.
	ii) It has high melting and boiling point.
	iii) It is a good conductor of electricity when in molten or in aqueous state.
	iv) It exists as a solid or in crystalline form.

Extract 7.1: An example of good responses in question 7.

In Extract 7.1, the candidate wrote correctly the formula XY for the compound formed and named the bond as ionic (electrovalent). The candidate also gave four correct properties of the compound XY.

On the other hand, the candidates who scored low marks were unable to identify the type of bond formed between elements X and Y in part (a). For instance, one candidate incorrectly stated that, *the type of bond formed is Covalent bond due to the sharing of electrons*. This candidate was unaware that compound XY should have an ionic bond which is formed by transfer of electrons. Correspondingly, there were cases in which some few candidates defined bond instead of specifying the type of bond present. For instance, one candidate defined covalent bond as *the type of chemical bond where share the element in electrochemical series*.

In part (b), most of the candidates did not manage to write the correct properties of the compound XY as some of them wrote partially while giving answers which did not address the requirement of the question. For instance, there were candidates who wrote that compound XY (NaF) conducts electricity. However, they failed to specify that the compound should be in molten form or aqueous state. Moreover, some candidates gave properties of mixtures, an indication that they misunderstood the



question. For example, one candidate wrote that *the substance can be split into its parts via physical means*. Poor performance of the candidates was attributed to inadequate knowledge on the concept of chemical bonding. Extract 7.2 illustrates one of the poor responses.

7	a)
	"The element X having atomic number 11 is Nitrogen and element Y having a atomic number 9 is Fluorine
	a) the formula of the compound and state the type of bond formed in the compound is
7	b)
	The properties of compound formed
	→ i) in the laboratory
	ii) in hospital
	iii) in the industries
	iv) it formed at home

Extract 7.2: An example of poor responses in question 7.

In Extract 7.2, the candidate named incorrectly the elements as nitrogen and fluorine, instead of giving the type of bond and the formula of compound XY. In part (b), the candidate wrote the application of the compound XY instead of giving its properties.

### 2.2.6 Question 8: Non-metals and Their Compounds

This question consisted of parts (i), (ii), (iii) and (iv). The candidates were required to explain the following facts with the aid of balanced chemical equations:

- Sulphur dioxide in solution is a powerful reducing agent.
- Sulphur dioxide in solution acts as a bleaching agent.
- Sulphur dioxide can reduce chlorine and itself become oxidized.
- When hydrogen sulphide is passed through sulphur dioxide gas, yellow deposits are produced.

This question was attempted by 111,907 (68.3%) candidates, out of whom 99.3% scored 0 to 2.0 marks, 0.4% scored 2.5 to 4.5 marks and only 0.3% scored 5.0 to 7.0 marks. Candidates who scored 3.0 marks and above were 93.0% with 0.7% scoring a zero mark. This indicates that the general performance in this question was poor. Summary of candidates' performance is shown in Table 2.

Table 3: Performance of candidates in question 8.

Scores (Marks)	0 – 2.0	2.5 - 4.5	5.0 – 7.0
Percentage of Candidates	99.3	0.4	0.3

Analysis of the responses shows that most candidates scored low marks as they failed to explain the asked concepts. They also failed to use balanced chemical equations in the respective concepts. Some of them gave partial answers while others gave vague explanations. For instance, one candidate responded to item (i) by writing: *in the solution sulphur dioxide releases its sulphur faster than oxygen*. In item (ii), most of the candidates could not account for the bleaching property of sulphur dioxide when in solution. An example was from a candidate who wrote; *sulphur in solution it act as a bleaching agent,because it can dissociate*.

Similarly, the majority of candidates responded incorrectly to items (iii) and (iv). In most cases, chemical equations were not included in their responses. The main reason for the poor performance was the lack of appropriate knowledge about properties of compounds of non-metals. Extract 8.1 depicts a sample of poor responses.

08. TO EXPLAIN:

i) Sulphur dioxide when in solution form has the reducing agent power.

This is whereby when it is in solution it has / have high ability to break bond and reduce the others due to its reducing power.

ii) Sulphur dioxide in solution acts as a bleaching agent.

This is because when the sulphur is in liquid form it is soluble / it is applicable in many things and thus it bleaches different things / objects.

iii) Sulphur dioxide can reduce chlorine and itself becomes oxidized.

Sulphur dioxide can reduce chlorine because chlorine doesn't have the reducing power while sulphur dioxide has the reducing power. Moreover chlorine gas has the highest oxidizing power.

iv) When hydrogen sulphide is passed through sulphur dioxide gas, yellow deposits are produced.

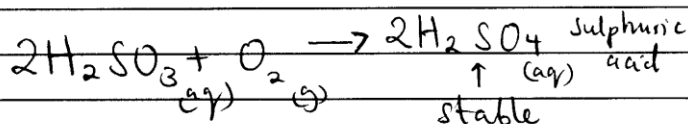
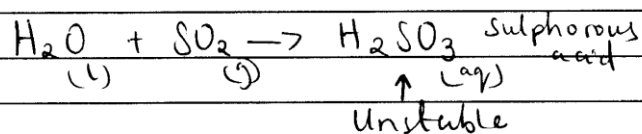
08	iv)
	The yellow deposits are produced
	because sulphur dioxide acts as the
	bleaching agent.

Extract 8.1: An example of poor responses in question 8.

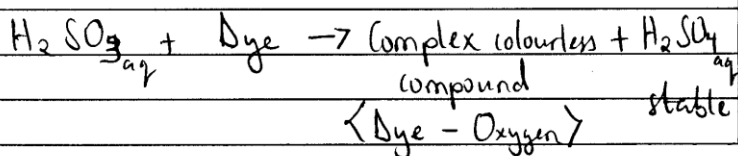
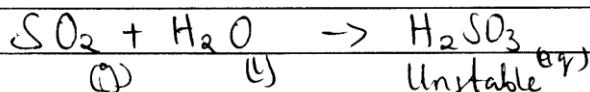
In Extract 8.1, the candidate gave incorrect explanations and did not write any chemical equation.

On the contrary, the few candidates who managed to give correct responses accounted clearly for the scientific facts in (i) – (iv) with the aid of balanced chemical equations. A sample of good responses is shown in Extract 8.2.

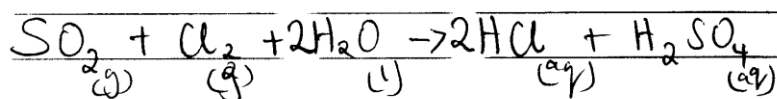
8. i) Sulphur dioxide in water forms Sulphurous acid which is very unstable and reduces other elements itself being oxidized to Sulphuric acid



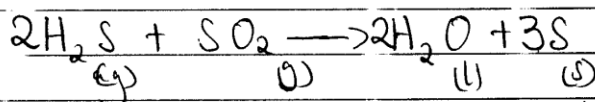
8 ii) When Sulphur dioxide dissolves in water it forms Sulphurous acid which is very unstable and it removes oxygen from dye material thus bleaching it itself being oxidized to Sulphuric acid.



8. (ii) Sulphur dioxide with halogenated water like chlorine water forms an acid and Sulphuric acid. It lowers the oxidation state of chlorine gas from zero to negative one in hydrochloric acid and itself oxidized to sulphuric acid



8. iv) Sulphur dioxide oxidises hydrogen sulphide gas to water and itself is reduced to Sulphur which are yellow deposits. This reaction takes place in presence of moisture as a catalyst.



yellow  
deposits

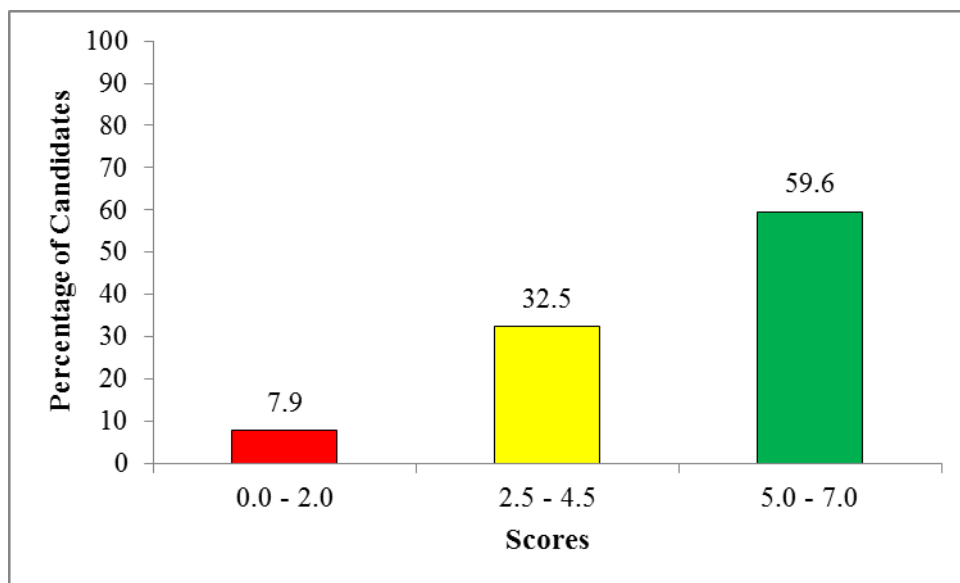
Extract 8.2: An example of good responses in question 8.

In Extract 8.2, the candidate gave correct explanations in all parts of the question being supported with chemical equations.

### 2.2.7 Question 9: Matter

The question consisted of parts (a) and (b). Part (a) required the candidates to write the chemical symbols for beryllium, boron, neon, nitrogen and phosphorus. Part (b) required candidates to account for the fact that some of the elements are assigned symbols with only one letter while others bear symbols having two letters.

The analysis of candidates' performance shows that the question was attempted by 160,167 (97.8%) candidates. Candidates who scored 0 to 2.0 marks were 7.9%, those who scored 2.5 to 4.5 marks were 32.5% and 59.6% scored 5.0 to 7.0 marks. Thus, the general performance of the candidates in this question was good as 92.1% scored 2.5 marks and above. Statistics of performance are summarized in Figure 8.



**Figure 8:** *Performance of candidates in question 9.*

The candidates who scored high marks were able to write the chemical symbols for beryllium, boron, neon, nitrogen and phosphorus which are Be, B, Ne, N and P, respectively. They also clearly explained the reason some elements are assigned symbols with only one letter while others bear symbols with two letters. For instance, one candidate wrote that it is done to avoid two or more elements having the same chemical symbol. This is because there are elements which have the same first letter such as beryllium and boron. Extract 9.1 illustrates a sample of good responses in this question.

09.	a) The chemical symbols are:
	i) Beryllium - <u>Be</u>
	ii) Boron - <u>B</u>
	iii) Neon - <u>Ne</u>
	iv) Nitrogen - <u>N</u>
	v) Phosphorus - <u>P</u>
09	b) Some symbols are assigned with a single letter since they were considered as the English names that use the first letter in naming them.
	<u>While</u>
	Others are bearing two letters so as to easily differentiate them from the ones which have equal beginning letters.
	Example Beryllium and Boron, Neon and Nitrogen.

Extract 9.1: An example of good responses in question 9.

Extract 9.1 shows responses given by a candidate who wrote correct symbols of the elements in part (a) and gave appropriate justification for the difference in assigning chemical symbols to elements.

On the other hand, the candidates who scored 0 to 2 marks failed to write the chemical symbols for the given elements in part (a). The common misconception to most candidates in this part was writing the first letter of the chemical symbols in lowercase. For instance, one candidate wrote b, n, n and p for boron, neon, nitrogen and phosphorus respectively. This implied that the candidate had insufficient knowledge on the concept of chemical symbols.

In part (b), some of the candidates gave incorrect explanations regarding assigning chemical symbols. For example, one candidate explained that; *those bearing one letter is because of one atom and if two atoms are present two letters are used*. In a similar case, another candidate wrote that *small atoms have one letter and big atoms are given two letters*. Further



analysis of the candidates' responses showed that some of them skipped the question. Generally, the candidates had inadequate knowledge on the chemical symbols of elements. Extract 9.2 illustrates a sample of poor responses.

QNS		
9(a)	$\text{Be} + \text{b} + \text{m} \text{ NO}_2 \rightarrow \text{phosphorus}$	
	(b) Some Some Element Assign Symbol with	
	with only letter because of Element substance	
	which consist of two or more element combined	
	together.	

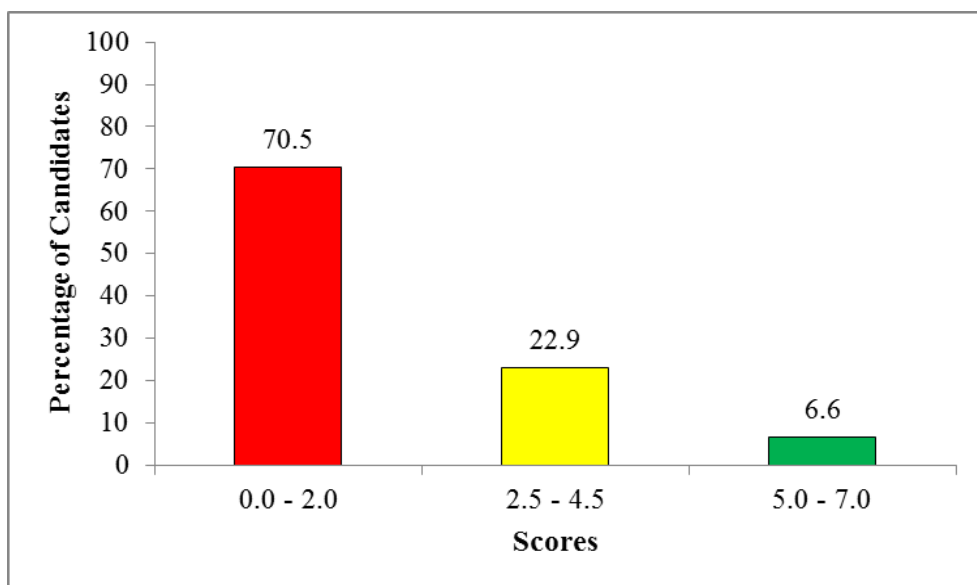
Extract 9.2: An example of poor responses in question 9.

In Extract 9.2, the candidate wrote an incorrect chemical reaction instead of chemical symbols in part (a). In part (b), the candidate gave a wrong reason on why some elements are assigned one or two letters while writing their chemical symbols.

## 2.2.8 Question 10: Formula, Bonding and Nomenclature

Question 10 was comprised of parts (a) and (b). In part (a), the candidates were required to give three advantages of using chemical equations over word equations. In part (b), they were required to calculate the molecular formula of a compound composed by 22.2% zinc, 11.6% sulphur, 22.3% oxygen and the rest percentage being water of crystallization. The molecular mass of the compound was given as 283.

The question was attempted by 159,452 (97.3%) candidates, out of whom 70.5% scored 0 to 2.0 marks, 22.9% scored 2.5 to 4.5 marks and 6.6% scored 5.0 to 7.0 marks. The candidates who scored 2.5 marks and above were only 29.5% implying that the performance was poor. Figure 9 shows the summary of performance in question 10.



**Figure 9:** Performance of candidates in question 10.

In part (a), candidates who failed to give correct responses to most part of the question, wrote statements which did not satisfy the demand of the question. For example, one candidate wrote the following statements; (i) *it help to form double reaction of compounds* (ii) *it helps to produce simpler substance of the element.* (iii) *it help to form reactant and product.* Those statements suggest that the candidate understood the requirement of the question but had inadequate knowledge concerning chemical equations. Other candidates wrote irrelevant responses, which implied guessing. For instance, one candidate wrote (i) *the equation is understood well to the people.* (ii) *it is simple equation* (iii) *it does so accurate to other equations.* The required advantages of chemical equations over word equations include (i) *All types of atoms involved are shown in the equation* (ii) *States of reactants and products are normally shown* (iii) *The atoms present can be balanced.*

Similarly, part (b) was poorly attempted by most of the candidates. Some of them failed to compute the percentage of the water of crystallization at the initial stage of calculating the molecular formula of hydrated zinc sulphate. Others, hardly wrote the percentages for each element without moving to further steps of calculation. There were also candidates who incorrectly dealt with zinc, sulphur and oxygen without considering the water of

crystallization in the calculation. The failure of candidates in this question was mainly due to poor mathematical skills. Extract 10.1 shows a sample of poor responses given by one of the candidates.

10a%	10a% is manufacture of margarine is manufacture of industries. is manufacture of ammonia.			
10b%	%percentage	Zn	S	O
	%percentage	22.2%	11.6%	22.3%
	impure	65%	32%	16%
	water of Cryst allization.	34	317.5	134.5
		34	34	34
	%percentage	= 1	= 933	= 43.5
		1	9.33	43.5.
	<u>Zn<sub>1</sub>S<sub>9</sub>O<sub>4</sub></u>			
	Calculate the molecular formular of the molecular mass. is 283.			
	Zn <sub>1</sub> S <sub>9</sub> O <sub>4</sub> = Molecular mass is 283.			
	(64x1) (32x9) (16x4) = 283			
	64 + 288 + 64 = = 283			
	352 + 64 = 283			
	<u>416</u> = <u>283</u> =			
	283 283			
	= 11.1 Molecular mass:			

Extract 10.1: An example of poor responses in question 10.

In Extract 10.1 part (a), the candidate gave uses of hydrogen gas instead of the advantages of using chemical over word equations. In part (b), the candidate used wrong mathematical procedures to calculate the percentage composition of the compound.

Candidates who managed to give correct responses wrote at least three advantages of using chemical equations over word equations. They also calculated the molecular formula of the compound using correct mathematical procedures. Generally, those candidates had appropriate knowledge on how to write chemical formula. Extract 10.2 shows a sample of good responses.

10 (a)	- Help us to determine relative quantities of substances used in a reaction.
	- Help us to determine states of the substances in the reaction (i.e. either solid, aqueous or gas or liquid)

- Help us to balance the chemical equation					
$\% \text{ of H}_2\text{O} = 100 - 56.1 = 43.9$					
(b)	ELEMENTS	Zn	S	O	H <sub>2</sub> O
	% comp	22.2	11.6	22.3	43.9
	RAM	65	32	16	18
	% comp/RAM	22.2	11.6	22.3	43.9
		65	32	16	18
		0.342	0.363	1.394	2.439
		0.342	0.342	0.342	0.342
		1	1	4	7
Empirical formula is $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$					
from $\text{ef} = n(\text{sum of RAM})$					
molecular mass = $n(\text{sum of RAM})$					
$283 = n(65 + 32 + (4 \times 16) + (7 \times 18))$					
$283 = n(287)$					
$n \approx 1$					
from $\text{mf} = n \times \text{ef}$					
$\text{mf} = 1 \times (\text{ZnSO}_4 \cdot 7\text{H}_2\text{O})$					
$\therefore$ Molecular formula is $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$					

Extract 10.2: An example of good responses in question 10.

Extract 10.2 is a sample of responses from a candidate who correctly gave three advantages of using chemical equations over word equations. Also, the candidate calculated correctly the molecular formula of the compound.

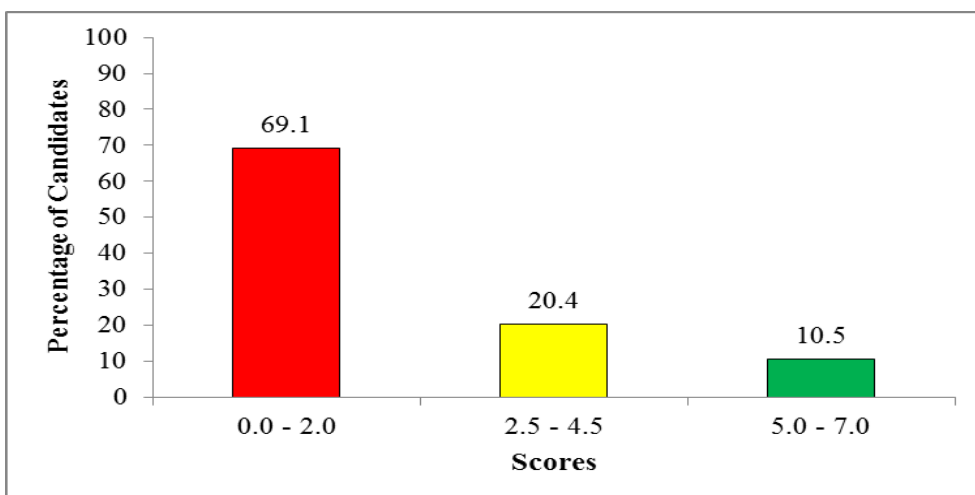
### 2.2.9 Question 11: Chemical Equations

The question appeared as follows: *A form three student conducted experiments in the laboratory to synthesize nitrogen, ammonia and ethane. The experimental results were tabulated as follows.*

<i>Experiment</i>	<i>Reagents</i>	<i>Conditions</i>	<i>Products</i>
1	Lead nitrate	Heat	Lead oxide, oxygen gas and nitrogen gas
2	Gaseous hydrogen and gaseous nitrogen	Catalyst	Ammonia gas
3	Ethene gas and hydrogen gas	Catalyst	Ethane

The candidates were required to write word equations and their corresponding chemical equations to summarize the reactions taking place in each of the experiments 1 to 3.

The analysis of candidates' performance shows that, this question was attempted by 136,811 (83.5%) candidates in which 69.1% scored 0 to 2.0 marks, 20.4% scored 2.5 to 4.5 marks and 10.5% scored 5.0 to 7.0 marks. The general performance was average as 30.9% of the candidates scored 2.5 marks or above. Summary of candidates' performance is shown in Figure 10.



**Figure 10:** Performance of candidates in question 11.

Candidates who scored high marks wrote correctly, the word equations with their corresponding chemical equations for the reactions taking place in experiments 1 to 3. Those candidates had adequate skills of writing both word and chemical equations. Extract 11.1 shows a sample of correct responses to this question.

11.	Experiment 1:
	Lead Nitrate $\xrightarrow{\Delta}$ Lead Oxide + Oxygen gas + Nitrogen gas.
	$2\text{Pb}(\text{NO}_3)_2 (\text{s}) \xrightarrow{\Delta} 2\text{PbO} (\text{s}) + \text{O}_2 (\text{g}) + 4\text{NO}_2 (\text{g})$
	Experiment 2:
	Nitrogen gas + Hydrogen gas $\xrightarrow{\text{catalyst}}$ Ammonia gas.
	$\text{N}_2 (\text{g}) + 3\text{H}_2 (\text{g}) \xrightarrow{\text{catalyst}} 2\text{NH}_3 (\text{g})$
	Experiment 3:
	Ethane gas + Hydrogen gas $\xrightarrow{\text{catalyst}}$ Ethane.
	$\text{C}_2\text{H}_4 (\text{g}) + \text{H}_2 (\text{g}) \xrightarrow{\text{catalyst}} \text{C}_2\text{H}_6 (\text{g})$

Extract 11.1: An example of good responses in question 11.

Extract 11.1 is a sample of a response of a candidate who wrote correctly both equations for experiment 1, 2 and 3.

On the other hand, the candidates who scored low marks failed to write the correct word equations and chemical equations for experiments 1, 2 and 3. Some of the candidates wrote statements with no proper meaning, instead of chemical equations. For example, one candidate wrote; (i) *lead nitrate passed through heat to produce lead oxide, oxygen gas and nitrogen gas.* (ii) *Gaseous hydrogen react to gaseous nitrogen under a catalyst to produce ammonia gas* (iii) *Ethene gas react to hydrogen gas under a catalyst and formed Ethane.* Such responses gave a reflection that the candidate had inadequate knowledge on formulating chemical equations from word equations. Other candidates wrote inappropriate chemical symbols and state symbols in their chemical equations. For example, one candidate wrote; (i)  $pb \rightarrow pbo + o_2 + H_2$ . (ii)  $H_2N_2 \rightarrow \text{Ammonia}$  (iii)  $CH_2 + H_2 \rightarrow CH_3$ . All the three equations are not correct. The state symbols were not shown as required. The same candidate did not write word equations. In addition, the candidate did not balance the chemical equations. Such responses indicated that the candidates lacked skills in writing both word and chemical equations. Failure of the candidates to write correct equations was attributed to inadequate knowledge on chemical reactions and inadequate skills of writing balanced chemical equations. Extract 11.2 shows a sample of poor responses from one of the candidates.

11	i) Experiment 12
	$H_2 + N_2 \rightleftharpoons NH_3$ (aq)
	ii) Experiment 13
	$CH_2 + H_2 \rightleftharpoons CH_3$
	iii) Experiment 01
	$PbN_2 \xrightarrow{\Delta} PbO + O_2 + N_2$ (aq) (aq)

Extract 11.2: An example of poor responses in question 11.

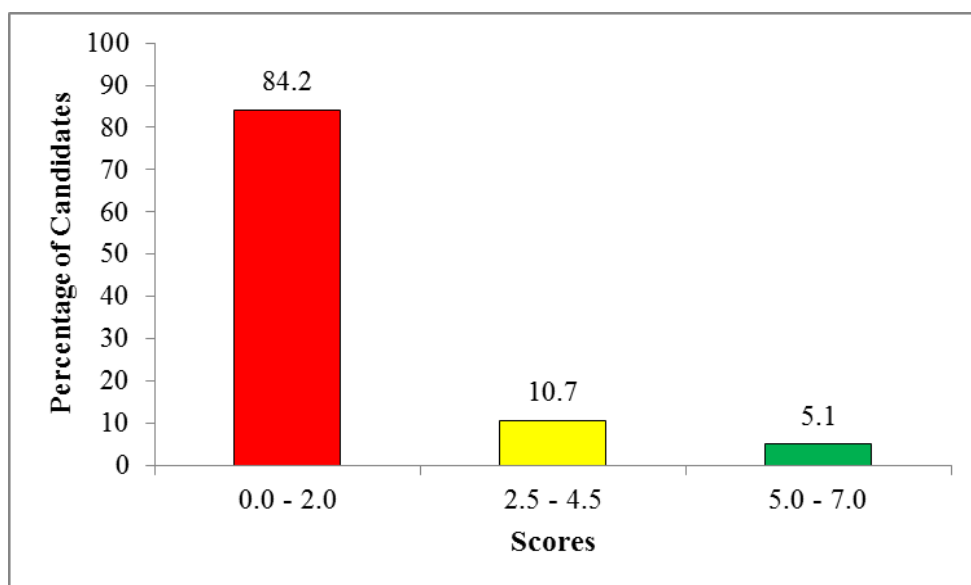
Extract 11.2 is a response from a candidate who gave incorrect chemical equations for experiment 1, 2 and 3.



### 2.2.10 Question 12: Fuels and Energy

The question consisted of parts (a) and (b). Part (a) required the candidates to give four ways in which fossil fuels are detrimental to the environment. In part (b), they were required to explain the production of biogas by using domestic wastes.

The analysis of candidates' performance shows that, this question was attempted by 146,291 (89.3%) candidates in which 84.2% scored 0 to 2.0 marks including 53.5% who scored a zero mark. Those who scored 2.5 to 4.5 marks were 10.7% and 5.1% scored 5.0 to 7.0 marks. The general performance was poor as only 15.8% of the candidates scored 2.5 marks and above. Figure 12 gives summary of the performance of the candidates.



**Figure 12:** Performance of the candidates in question 12.

The candidates who scored low marks failed to explain how the fossil fuels are detrimental to the environment in part (a). For instance, one candidate wrote; (i) *it used to lubricate machine* (ii) *it used for cooking* (iii) *it used to burning waste material* (iv) *Recycling and re-use*. The candidate gave responses pertaining to the uses of fuels, an indication that he/she did not understand the requirement of the question. Others responded by writing the qualities of a good fuel instead of harmful effects of fossil fuels. For

example, one candidate wrote; (i) *Does not poisonous* (ii) *Environmental friendly, example charcoal* (iii) *it is cheap* (iv) *it has high heat content*.

In part (b), some of the candidates gave partial answers while others failed to answer the question completely. Most of them had poor English language proficiency in such a way that their responses were not understood. For example one of the candidates responded that *the biogas was be produced from the fees of the animal such as cow and also biomas produced when humanbeing feces collect and in place that it contain most duty gases from feces of animals*. Generally, the candidates had inadequate knowledge on the mechanism of the biogas plant. Extract 12.1 illustrates a sample of poor responses from one of the candidates.

12.	(a)
	(i) Educated should be provided in important environmental conservation; This means that the people there are used in burning of fossils fuels there affected in environmental conservation.
	(ii) Excessive uses of insecticides and pesticides in the environment; The animals are common excessive uses in the environmental areas.
	(iii) The people should be burning material in the fuels; This means that the people are used fuel in heat and light.
	(iv) The people should be recycled; This means that the people are recycled in waste materials in the fuel and their produce low of ignition point.
	(b)
	(i) Used in cooking food; This means that the biogas are goods of used in cooking food in domestic wastes materials.
	(ii) Used in warming of the body; This means that the people are used biogas in warming of the body and the biogas are used in warming other materials.
	(iii) Used in production materials; This means that the instrument in biogas are used in production materials in domestic wastes.

Extract 12.1: An example of poor responses in question 12.

Extract 12.1 is a sample of a response from a candidate who failed to explain the ways in which fossil fuels are detrimental to the environment and how biogas is produced by using domestic waste.

On the other hand, candidates who scored high marks in this question explained clearly four ways in which fossil fuels are detrimental to the

environment. They also managed to explain briefly the production of biogas by using domestic waste. Extract 12.1 illustrates a sample of good responses from one of the candidates.

12	(a) (i) Combustion of fossil fuels release carbon dioxide and sulphur dioxide which pollute the air causing acid rain.
	(ii) where fossil fuels such as coal are mined trees and other plants are cleared thus destructing the environment.
	(iii) Spills of petroleum during mining in the sea destructs marine ecosystem for instance exchange of gas between the water and air.
	(iv) Residues of fossil fuels for instance from petroleum refinery industry once dumped either in water or on land pollutes and affect the environment.
	(b) Domestic waste especially sewage are fermented in a large confined container <sup>(biogas plant)</sup> usually constructed under ground. Upon fermentation the wastes release methane among other traces of gases. Methane is the main component of biogas and it is piped off and stored ready for use.
	When fermentation ceases the waste are taken out and being processed to make fertilizer or else new wastes are then put in the container for <sup>further</sup> production of biogas.

Extract 12.2: An example of good responses in question 12.

In Extract 12.2, the candidate correctly explained four ways in which fossil fuels are detrimental to the environment. The candidate also explained the production of biogas using domestic wastes.

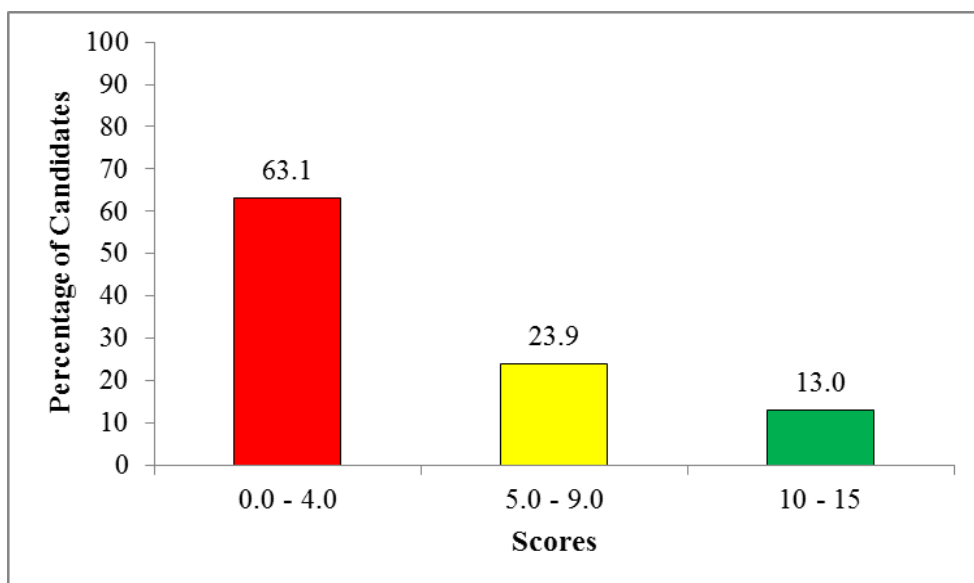
### 2.3 Section C: Essay Questions

This section had two questions carrying fifteen (15) marks each. Candidates were required to answer only one (1) question.

### 2.3.1 Question 13: Laboratory Techniques and Safety

In this question, the candidates were required to explain the handling of chemicals having the warning signs of flammable, corrosive, harmful, explosive and toxic in a laboratory.

The analysis of candidates' performance shows that the question was opted by 73,844 (45.1%) candidates of whom 63.1% scored 0 to 4.0 marks, 23.9% scored 5 to 9 marks and 13% scored 10 to 15 marks. The percentage of candidates who scored 5 marks and above was 36.9% implying that the general performance was average. Figure 12 gives a summary of the performance in this question.



**Figure 12:** *Performance of candidates in question 13.*

The candidates who scored high marks managed to write essays adhering to the requirements of the question. They started by writing an appropriate brief introduction. The main body was presented in paragraphs. Each of the paragraphs explored a specific category of chemicals. Finally, they gave a precise and concise conclusion in the last paragraph. Extract 13.1 shows a sample of good responses in this question.

13.	Chemicals are compounds formed after chemical reactions to take place. Warning signs are precaution signs used to warn the user. In term of chemical warning signs refers to precaution signs to warn the user of a particular chemical. Warning signs are usually labelled on the reagents of a particular chemical. Each chemical have their properties and effects. There are warning signs such as flammable, harmful, corrosive, explosive and toxic as found in laboratories. Each chemical with a warning sign has its way to handle so that to not cause problems. The following are ways to handle chemicals according to their specific warning signs.
	<b>Flammable chemicals:</b> These are chemicals which catch fire easily when brought near with a burning portion. Flammable chemicals should not left open near the burning flame as it evaporate flammable gases. But also should not be brought near the burning flame as it can catch fire easily. Example of flammable chemicals are butane and petrol especially liquidified petroleum gas.
	<b>Corrosive chemicals:</b> the substances that can corrode a surface such as skin and table when comes into contact. When handling such substance put it away from your forehead and wear protective clothes such as gloves to prevent it from coming into contact with a skin. Example of corrosive chemicals are concentrated sulphuric acid and concentrated hydrochloric acids.
	<b>Harmful chemicals:</b> These are substances which can harm the body when enter in the body through any opening for example inhaling harmful gases. These chemicals should be handled by making sure that they can not be taken into the body by means of inhaling, swallowing or coming into contact with open skin. Example of these chemicals are chlorine gas and carbonmonoxide fumes can be prevented using nose masks.

13	<p>Toxic chemicals : Toxic chemicals are substances which can cause death <del>through</del> when taken in the body through mouth. Toxic substances should not be touched by bare hand hence one can bring it into contact with mouth hence when handling it one should use gloves. Example of toxic substance is Jik</p> <p>Explosive chemicals : Are substances which explode when not handled well. Explosive chemicals should be handled with care to prevent them from falling down also should not be kept in glass containers because can easily explode and cause injuries to people due to glass particles.</p> <p>Generally chemical warning signs are very important because they inform users so that one can know on how to handle the equipments well. Therefore people should be aware of warning signs so as to know the effects caused by each warning signs and how they can handle to prevent accidents in the laboratory.</p>
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Extract 13.1: An example of good responses in question 13.

Extract 13.1 is a sample of responses from a candidate who correctly explained how to handle flammable, corrosive, harmful, explosive and toxic chemicals in the laboratory.

However, the candidates who scored low marks in this question failed to write a relevant introduction in relation to the given question. Others sketched diagrams of the warning signs instead of writing an essay. This was attributed to inability to understand the demand of the question. Other candidates wrote vague sentences due to poor English language proficiency. For example, one candidate wrote; *hamful explosive, this is a substance that cause the death, it used in the laboratory*. There were also candidates who presented their work in a disorganized manner and gave inappropriate conclusions. For instance, there was a candidate who wrote that, *therefore students and teachers should be carefully when are in the laboratory so as to help the accidents which are caused by careless of teacher and students*. These incorrect responses indicated that the candidates lacked sufficient knowledge on the topic of *Laboratory*

*Techniques and Safety.* Extract 13.2 shows a sample of poor responses given by one of the candidates.

13	<p>Warning signs - is the signs where by represent when people or person take accident in the laboratory</p> <p>Precaution of touch or smelling Acid, is the situation where by a people or person feel known rule of laboratory event your not chemical of laboratory take effect or problem when of touch or smelling but many people your not literacy rate in the school or village take accident and kill innocent people <del>by the</del> where by accident example people kill innocent people in the accident of car District of Morogoro</p> <p>Your not smoke about <del>flammar</del><sup>gases</sup>, is the situation where by a people of Tanzania your not many educate of known accident of road or event laboratory your smoke about gases take accident or fire in the laboratory or road and ability people of Tanzania your turn of known <del>we</del> go about gases your not used smoke, fire causes of accident and kill people <del>your not</del> innocent in the road or laboratory</p> <p>Take admission for teacher/technical touch thing, is the situation where by many people in the laboratory go to touch Acid or thing where by not known and touch poison where by accident go to eat you not washing your hand therefore ability of kill people of laboratory when touch poison touch another people of laboratory</p> <p>Avoid to mixed chemical/poison, is the situation where by people of school have in the laboratory go to mixer chemical in order to have result take by the mixer experiment but another chemical take poison and ability of causes of accident of fire in the laboratory and kill innocent people of laboratory</p>
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13	<p>Storage fraction clean and safe, is the situation where by teacher or technical staff keep things where by a laboratory cause affect in the people and storage fraction is clean and safe for stored in the laboratory and avoid people cause accident or problem and storage fraction clean and safe is avoid dangerous of people in the laboratory</p> <p>Avoid cause experiment your not instruction and teacher or technical, is the situation where by a people take known and event hearing instruction of teacher or technical in the laboratory in order to take experiment used to chemical, gases in the laboratory but people in the school fail understand rules of laboratory and go to causes of accident in the laboratory</p> <p>Teacher / technical provide instruction before students in the laboratory, is the situation where by people or teacher provide instruction before the laboratory students your not understand teacher / technical cause provide for that punishment for student your not understanding in order to help and accident in the laboratory or kill innocent people of laboratory</p> <p>Teacher / technical better being carefully and students of the laboratory in order to avoid dangerous or accident and ability kill people for one person where by your not understand instruction and death many people in the laboratory</p>
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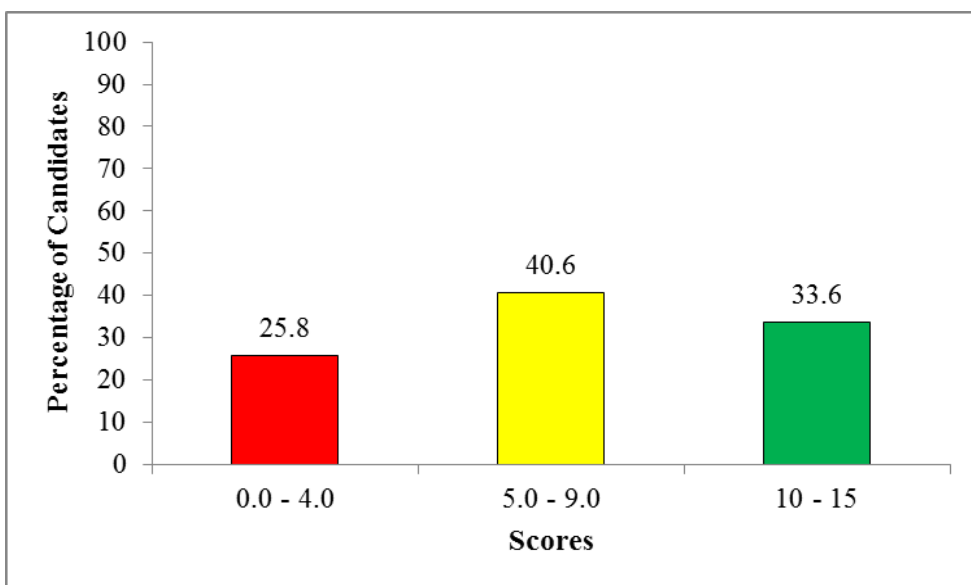
Extract 13.2: An example of poor responses in question 13.

In Extract 13.2, the candidate wrote the laboratory rules instead of explaining the handling of flammable, corrosive, harmful, explosive and toxic chemicals in the laboratory.

### 2.3.2 Question 14: Extraction of Metals

The question required the candidates to explain six measures to minimize the environmental degradation caused by extraction of metals in Tanzania.

The question was opted by 86,138 (52.6%) candidates of which 25.8% scored 0 to 4.0 marks, 40.6% scored 5.0 to 9.0 marks and 33.6% scored 10.0 to 15.0 marks. The percentage of candidates who scored 5.0 marks and above was 74.2% implying that the overall performance was good. Figure 13 gives a summary of the candidates' performance.



**Figure 13:** *Performance of candidates in question 14.*

The candidates who scored high marks in this question managed to write essays that adhere to the demands of the question. They began writing a brief but substantial introduction. They organized the main body into five to seven paragraphs. Finally, they gave relevant conclusions summarizing the whole package about handling of chemicals in the laboratory. Extract 14.1 shows sample of good responses in question 14.

14. Extraction of metals is the obtaining of metals from their ores underground. These metals are extracted by drilling, underground mining to the ores which contain such metals. Example Iron can be extracted from the following ores namely haematite ( $\text{Fe}_2\text{O}_3$ ), Magnetite ( $\text{Fe}_3\text{O}_4$ ) Iron pyrites ( $\text{FeS}_2$ ), Copper can also be extracted from Copper pyrites ( $\text{CuFeS}_2$ ). On the other hand Sodium can be extracted from rock salt like (NaCl) Sodium chloride. In Tanzania, metals are extracted in most regions since there is gold, Tanzanite (Amethyst), among others. The following are the six measures to minimize degradation caused by extraction of metals in Tanzania;

The government should enforce laws and policies to those people who extract minerals without protecting the environment, for example those using bombs, explosives in the extraction of metals. The government should ensure that all activities concerning extraction of metals are carried in areas set for such activities and not anywhere predicted to have such metals.

Creation of public awareness on the importance of the environment by encouraging miners to use proper methods of extraction of metals so as to minimize the degradation of the environment. People should be educated to plant trees whenever they cut trees and also plant trees in areas with no trees so as to avoid soil erosions among a few.

Holes, pits and drills made during extraction of metals should be filled with the soil and rocks so as to avoid soil erosion after the completion of extracting the metals. Holes and pits should not be left unfilled because they may cause death of people, animals (both wild and

14.	domestic animals. This will also prevent water logging which becomes breeding sites of mosquitoes that cause malaria to human beings.
	Employment of new methods of extracting metals from their ores which do not involve the use of bombs and explosives to break the hard rocks so as to reduce the degradation of the environment. The methods to be used in extraction should be those of less effects to the environment such as placer mining methods.
	Regular maintenance and checkups of the machines such as drills, caterpillars, scrapers, lorries and heavy trucks used in mining activities so that they emit less smoke to the environment. The exhaust systems of the machines should be well maintained so that harmful gases or heavy smokes are lowly emitted to the environment.
	Using sustainable sources of energy such as natural gas, water energy, wind energy in activities concerning extraction of metals so as to run heavy machines, trucks among a few. Sustainable energy sources produces little or no smoke to the environment when compared to coal and petrol. This will reduce the degradation of the environment.
	Conclusively, so as to protect the environment from destruction through extraction of metals, people should be educated on the importance of the environment, avoid deforestation, maintenance of the machines regularly and lastly the government should enforce laws and policies so as to curb those who will destruct the environment in one way or another.

Extract 14.1: An example of good responses in question 14.

Extract 14.1 shows responses of a candidate who correctly explained six measures to be taken in order to minimize environmental degradation due to extraction of metals in Tanzania.

Conversely, the candidates who scored low marks in this question failed to write a relevant introduction in relation to the given question. Others switched to responses addressing other topics. For example, some candidates wrote about soil conservation. These candidates discussed points such as, contour farming, overgrazing, monocropping and crop rotation, instead of explaining the measures for minimizing the environmental degradation caused by extraction of metal in Tanzania. This was due to failure to comprehend the demand of the question. Other candidates wrote vague sentences because of poor English language proficiency. Similarly, there were also some candidates who mentioned some points without elaborating them. Others presented their work in a disorganized manner and concluded by mixing unrelated ideas. For example, one candidate wrote that, *those mentioned above are the measures to be taken in order to minimize the extraction of metals in Tanzania. This is present due to misunderstanding of other people so in order to avoid any people should be aware about how to minimize the environmental degradation.* Failure of the candidates to give correct responses indicated that, they lacked adequate knowledge on the effects of extraction of metals to the environment. They also lacked skills of organizing ideas to accomplish an essay. Extract 14.2 shows a sample of poor responses given by one of the candidates.

14.	<p>Environmental degradation, is the transportation of material from one place to another within the surrounding. The following are the measures for minimizing the environmental degradation caused by extraction of metals.</p> <p>In Tanzania those are-</p> <p>Production of education, this means people due to the various human activities within the body.</p> <p>Equal social services, this means that when the people during the society there is an equal social services such as radio, television.</p> <p>To avoid loss of biodiversity. Also due to minimize land environmental degradation there is to avoid loss of biodiversity from one country such as lumbering activities and forestry activities within your body.</p> <p>Raw material for the industries. Also some people due to give about knowledge there is to give raw materials from industries within the various human being within the environmental degradation.</p> <p>Avoid parasite and disease, Also the plant and animal within the society people educated within the body then there is to increasing avoiding the spread of disease within the society.</p>
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14	Avoid knowledge -This means that in the environmental degradation there is to avoid knowledge with in certain phenomena either from one place to another with in the society.
	generally, when the people with your international environment need about knowledge and educated with in the society.

Extract 14.2: An example of poor responses in question 14.

Extract 14.2 is a sample response from a candidate who gave wrong statements as measures for minimizing the environmental degradation caused by extraction of metals in Tanzania.

### 3.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH TOPIC

In CSEE 2019, a total of 18 topics out of 27 topics were examined in Chemistry. The general performance in all the topics was average as 42.2 percent of the candidates scored above the average. Candidates' performance was the highest with 92.1 percent in the topic of Matter which was examined in question nine. Question one which was composed from the topics of *Organic Chemistry; Water; Hydrogen; Fuels and Energy; Matter; Oxygen and Soil Chemistry* was the second highly performed with 82.1 percent. The topic of *Extraction of Metals* also attained good performance with 74.2 percent of candidates who passed.

Candidates' performance was average in six (6) topics which were: *Acids, Bases, and Salts, Scientific Procedures, Laboratory Techniques and Safety, Formula, Bonding and Nomenclature, Hardness of Water and Chemical Equations.*

On the contrary, the topics of *Chemical Kinetics, Equilibrium and Energetics, The Mole Concept and Related Calculations, Pollution and Non-metals and Their Compounds* were poorly performed by the candidates. Summary of the candidates' performance in all topics examined is shown in the appendix.

## 4.0 CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Conclusions

The overall analysis showed that the general performance of the candidates in Chemistry for CSEE 2019 was good as 76.76 percent of the candidates passed. However, the performance of the candidates in some of the topics was weak due to a number of reasons. The following are the factors which caused failure of candidates.

- (a) Inadequate knowledge in various topics as some of the candidates' responses were far from the required answers. There were cases in which candidates skipped some items or gave incomplete answers.
- (b) Inappropriate use of chemical symbols, chemical formulae and inability to write well balanced chemical equations. For instance, some candidates wrote incorrect chemical equations in questions number 5, 8 and 11.
- (c) Poor numerical skills including the wrong manipulation of units in calculations. This was evident in responses given by the candidates to question 3 and 10.
- (d) Poor English language proficiency as shown by some responses from the candidates who failed to convey their ideas.
- (e) Inability to identify the demand of the questions. Some candidates' responses referred to concepts which were different from those asked.
- (f) Lack of individual skills to organize ideas and concepts when giving explanations especially in essay type questions.

### 4.2 Recommendations

In order to improve the performance of the candidates in Chemistry subject, the following suggestions are presented:

- (a) Teachers and school administrators are advised to emphasize English speaking and writing programs in their institutions.
- (b) The topic of *Mole Concept and Related Calculations* should be given a special consideration such as the use of models, wall charts,



pictures and more examples involving calculations being done group wise then individually during teaching and learning process.

- (c) Teachers should regularly make use of teaching aids such as models of molecules and charts showing formulae of reaction equations during teaching various chemistry topics.
- (d) Students should be advised to spend their time to practice writing chemical formulae and balancing chemical equations.
- (e) Students are advised to read questions carefully and understand their demands before attempting them.

## Appendix

### ANALYSIS OF CANDIDATES' PERFORMANCE PER TOPIC

S/N	Topic	Question	Percentage of Candidates who Scored an average of 30 Marks and above	Remarks
1	Matter	9	92.1	Good
2	Organic Chemistry; Water; Hydrogen; Fuels and Energy; Matter; Laboratory techniques and Safety; Oxygen and Soil Chemistry.	1	82.1	Good
3	Extraction of Metals	14	74.2	Good
4	Acids, Bases and Salts	4	58.5	Average
5	The Scientific Procedures	2	42.4	Average
6	Laboratory Techniques and Safety	13	36.9	Average
7	Bonding, Formula and Nomenclature	7 & 10	34.8	Average
8	Hardness of Water	5	32.7	Average
9	Chemical Equations	11	30.9	Average
10	Chemical Kinetics, Equilibrium and Energetics	6	29.5	Weak
11	Mole Concept and Related Calculations	3	18.5	Weak
12	Pollution	12	15.8	Weak
13	Non-metals and Their Compounds	8	0.7	Weak

