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

CANDIDATES' ITEM RESPONSE ANALYSIS REPORT ON THE CERTIFICATE OF SECONDARY EDUCATION EXAMINATION (CSEE) 2021

CHEMISTRY

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032 CHEMISTRY

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FOREWORD

This Candidates' Item Response Analysis Report in Chemistry subject on the Certificate of Secondary Education Examination (CSEE) 2021 has been prepared to provide feedback to teachers, students, parents, policy makers and the public in general about performance of candidates and the challenges they experienced in attempting the examination questions.

The Certificate of Secondary Education Examination is a four-year summative evaluation which, among other things, shows the efficiency of the education system in general and the education delivery system in particular. Essentially, candidates' responses to the examination questions is a solid indicator of what the education system was able to offer to candidates in their four years of secondary education.

Generally, in 2021 the candidates performed well in Chemistry subject with a significant improvement of 4.93 per cent when compared to the performance in 2020. However, some of the candidates scored low marks. The candidates who scored high marks had adequate knowledge of concepts in Chemistry and managed to apply mathematical skills effective. Contrarily, those who scored low marks lacked adequate knowledge of the subject matter and failed to write chemical equations and formulas. They also showed poor mathematical skills and English language proficiency.

The feedback provided will enable the education administrators, school managers, teachers and students to identify proper measures to be taken in order to improve the candidates' performance in future examinations by the Council.

The National Examinations Council of Tanzania would like to thank all individuals who provided valuable assistance in the preparation of this report in various capacities.

Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

The 2021 Chemistry examination was set according to 2019 examination format. The format is based on 2007 Chemistry syllabus (3rd reprint in 2017) for ordinary level of secondary education.

The examination comprised two papers, 032/1 Chemistry 1 (Theory paper and 032/2 Chemistry 2 (Actual Practical Paper).

The theory paper encompassed sections A, B and C. Section A consisted of two objective questions. Question 1 consisted of ten multiple choice items while question 2 had five items for matching. Section B consisted of ten short answer questions whereas section C comprised two essay questions. All questions in sections A and B were compulsory whereas in section C, candidates were required to answer only one question.

The practical paper had 3 alternatives; 032/2A Chemistry 2A, 032/2B Chemistry 2B and 032/2C Chemistry 2C. Each alternative paper consisted of two compulsory questions carrying 25 marks each. Candidates were supposed to sit for either of the alternatives.

A total of 152,105 candidates sat for the Chemistry examination whereby the overall performance was good (92.02%). Relatively, candidates' performance in 2021 has increased by 4.93 per cent compared to the performance in 2020 which was 87.09 per cent.

2.0 ANALYSIS OF CANDIDATES' PERFORMANCE ON EACH QUESTION

The analysis of candidates' performance in each question is done by indicating the task of the question, performance of the candidates and explanation on how they responded. In some cases, extracts from candidates' responses are used to justify cases presented. Candidates' performance is categorized into three intervals based on percentage of marks scored by candidates in each question. The intervals are 0 – 29, 30 – 64 and 65 – 100 per cent which are classified as poor, average or good, respectively.

2.1 032/1 CHEMISTRY 1

This paper had a total of 14 questions; two questions in section A, ten questions in section B and two questions in section C. In section A, question 1 carried a total of ten (10) marks while question 2 carried five (05) marks. Each question in sections B and C carried 7 marks and 15 marks, respectively. All questions in section A and B were compulsory and the candidates were required to attempt only one question in section C.

2.1.1 Question 1: Multiple Choice Items

The question consisted 10 items set from 7 topics which are: *Air combustion, Rusting and Fire Fighting; matter; Formula bonding and Nomenclature; Chemical Equations; Soil Chemistry; Atomic Structure* and *Extraction of metals*. In each item, the candidates were required to choose the correct answer from the given alternatives A to E and write its letter beside the item number in the answer booklet provided.

This question was attempted by 152,082 (100%) candidates. Analysis of the candidates' performance indicates that 5.79 per cent scored from 0 to 2.0 marks, 58.16 per cent scored from 3.0 to 6.0 marks while 36.05 per cent scored from 7.0 to 10.0 marks. Generally, the performance on this question was good where 94.21 per cent of the candidates scored from 3.0 marks and above. The statistics on candidates' performance are displayed in Figure 1.

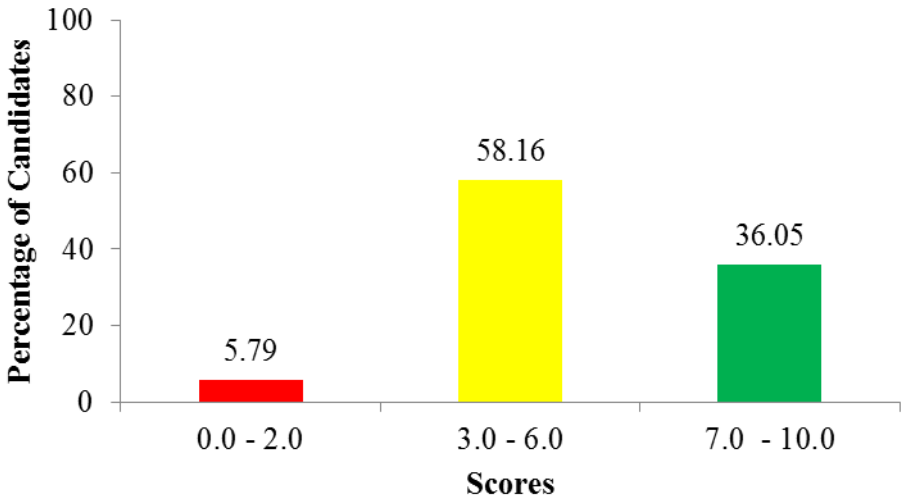


Figure 1: *Candidates' Performance in Question 1*

The candidates who scored high marks answered correctly most items of this question. This implies that those candidates had adequate knowledge of different concepts across topics from which the items were composed.

On the other hand, the candidates who scored low marks (5.79%) failed to attempt most of the items correctly. Essentially, those candidates had inadequate knowledge of different concepts tested.
In item (i), candidates were required to select a set of materials which can cause fire outbreak. The correct answer was *B, Oxygen, heat and fuel.* Candidates who chose the correct answer had sufficient knowledge on the three components which must be present to start fire. The candidates who opted for; *A, Oxygen, carbon and fuel* did not recognize that Carbon is not a component of fire tringle. Those who opted for *C, Oxygen, heat and carbon dioxide* failed to understand carbon dioxide is a fire extinguisher. Candidates who opted for alternative *D, Oxygen, foam and fuel* were not conversant that heat is missing in the set and that foam does not support combustion. Furthermore, candidates who wrote *E, Oxygen, heat and foam* failed to understand that foam does not support combustion, hence there is no fuel in the set.

In item (ii), candidates were required to identify the type of fire which occurs in vapour air mixture over the surface of flammable liquid. The correct answer was *B, Class B.* Candidates who chose the correct answer had the knowledge on the types of fire based on their sources. Those who chose *A, Class A* did not understand that fire class A is caused by a burning solid material. Candidates who opted for *C, Class C* failed to understand that fire class C is caused by burning gases. Similarly, option *D, Class D* was not the answer because it is associated with burning metals. Furthermore, candidates who opted for *E, Class E* did not realize that fire class E is associated with burning electrical equipment. Generally, candidates lacked sufficient knowledge of classifying fires based on the nature of the burning materials. Candidates were supposed to understand that fire class B occurs when the burning material is a liquid.

In item (iii), the candidates were required to identify a process which involves a chemical change. The correct answer was *D, Food scrap turns into compost*. Candidates who chose the correct answer adequately understood the characteristics of chemical change. On the contrary,

candidates who chose *A, Butter melts on warm toast* were not aware that solid butter melts into liquid which can still freeze back to solid, hence its melting is purely a physical change. Candidates who chose *B, Water evaporate from the surface* were not aware that evaporation is a physical process which can be reversed. Also, candidates who chose *C, Juice in a bottle freezes,* did not recognize that when juice freezes it can still melt back to form liquid, hence a physical change. Again, candidates who selected *E, Wet cloth dries* failed to realize that when drying a wet cloth, only water evaporates, thus does not form any new substance.

In item (iv), the candidates were required to identify the simplest formula of a compound formed by combining 36 g of magnesium and 14 g of nitrogen. The correct answer was C, Mg_3N_2. The candidates who got the correct answer applied the concept of valency correctly in determining simplest formula of the compound required. Candidates who chose *A, MgN* failed to recognize that the valence of magnesium is different from the valence of nitrogen. Candidates who chose *B, Mg_2N* did not realize that two atoms of magnesium cannot react with one atom of nitrogen. Those who were opted for distractor *D, MgN_2* did not realize that one atom of magnesium cannot react with two atoms of nitrogen. Moreover, candidates who wrote *E, Mg_4N_2* considered the valency of nitrogen being 4 instead of 3. Basically, the candidates had inadequate knowledge on bonding skills, hence failed to apply the concept of valency appropriately.

In item (v), the candidates were asked to give *the IUPAC name for H_2SO_4*. The correct answer was *B, Sulphuric (VI) acid*. Candidates who chose the correct answer managed to correctly calculate the oxidation state of sulfur in *H_2SO_4*. Candidates who chose *A, Sulphuric acid* failed to identify the oxidation state of sulfur. Those who opted for *C, Hydrogen sulphate* considered hydrogen as the central metal. Candidates who wrote *D, Dihydrogen sulphate* mistakenly applied rules of naming binary compounds. Also, candidates who wrote *E, Hydrogen tetrasulphate* regarded the compound as if it had four (tetra) sulphate groups while it had four hydrogen atoms. Generally, the candidates were not aware of the fact that in writing the IUPAC name of such a compound, it is necessary to indicate the oxidation state of the central atom which is sulphur.

In item (vi), the candidates were required to identify the type of chemical reaction represented by $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$. The correct answers were *A, Displacement reaction* or *E, Redox reaction.* Candidates who chose the correct answers realized that zinc had displaced hydrogen atom from hydrogen chloride and that there were both reduction and oxidation processes. Candidates who opted for alternative *B, Combination reaction* did not know that a combination reaction involves two reactants which combine to form one product. Candidates who chose *C Precipitation reaction* failed to realize that a precipitation reaction forms a solid substance. Similarly, candidates who selected *D, Decomposition reaction* did not understand that in decomposition reaction one reactant breaks to form two or more products. Basically, candidates failed to recognize the loss and gain of electrons associated with the atoms involved in bonding.

In item (vii), the candidates were asked to identify the concept referring to random movement of pollen grains suspended in air. The correct answer was *C, Matter is particulate in nature*. Candidates who chose the correct answer understood that the movement of pollen grains in air is due to random movement of particles of air, hence air is made up of particles. Candidates who opted for *A, Matter is lighter in nature* were attracted by the fact that floating substance (pollen grains) is less dense than the medium (air) in which it floats. Those who selected *B, Matter is solid in nature* failed to understand that although pollen grains are in solid state, not all substances exist as solids under normal conditions. Those who wrote *D, Matter is gaseous in nature* failed to recognize that matter can exist in three states. Similarly, candidates who chose *E, Matter is wave in nature* had a misconception that the movement of pollen grains was caused by waves in air.

In item (viii) candidates were required to state the role of organic matter in soil. The correct answer was *C, Reserving nutrients thus providing soil fertility*. Candidates who gave the correct answer had adequate understanding of the role played by each factor affecting soil fertility. Those who chose *A, Improving water infiltration of the soil* did not realize that water infiltration is affected by soil porosity and not organic matter. Those who opted for *B, Accelerating breakdown of organic matter,* exchanged the role of micro-organisms in the breakdown of organic matter with the role of organic matter itself. Those who chose *D, Converting*

nitrogen into nitrate, were not aware that nitrification process is not facilitated by organic matter in the soil. Candidates who chose *E, Providing a room for organic material such as nylons* did not realize that organic matter is always in constant state of decomposition, hence does not provide room for other materials. They did not realize also that nylons are not among the organic nutrients in the soil.

In item (ix), the candidates were required to identify the given pair of nuclides that form isotopes. The correct answer was *C,* ${}^{16}_{8}Z$, ${}^{17}_{8}Z$, ${}^{18}_{8}Z$. Candidates who chose the correct answer understood that isotopes of the same element have got the same atomic mass but differ in number of neutrons. Candidates who chose *A,* ${}^{16}_{8}Z, {}^{7}_{8}Z$, ${}^{18}_{9}Z$ or *D,* ${}^{16}_{8}Z$, ${}^{17}_{8}Z$, ${}^{18}_{9}Z$ incorrectly assumed that isotopes differ in both the number of protons and neutrons. Those who opted for *B,* ${}^{16}_{7}Z$, ${}^{16}_{9}Z$, ${}^{16}_{8}Z$ incorrectly regarded isotopes to having similar atomic weights. Candidates who wrote *E* ${}^{16}_{9}Z$, ${}^{16}_{8}Z$, ${}^{17}_{8}Z$ did not realize that isotopes do not have different number of protons.

In item (x), the candidates were required to identify the criterion of choosing the best method to extract a particular metal from its ore. The correct answer was *D, How it react with other materials*. Candidates who chose the correct answer had adequate knowledge that the choice of methods of extracting metals depends on their chemical properties (reactivity). Candidates who opted for *A, the metal's economic value* did not understand that economic value of a metal does not determine the method of extraction. Those who chose *B, its Availability in an area* failed to realize that availability has nothing to do with the method of extraction. Similarly, candidates who opted for *C, the metals ore impurities* did not understand that impurities do not determine the best method of extracting metals. Candidates who wrote *E, The metal's shininess* failed to realize that shininess is a physical property of metals which distinguish them from non-metals.

2.1.2 Question 2: Matching Items

The question was based on the topic of *Laboratory Techniques and Safety* and consisted of five items in List A which were to be matched with seven responses (A – G) in List B. The question was as follows:

*Match the uses of First Aid Kit items in **List A** with the respective items in **List B** by writing the letter of the correct response besides the item number in the answer booklet provided.*

List A	List B
(i) Washing out foreign particle from eye and cleaning wounds. *(ii) Cleaning wounds to kill germs and bacteria.* *(iii) Preventing the skin from moisture loss through evaporation.* *(iv) Treating fungal infection.* *(v) Washing hands, wounds and equipment.*	A *Antiseptic* *B Detergent* *C Gentian violet* *D Iodine tincture* *E Petroleum jelly* *F Saline* G *Sterile gauze*

The question was attempted by 152,082 (100%) candidates in which those who scored from 0 to 1.0 mark were 38.30 per cent, 2.0 to 3.0 were 50.12 per cent while those who scored from 4.0 to 5.0 marks were 11.58 per cent. Generally, candidates' performance in this question was average as 61.70 per cent of the candidates scored 2.0 marks or above. Summary of the performance in this question is represented in Figure 2.

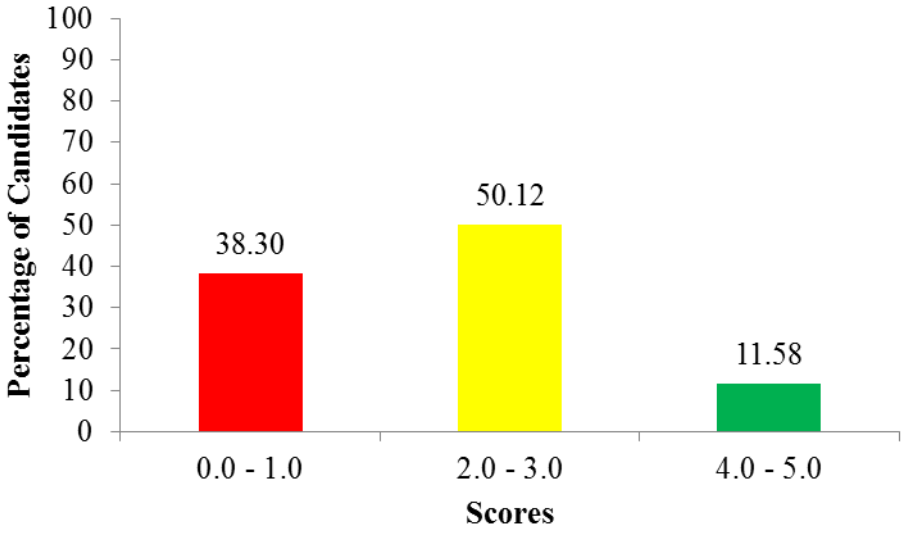
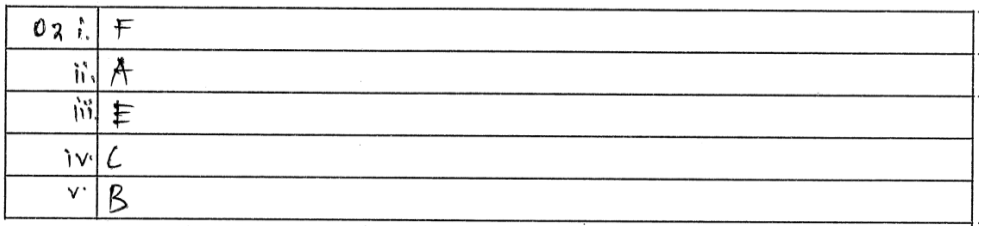


Figure 2: *Candidates' Performance in Question 2*

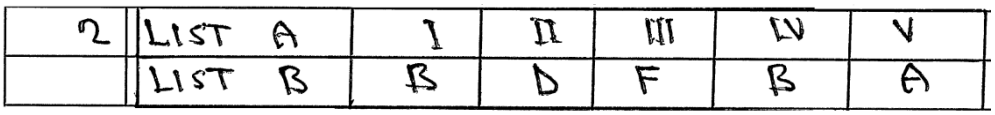
The candidates who scored high marks in this question correctly matched the First Aid Kit items with their respective uses. This implies that they had sufficient knowledge on the uses of the First Aid Kit items. Extract 2.1 indicates correct responses from one of the candidates.



Extract 2.1: A sample of correct responses in question 2

In extract 2.1, the candidate matched correctly all items in List A with their corresponding uses from List B.

On the contrary, candidates who scored low marks (38.30%) matched the First Aid kit items given with incorrect uses. Some of them incorrectly wrote *D, Iodine tincture* as a substance which can be used to wash foreign particles from eye and clean wounds. The candidates did not realize that although iodine tincture is used to clean wounds, it is not applicable to treat eyes. Other candidates responded to item (ii) by writing *C, Gentian violet*. Those candidates were supposed to understand that gentian violet is used to treat fungal infections of the skin. Candidates who opted for *F, Saline* for item (iii) *Preventing the skin from moisture loss through evaporation* did not realize that saline is used to wash out eyes and clean cuts. In item (v) *Washing hands, wounds and equipment* there were candidates who opted for *A, Antiseptic*. Those candidates did not understand that washing is done by using detergent rather than antiseptic. Extract 2.2 is a sample of incorrect responses from one of the candidates.



Extract 2.2: A sample of incorrect response in question 2

In extract 2.2, the candidate failed to identify uses of all items of the First Aid Kit given in the question. In addition, the candidate repeated opting for B which is an indication of guessing.

2.1.3 Question 3: Compounds of Metals

The question consisted of two parts, (a) and (b). Part (a) of the question, was based on the effect of heat on different salts. The candidates were required to use chemical equations to show how carbonates and sulphates behave when subjected to heat. In part (b) candidates were given the statement that; *Ammonium nitrate does not react like the other nitrates (with exception of the alkali metal nitrates).* The candidates were required to explain this fact with the help of chemical equations.

A total of 139,107 (91.5%) candidates attempted this question. Statistics of performance indicated that 97.50 per cent of the candidates scored from 0 to 2.0 marks with 76.64 per cent scoring a zero mark. Candidates who scored from 2.5 to 4.5 marks were 2.22 per cent while the remaining 0.28 per cent scored from 5.0 to 7.0 marks. Thus, the general performance was weak since only 2.50 per cent of the candidates scored 2.5 marks or above. Table 2 gives summary of candidates' performance in this question.

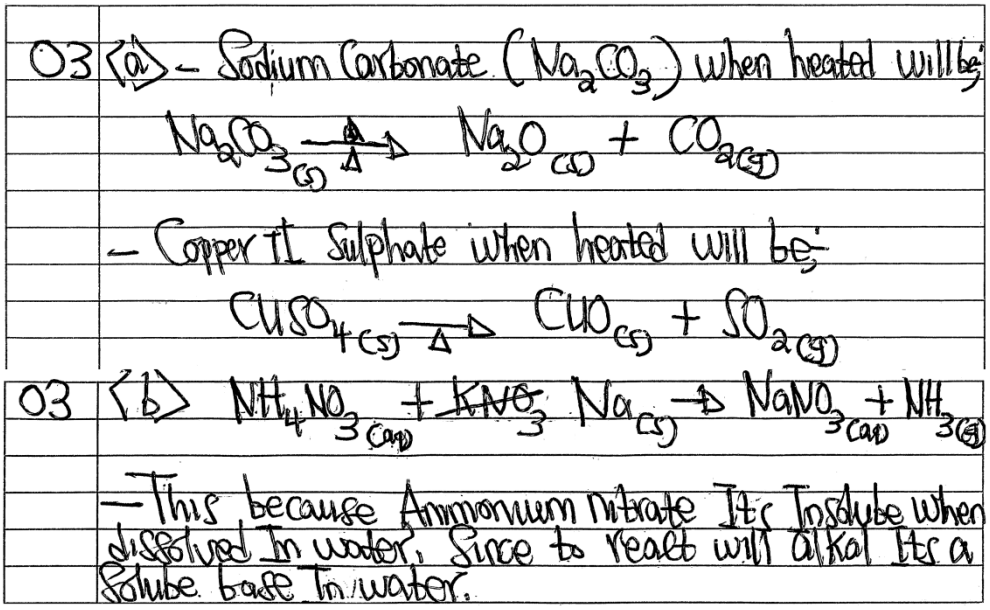
Table 2: Candidates' Performance in Question 3

Scores	Percentage (%)	Remarks
0.0 – 2.0	97.50	Weak
2.2 – 4.5	2.22	Average
5.0 – 7.0	0.28	Good

The candidates who scored low marks wrote incorrect chemical equations showing the effect of heat on carbonates and sulphates in part (a). Some of them wrote correct molecular formula of carbonates and sulphates but indicated incorrect products in the chemical equations. These candidates failed to understand that most carbonates decompose on heating except those of sodium and potassium. In another case, candidates did not comprehend that most of sulphates are stable on heating except a few which decompose to form metal oxide and sulphur trioxide. In case the sulphates are hydrated, candidates were supposed to understand that heating them causes removal of the water of crystallization leaving behind anhydrated sulphate.

Similarly, most of the candidates failed to elaborate the unique chemical properties of ammonium nitrate from most of the nitrates in part (b). In

attempting the question, most of the candidates wrote incorrect chemical equations. Others stated physical properties of ammonium nitrate such as boiling point and molecular weight while others cited the appearance and constituent atoms of ammonium nitrate. There were also candidates who wrote ways of preparing ammonium nitrate such as through reacting ammonia gas with nitric acid and others gave properties which apply generally to most of nitrate compounds. The candidates were supposed to understand that when ammonium nitrate is decomposed, it produces dinitrogen oxide and water while other nitrates decompose to give metal oxide, nitrogen dioxide and oxygen gas. Extract 3.1 shows a sample of incorrect responses from one of the candidates.



Extract 3.1: A sample of incorrect responses to question 3

In extract 3.1, the candidate showed decomposition of sodium carbonate to form sodium oxide and carbon dioxide in part (a) contrary to the fact sodium carbonate do not decompose on heating. He/she also indicated SO_2 in the decomposition of copper sulphate instead of SO_3. In part (b), the candidate mentioned solubility of ammonium nitrate which is a physical property instead of giving peculiar chemical properties of ammonium nitrate with the aid of chemical equations.

On the other hand, few candidates who scored high marks managed to explain chemical properties of carbonates, sulphates and ammonium nitrate

with the aid of chemical equations. Extract 3.2 shows a sample of correct responsesfrom one of the candidates.

3 (a) i) Salts of carbonates.

All salts of carbonates decompose on heating to liberate a metal oxide and carbon dioxide gas with exception of the carbonates of potassium (K) and sodium who does not decompose due to the strong metalic bond.

Examples.

$CaCO_{3(s)} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}$

$K_2CO_{3(s)} \xrightarrow{\Delta}$ Not reaction.

ii) Salts of sulphates.

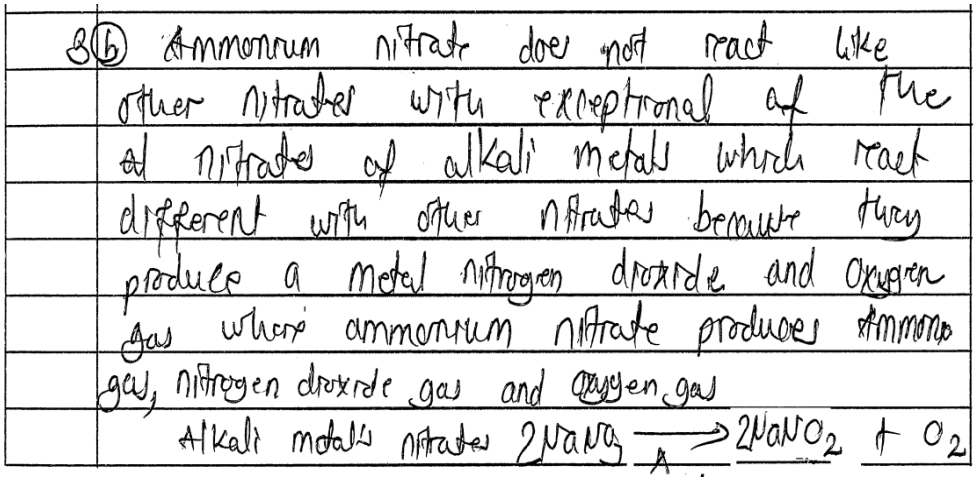
All salts of sulphates decomposes to liberate a metal oxide, sulphur dioxide and oxygen gas but with the exception of the potassium (K) and sodium (Na) which does not decompose. Due to the

(a) i) Strong metallic bond existing in between the components.

Example;

$2PbSO_{4(s)} \xrightarrow{\Delta} 2PbO_{(s)} + 2SO_{2(g)} + O_{2(g)}$

$K_2SO_{4(aq)} \xrightarrow{\Delta}$ No reaction.



Extract 3.2: A sample of correct responses in question 3

In extract 3.2, the candidate attempted part (a) by explaining properties of carbonates and sulphates when subjected to heat with the aid of balanced chemical equations. In part (b), he/she correctly explained chemical properties of ammonium nitrate.

2.1.4 Question 4: Formula, Bonding and Nomenclature

The question comprised parts (a) and (b). Part (a) stated that; *A Form IV student was asked to react phosphate ion and sodium ion forming compound W.* The candidates were asked to suggest the IUPAC name of W and find the oxidation state of phosphorous in W.

In part (b) the candidates were required to calculate the percentage composition of lead in the compound $Pb(NO_3)_2$.

The question was attempted by 151,946 (99.9%) candidates. The candidates who scored from 0 to 2.0 marks were 64.80 per cent, 2.5 to 4.5 marks were 24.63 per cent and 5.0 to 7.0 marks were 10.57 per cent. Generally, performance of the candidates in this question was average with 35.20 per cent of the candidates scoring 2.5 marks or above. Summary of candidates' performance is displayed in Figure 3.

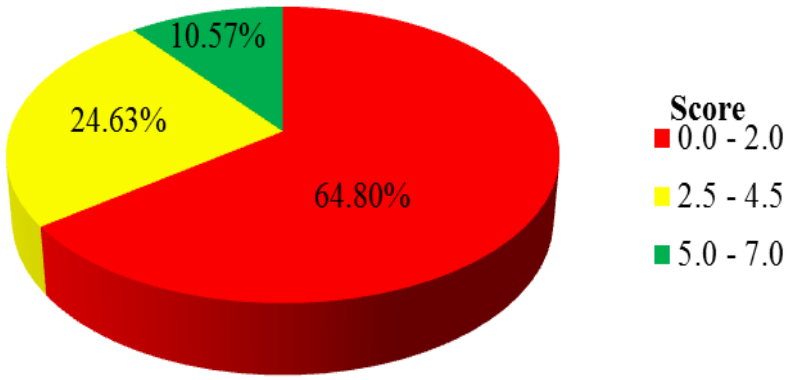
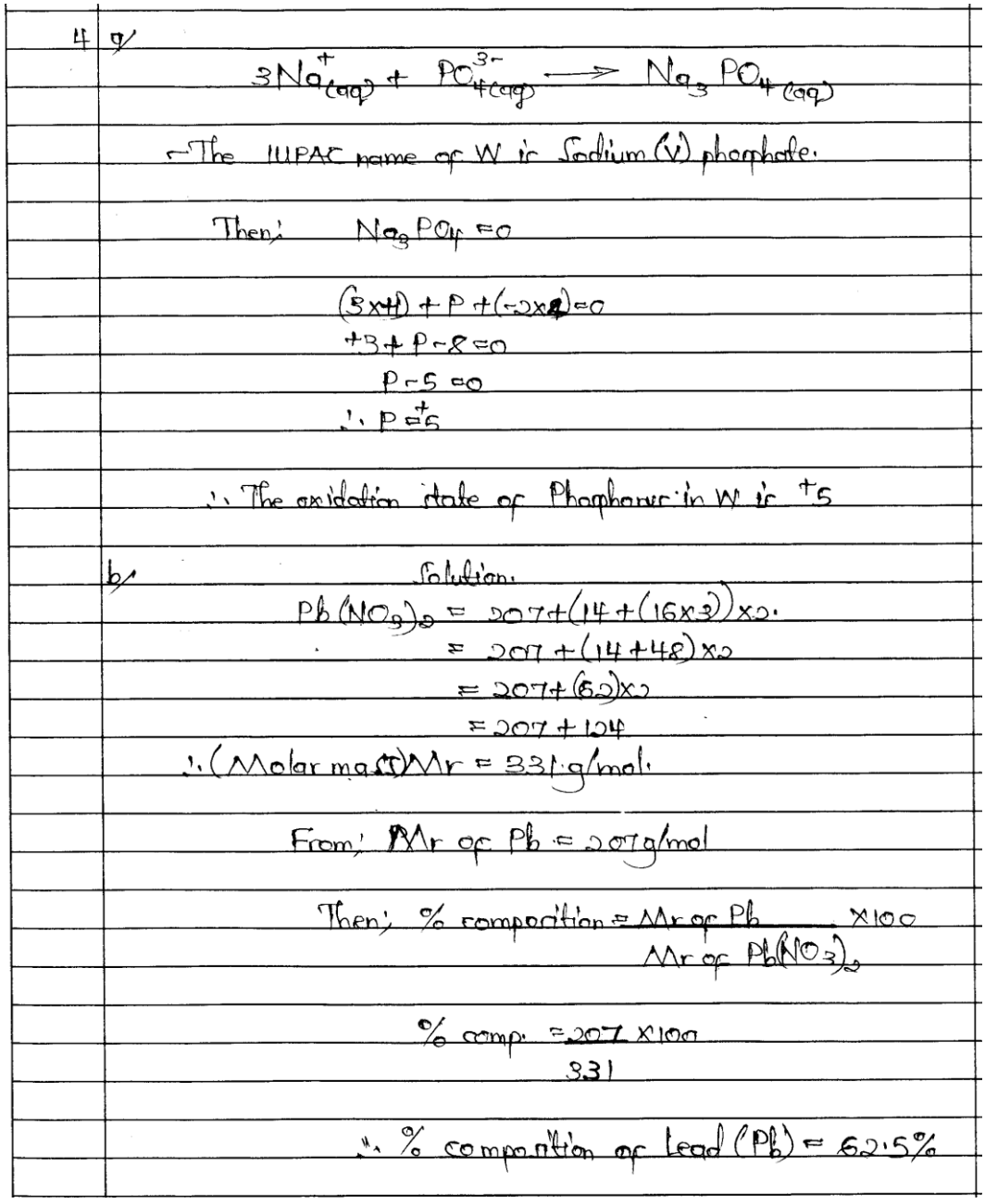


Figure 3: *Candidates' Performance in Question 4*

Candidates who scored high marks in this question wrote correct chemical formula of the binary compound (Na_3PO_4) and subsequently gave IUPAC name of compound W in part (a). The candidates also managed to calculate oxidation state of phosphorus in compound W which was 5+.

In attempting part (b), the candidates calculated the percentage composition of lead in $Pb(NO_2)_2$ correctly. These candidates had adequate knowledge on bonding concept as well as numerical skills. Extract 4.1 shows sample of correct responses from one of the candidates.

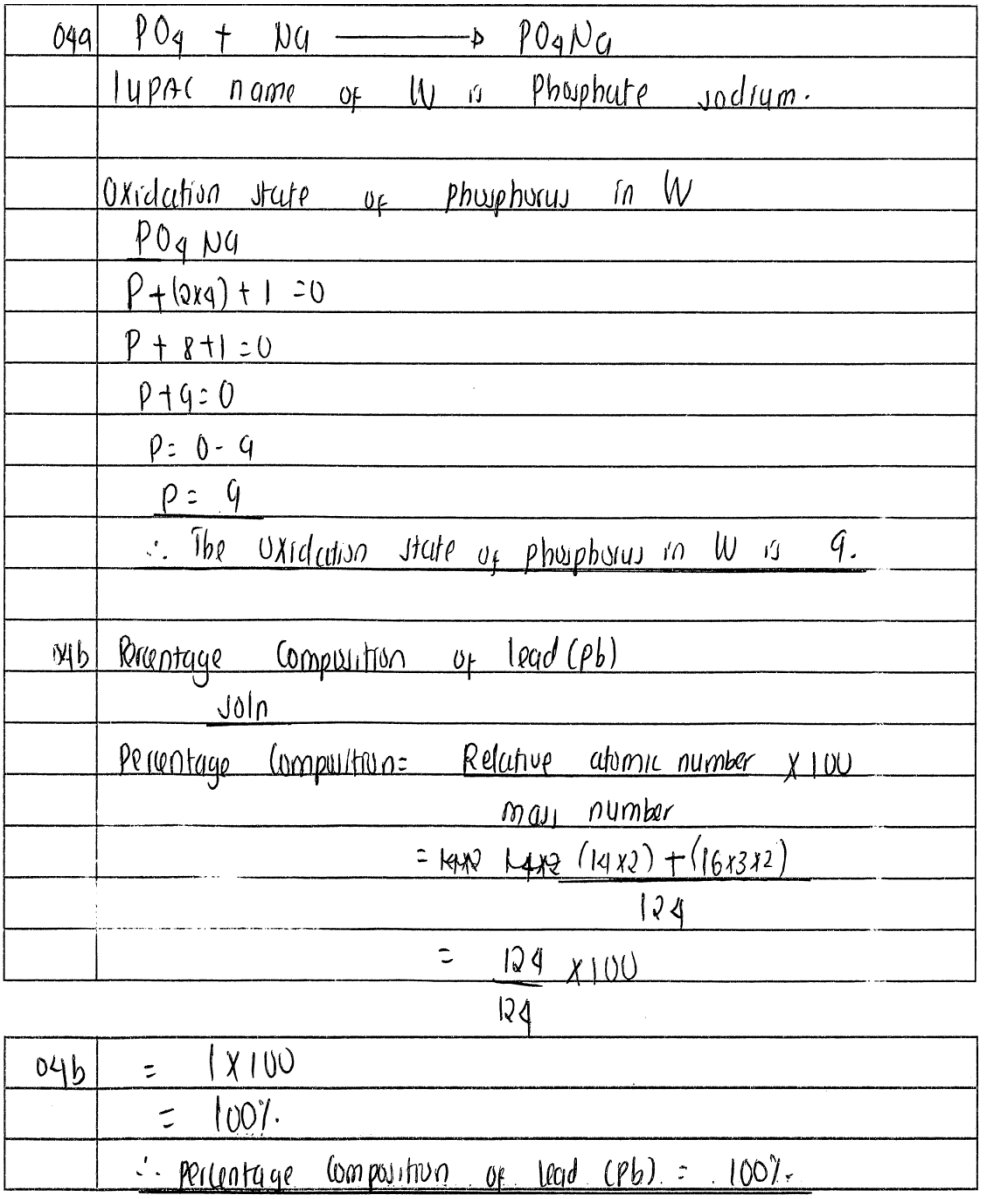


Extract 4.1: A sample of correct responses in question 4

In extract 4.1, the candidate applied bonding skills to arrive at correct naming of compound W. He/she also correctly calculated oxidation state of phosphorus in part (a) and percentage of lead in the compound $Pb(NO_3)_2$ in part (b).

On the contrary, candidates who scored low marks failed to apply bonding skills to give formula of compound W in part (a), as a result they gave incorrect names to compound W. In calculating the oxidation state, candidates used inappropriate approaches, thus arrived at incorrect values instead of 5+ which was the correct one. For instance, one candidate wrote oxidation of phosphorus = *-3×4 + 1 = -11*. Moreover, some candidates did not indicate the positive sign of charge in the answer. Those candidates did not know that the oxidation state of compound W, Na_3PO_4 was zero as it is a neutral compound with no net charge. Few candidates incorrectly computed oxidation state by substituting atomic masses of the substituent elements which is not valid. In order to calculate oxidation state of element P, candidates were supposed to assign oxidation states of sodium and oxygen being +1 and -2, respectively. Failure of candidates in this part implies that they had inadequate knowledge on the concept of radicals and oxidation states

In part (b), some of the candidates who scored low marks used incorrect formulae to calculate percentage composition of lead in compound $Pb(NO_3)_2$. Some of them calculated the molar mass by 2 taking (207+14+16×3) instead of taking 207+3(14+16). Thus, they obtained a molar mass equal to 269 instead of 331. Other candidates also failed to multiply the atomic mass of oxygen by 3 (16×3), thus getting incorrect molar mass of lead(II) nitrate. In the same way, there were candidates who exchanged the numerator (207) and the denominator (331), hence got incorrect value of percentage composition which is greater than one hundred. Generally, the candidates in this category had inadequate knowledge on percentage composition as well as poor mathematical skills. Extract 4.2 is a sample of one of the poor responses from one of the candidates.



Extract 4.2: A sample of incorrect responses in question 4

In Extract 4.2, the candidate responded to part (a) by writing incorrect chemical equation, molecular formula and name of compound W. Substance PO_4Na which the candidate wrote and named as phosphate sodium do not exist. Furthermore, he/she gave incorrect oxidation state of phosphorus. In part (b), he/she used incorrect formula to calculate the percentage composition of lead, getting 100 per cent which is impossible. In addition, erroneously the candidate substituted data into the formula.

2.1.5 Question 5: Chemical Kinetics, Equilibrium and Energetics

The question had two parts, (a) and (b). In part (a), the candidates were required to give two points to explain how society can minimize the energy loss encountered in the use of charcoal and firewood. In part (b), they were required to state whether the following processes are exothermic or endothermic;

(i) Dissolving ammonium chloride in water.
(ii) Photosynthesis.
(iii) Combustion reaction.
(iv) Mixing water and potassium chloride.
(v) Mixing water and strong acids such as concentrated sulphuric acid.

This question was attempted by a total of 152,060 (100%) candidates. Analysis shows that the candidates who scored from 0 to 2.0 marks were 40.85 per cent, 2.5 to 4.5 marks were 48.40 per cent and 5.0 to 7.0 marks were 10.75 per cent. Generally, 59.14 per cent of candidates scored 2.5 marks or above which implies that candidates' performance was average in this question. Summary of candidates' performance is shown in Figure 4.

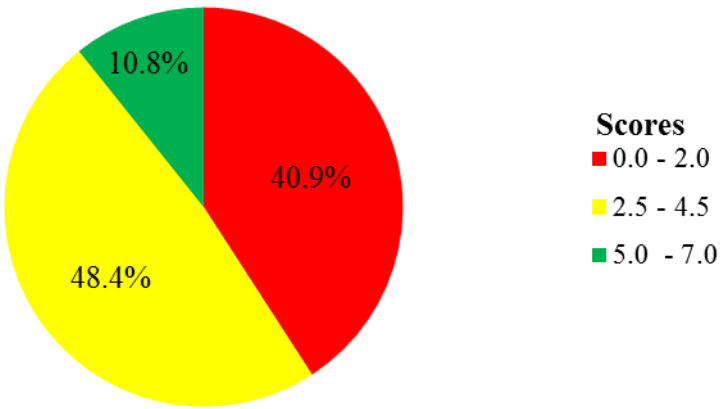
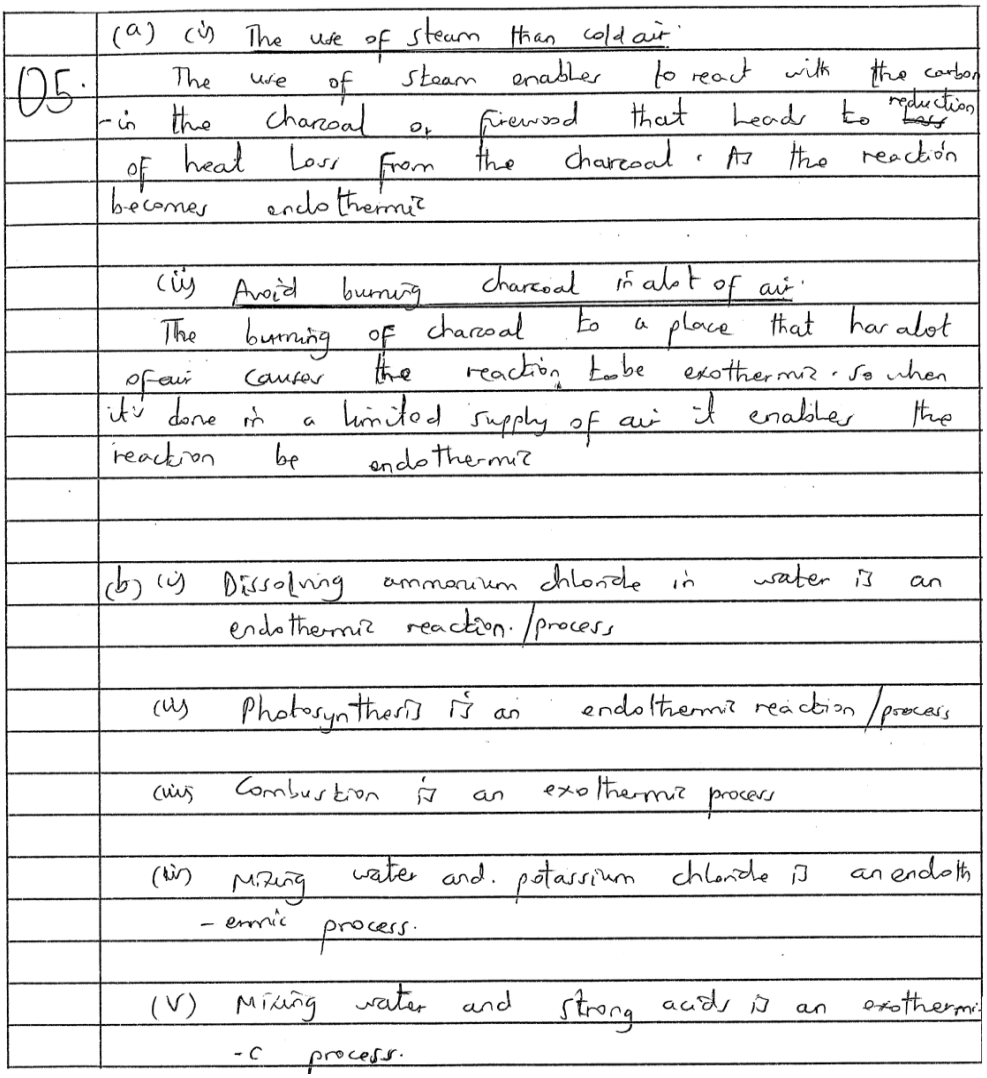


Figure 4: *Candidates' Performance in Question 5*

Candidates who scored high marks correctly attempted part (a) by stating ways through which people can minimize energy loss associated with the use of charcoal and firewood such as turning off the charcoal immediate after use. In part (b), candidates correctly categorized the five processes in

terms of exothermic and endothermic reactions. This implies that they had adequate knowledge on applying skills acquired in the classroom to minimize energy loss in using charcoal and firewood which is critical life problems in the society. Similarly, they proved to be conversant on energetics. Extract 5.1 shows a sample of correct responses from one of the candidates.

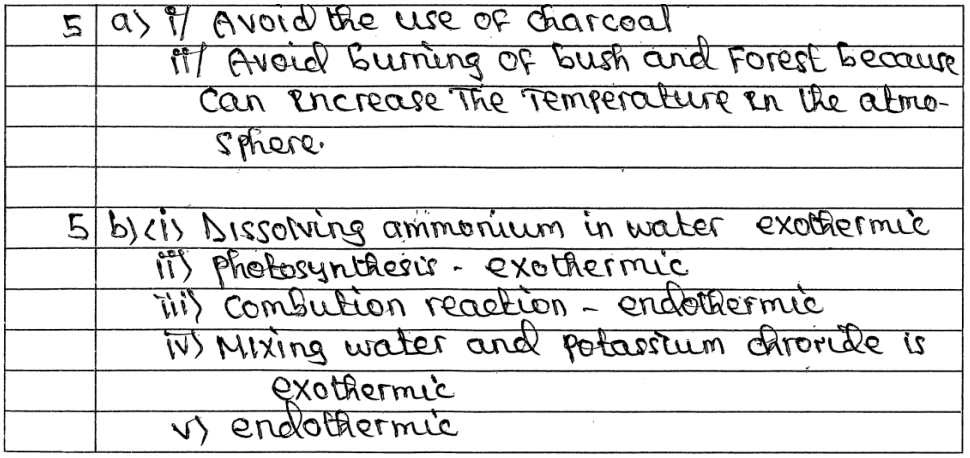


Extract 5.1: A sample of correct responses in question 5

In extract 5.1, the candidate gave correct explanation on the ways of minimizing energy loss during use of charcoal and fire wood in part (a). He/she also correctly identified endothermic and exothermic processes.

On the other hand, the candidates who scored low marks (40.85%) in this question gave inappropriate ways of minimizing energy loss associated with the use of charcoal and firewood. In most cases, the candidates cited shift to alternative sources of energy/fuel such as electricity and gas rather than using charcoal and firewood. Similarly, some candidates stated disadvantages of using charcoal and firewood as sources of heat in the society instead of modifications which can be accommodated in the society for more economic use of charcoal or firewood so as to avoid loss of energy.

In part (b), the candidates incorrectly categorized the five processes given. Dissolution of ammonium chloride in water, photosynthesis, mixing of water and potassium chloride are all endothermic processes contrary to responses of the candidates. This is because such processes involve absorption of energy. The remaining processes of combustion reactions and mixing of water with strong acids are exothermic processes due to the fact that they are associated with release of energy into the surroundings. Contrarily, candidates in this category exchanged exothermic processes with endothermic processes which can be a result of guessing of the answers. Extract 5.2 shows a sample of incorrect responses in this question.



Extract 5.2: A sample of incorrect responses in question 5

In extract 5.2, the candidate gave ways of minimizing air pollution in part (a). He/she interchanged endothermic and exothermic reactions in part (b).

2.1.6 Question 6: The Scientific Procedure

The question consisted of parts (a) and (b). In part (a), candidates were required to briefly explain the concept of scientific procedure. In part (b), they were required to give two points on the importance of the scientific procedure in daily life.

A total of 152,060 (100%) candidates attempted this question. Statistics of performance indicate that candidates who scored from 0 to 2.0 marks were 29.65 per cent, 2.5 to 4.5 marks were 35.28 per cent, and 5.0 to 7.0 marks were 35.07 per cent. Generally, performance of candidates in this question was good with 70.35 per cent scoring 2.5 marks or above. Summary of the performance is shown in Figure 5.

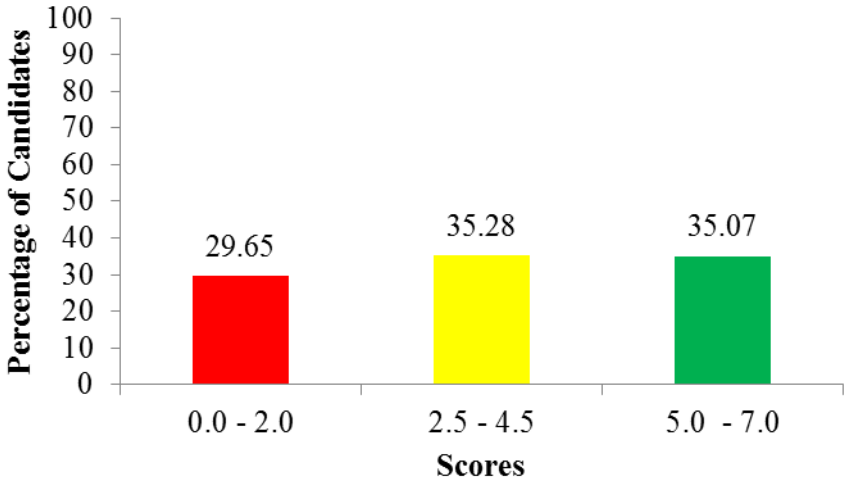


Figure 5: *Candidates' Performance in Question 6*

The candidates who scored high marks in this question gave concise explanation of the concept of scientific procedure in part (a). In part (b), they gave correct points on the importance of the scientific procedure. Such points were problem identification, hypothesis formulation, experimentation, data collection, data interpretation and conclusion. The correct responses given are an indication that these candidates had sufficient skills of applying scientific procedure in solving daily life problems. Extract 6.1 shows a sample of correct responses from one of the candidates.

6 (a) The scientific procedure is composed by a series of arrangement which are provide to solve a problem existing in the area. The following are the series of scientific procedures.

(i) Problem identification. This involve understanding of the problem to be researched

(ii) Hypothesis formulation. This is intelligent guess provide by a scientist about the problem cause.

(iii) Experimentation This procedure involve intensive work to test the hypothesis selected for experiment.

(iv) Data collection. The data are collected during experiment also. Data analysis is conducted during this process.

(v) Data interpretation. This is the stage whereby the data is studied for collect interpretation to the theory or an law.

(vi) Conclusion. This involves the formulation of laws and principle which have bee tested on the experiment.

6 (b)

(i) The scientific procedure help to solve different scientific problems such as outbreak of diseases and other phenomena in the Environment.

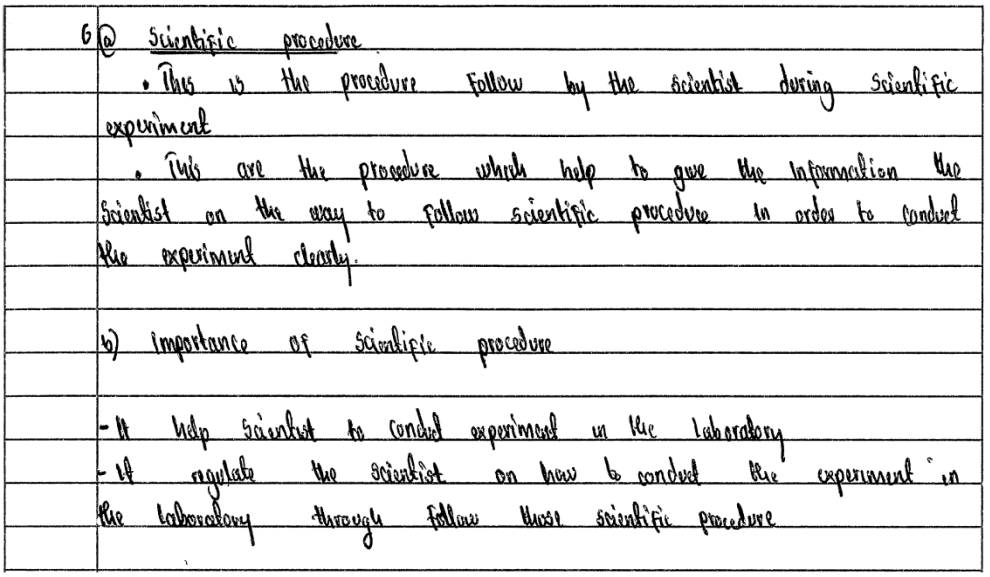
(ii) The scientific procedure help to formulate. Knowledge of new laws and principle which can be used in our society for different uses.

Extract 6.1: A sample of correct responses in question 6

In extract 6.1, the candidate gave correct explanation of the scientific procedure by including all stages involved in part (a). He/she stated appropriate points on the significance of the scientific procedure in part (b).

On the other hand, candidates who scored low marks failed to explain the concept of scientific procedure correctly in part (a). Some of them gave incorrect definitions. For instance, there were candidates who gave definition of experiment instead of scientific procedure.

In attempting part (b), some of the candidates gave incorrect importance of the scientific procedure. For example, one candidate wrote that the scientific procedure helps to give hypothesis. Also, some candidates cited that the scientific procedure helps to collect data while others stated that it enables to conduct experiment. Similarly, some candidates commented that the scientific procedure enable in data analysis. Basically, the common misconceptions of candidates was writing the stages involved in the scientific procedure itself rather than giving significance of the scientific procedure in daily life. Candidates in this category lacked thorough knowledge on scientific procedure. Extract 6.2 shows a sample of incorrect responses from one of the candidates.


6 (a) Scientific procedure

• This is the procedure follow by the scientist during scientific experiment

• This are the procedure which help to give the information the scientist on the way to follow scientific procedure in order to conduct the experiment clearly.

b) Importance of Scientific procedure

- It help scientist to conduct experiment in the laboratory
- It regulate the scientist on how to conduct the experiment in the laboratory through follow those scientific procedure

Extract 6.2: A sample of incorrect responses in question 6

In extract 6.2, the candidate gave explanation of experimental procedures instead of explaining the scientific procedure in part (a). In part (b), the candidate gave incorrect points on the importance of scientific in daily life.

2.1.7 Question 7: Water

In this question, candidates were required to construct a diagram of water cycle by using the following components: *clouds, cnimals, water in the soil, rain, plants, water springs, rivers, lakes and water vapour in the atmosphere.*

The question was attempted by 152,030 (100%) candidates. Statistics show that 22.77 per cent of the candidates scored from 0 to 2.0 marks, 27.21 per cent scored from 2.5 to 4.5 marks and 50.02 per cent scored from 5.0 to 7.0 marks. Generally, the candidates' performance in this question was good with 77.23 per cent of candidates scoring 2.5 marks or above. Summary of candidates' performance is shown in Figure 6.

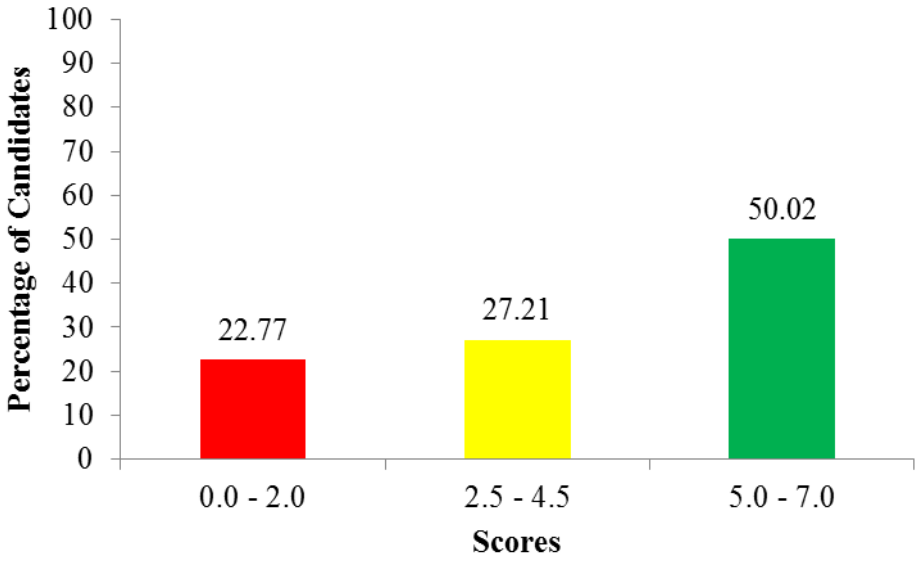
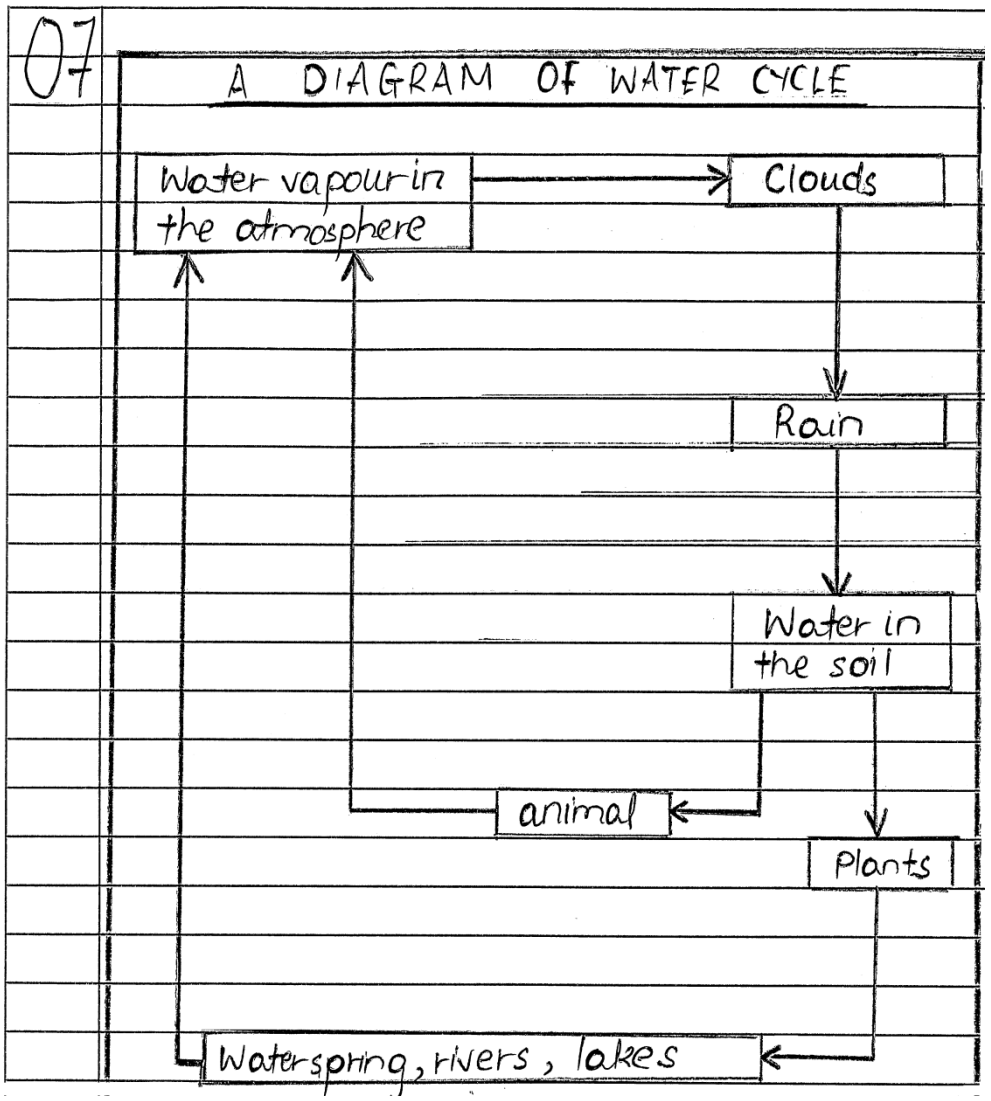


Figure 6: *Candidates' Performance in Question 7*

The candidates who scored high marks constructed water cycle correctly by assembling the components given. Some of them drew detailed diagrams by introducing backgrounds of some components such as clouds and rain water. Generally, the candidates were competent on water cycle. Extract 7.1 shows a sample of correct responses from one of the candidates.

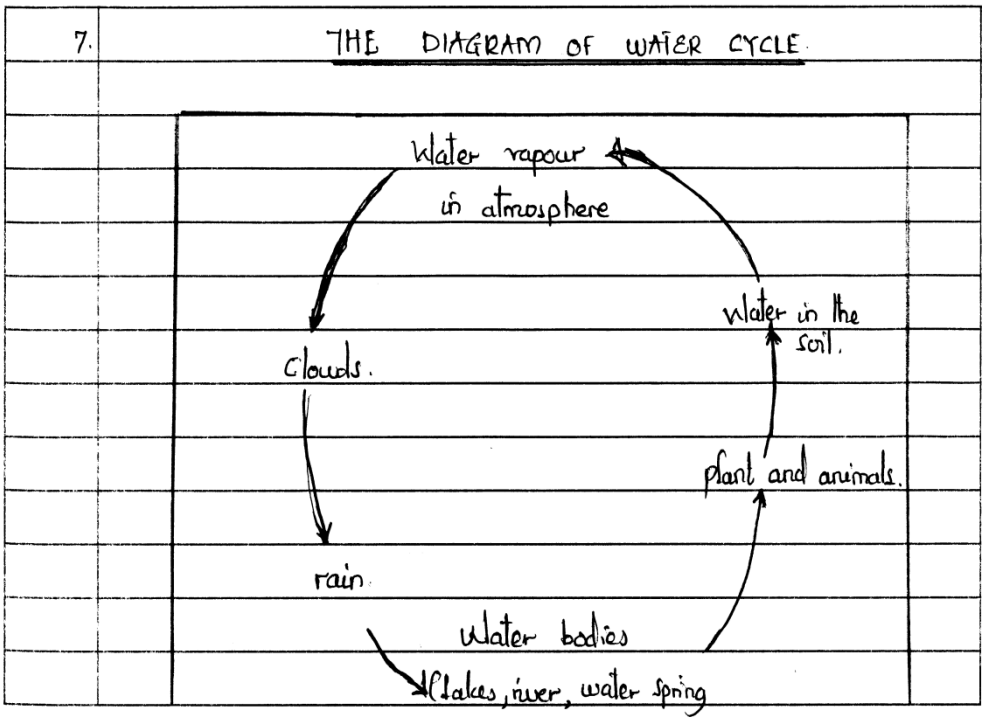


Extract 7.1: A sample of correct responses in question 7

In extract 7.1, the candidate drew a correct and self-explanatory schematic diagram of water cycle.

The candidates who scored low marks draw incorrect diagrams of water cycle. For instance, some of them drew arrows direct from animal to plants and others included arrows connecting animals to water springs instead of the opposite. Moreover, some candidates constructed diagrams by using lines instead of arrows to connect the components while few of them just copied the components without drawing and others drew awkward diagrams in ink instead of pencil. Failure of the candidates to construct

appropriate water cycle is an indication that they had insufficient knowledge on the hydrological cycle as well as drawing skills. Extract 7.2 displays a sample of incorrect responses from one of the candidates.



Extract 7.2: A sample of incorrect responses in question 7

In extract 7.2, the candidate drew incorrect diagram in which he/she failed to indicate that water vapour in air is principally formed directly from water bodies rather than water in the soil.

2.1.8 Question 8: Oxygen and Hydrogen

This question had two parts, (a) and (b) based on the following stem; *Suppose the two gas jars; one containing gas "A" and another containing gas "B" are made available to you. Gas "A" is used in hardening of margarine whereas gas "B" is used by mountain climbers.*

In part (a), the candidates were required to identify tests that they would conduct to identify each of the two gases. In part (b), they were required to give two physical properties and three chemical properties that could be used to distinguish gas "A" from gas "B".

The question was attempted by a total of 151,957 (99.9%) candidates. Statistics of performance show that 83.99 per cent scored from 0 to 2.0 marks, 12.22 per cent scored from 2.5 to 4.5 marks and 3.79 per cent scored from 5.0 to 7.0 marks. Candidates who scored 2.5 marks or above were only 16.01 per cent, indicating weak performance in this question. Summary of candidates' performance is displayed in Figure 7.

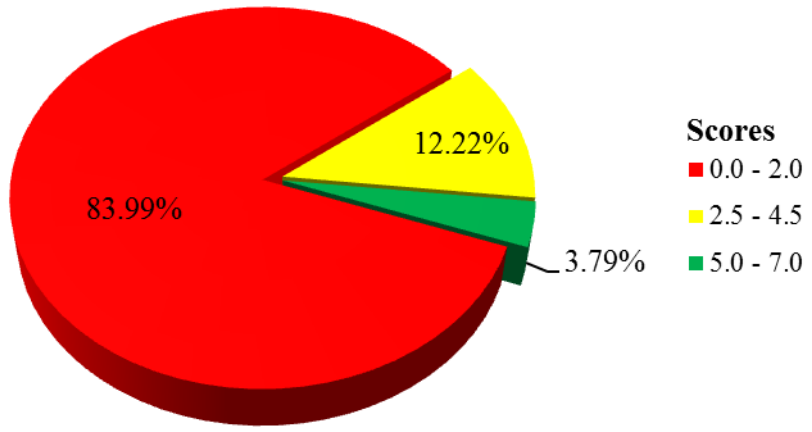
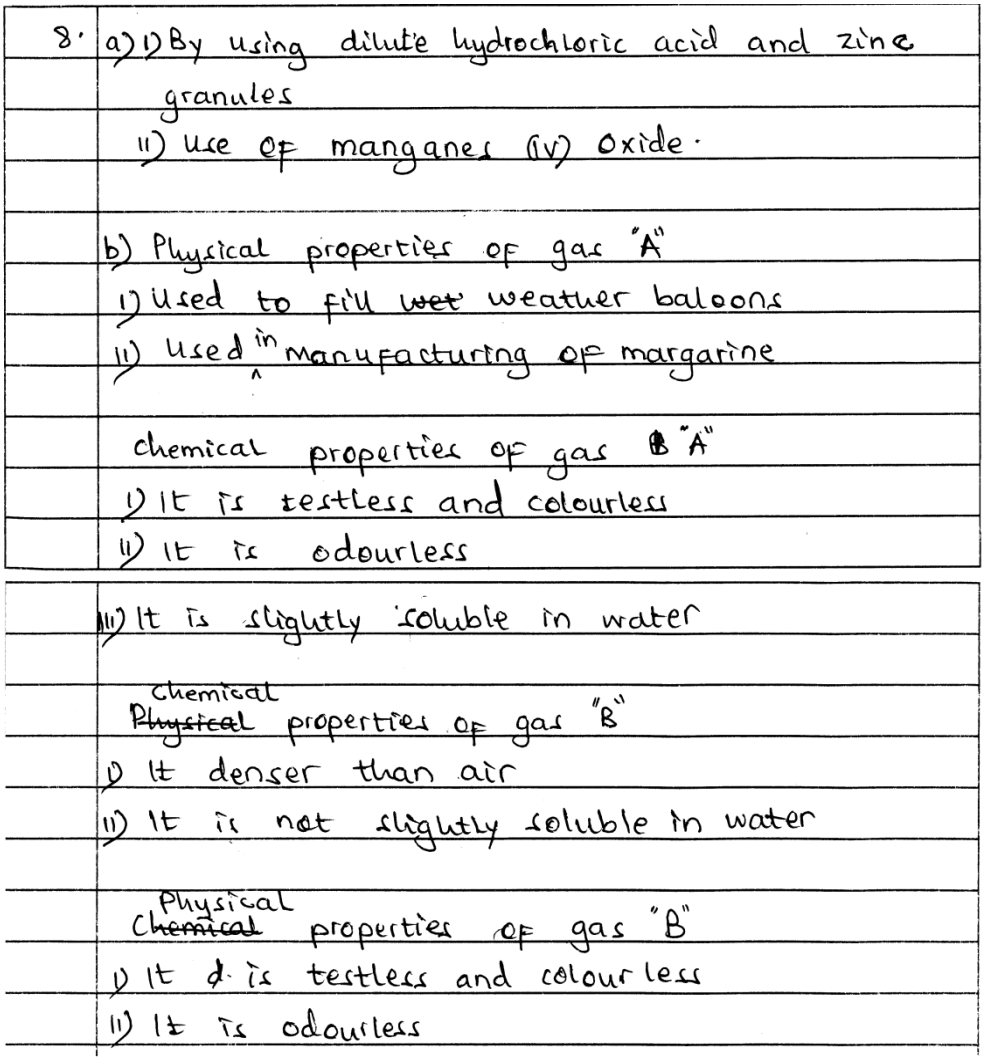


Figure 7: *Candidates' Performance in Question 8*

Candidates who scored low marks (83.99%) failed to give test for each of the two gases. Some candidates swapped the tests for gas A and gas B in part (a). For, instance, one candidate wrote that *Gas A ignite a glowing splint in a test tube* while another candidate wrote that *Gas B burns with pop sound*. Likewise, there were candidates who wrote tests of other gases such as carbon dioxide and hydrogen chloride. Other candidates responded by writing uses of hydrogen and oxygen gases while some differentiated the two gases by giving general properties of the two gases contrary to the demand of the question.

In part (b), the candidates responded by giving properties that cannot be used to distinguish the two gases. For instance, one candidate wrote *solubility in water* without giving more details. Other candidates gave uses of the gases instead of required physical and chemical properties. There were also candidates who gave similarities between the two gases. For example, one candidate wrote *Gas A and gas B are colourless, tasteless*

and odourless. Similarly, some candidates gave ways of preparing the two gases in the laboratory instead of distinguishing properties. Another misconception observed is that some of the candidates identified the constituent atoms of gas A and B. Such responses signify that the candidates had insufficient knowledge on both chemical and physical properties of hydrogen and oxygen gases which were represented by letters "A" and "B", respectively. Extract 8.1 shows a sample of incorrect responses from one of the candidates.


8. a) i) By using dilute hydrochloric acid and zinc granules
ii) Use of manganes (iv) Oxide.

b) Physical properties of gas "A"
i) Used to fill ~~wet~~ weather baloons
ii) Used in manufacturing of margarine

chemical properties of gas "A"
i) It is testless and colourless
ii) It is odourless
iii) It is sligtly soluble in water

~~Physical~~ Chemical properties of gas "B"
i) It denser than air
ii) It is not sligtly soluble in water

~~Chemical~~ Physical properties of gas "B"
i) It d is testless and colourless
ii) It is odourless

Extract 8.1: A sample of incorrect responses in question 8

In extract 8.1, the candidate gave reagents and enzyme required in laboratory preparation of hydrogen gas (A) instead of giving test for each

gas. He/she gave general properties of the two gases including similarities between the two gases.

Despite failure of many candidates, few of them (3.79%) scored high marks. Those candidates gave correct tests to identify each of the gases in part (a). They also managed to give properties that distinguish the gases as demanded in part (b). Extract 8.2 illustrates incorrect responses from one of the candidates.

8 a)

i) Gas A - Produce pop sound when heated

Gas B - It relight wooden glowing splint

b) • Physical properties.

Gas A	Gas B
i) It is less denser than air	- it is slightly denser than air
ii) has low boiling point	- Has high boiling point compared to gas A

• Chemical properties.

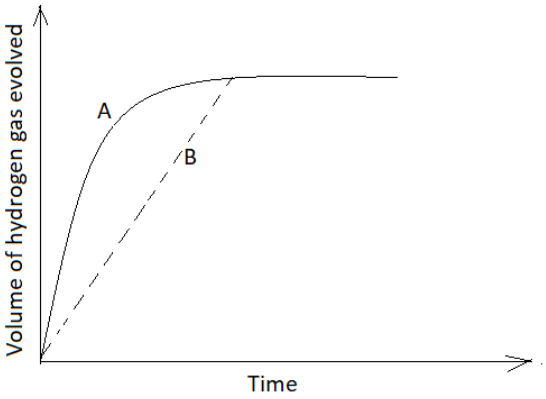
Gas A	Gas B
i) Do not support combustion	- Supports combustion
ii) It is flammable	- It is not flammable
iv) It produce pop sound when heated	- Relight wooden glowing when splint.

Extract 8.2: A sample of correct responses in question 8

In extract 8.1, the candidate correctly gave test for each gas in part (a) and physical and chemical properties to distinguish the two gases in part (b).

2.1.9 Question 9: Chemical Kinetics, Equilibrium and Energetics

In this question the candidates were given the statement; *Two experiments A and B were conducted to prepare hydrogen gas by varying the size of zinc granules which were reacted with dilute hydrochloric acid. All other factors were kept constant in the two experiments. Data obtained were used to plot the following graph:*



The candidates were required to explain the differences in the results of experiments A and B, and to give factors which could be adjusted to increase yield of the product.

The question was attempted by 151,963 (99.9%) candidates. Statistics of candidates' performance indicate that 80.11 per cent scored from 0 to 2.0 marks, 17.07 per cent scored from 2.5 to 4.5 marks whereas 2.82 per cent scored 5.0 to 7.0 marks. Generally, the performance was weak in which only 19.89 per cent of candidates scored 2.5 marks or above. Summary of candidates' performance is shown in Figure 8.

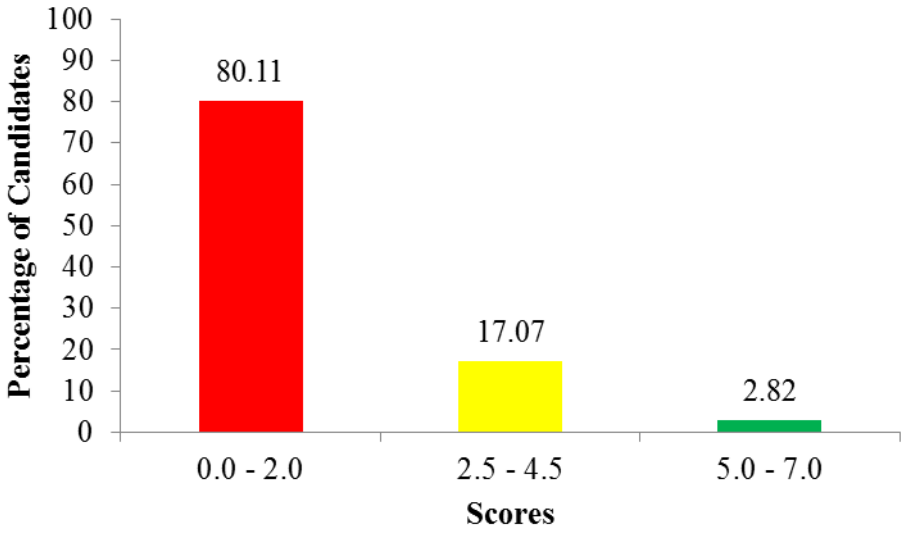
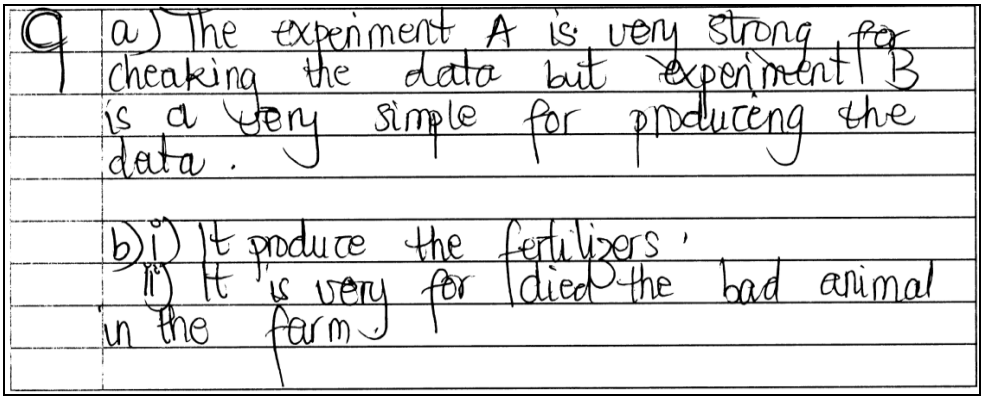


Figure 8: *Candidates' Performance in Question 9*

Candidates who scored low marks failed to explain the way surface area affects rate of chemical reactions in part (a). Some of them wrote that increase in surface area do not affect rate of chemical reaction. Others stated that surface area favours the products. Candidates were supposed to understand that rate of reaction increases with increase in surface area which can be attained by grinding solid chemicals into small particles. In part (b), the candidates also failed to give factors which could be adjusted to increase the yield of the product in the given chemical reaction which are temperature, catalyst and concentration. A sample of incorrect responses is presented in Extract 9.1.

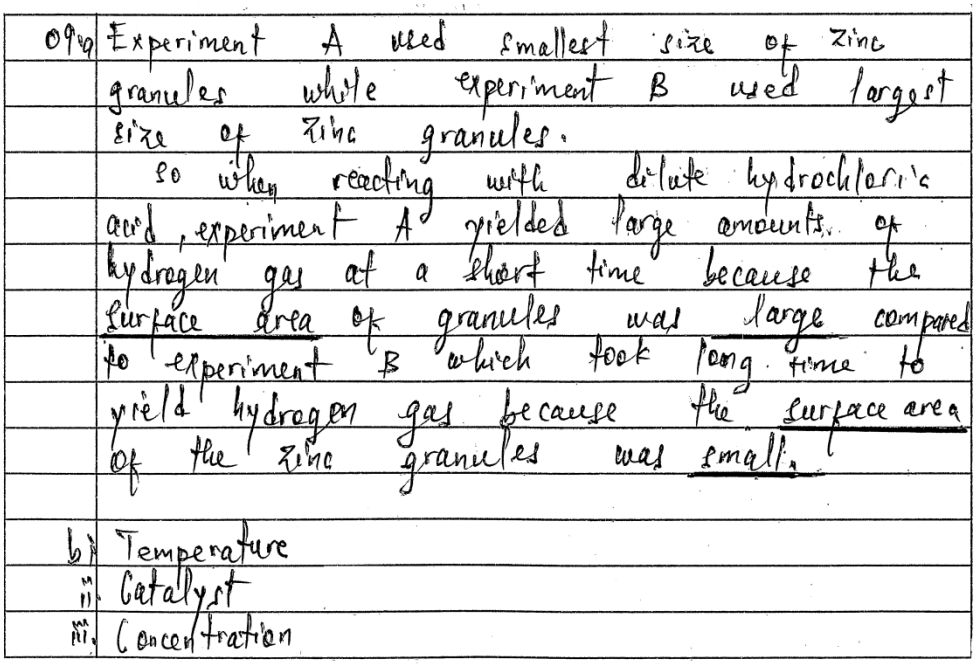

9 a) The experiment A is very strong for cheaking the data but experiment B is a very simple for producing the data.

b) i) It produce the fertilizers.
ii) It is very for died the bad animal in the farm.

Extract 9.1: A sample of incorrect responses in question 9

In Extract 9.1, the candidate gave incorrect difference between experiment A and B in part (a). The candidate was supposed to understand that the reaction in experiment A, was taking place at a higher rate than that of experiment B. This is because at a given time there were more hydrogen gas that evolved in experiment A as compared to experiment B. In part (b), the candidate gave irrelevant answers to the demand of the question.

However, few candidates (19.89%) who performed well in this question recognized that reaction A was faster than reaction B in part (a). In part (b), they mentioned the correct factors which could be adjusted to increase the yield of hydrogen gas as Extract 9.2 shows.



Extract 9.2: A sample of correct responses in question 9

In Extract 9.2, the candidate interpreted the graph by distinguishing the rate of reaction in experiment A from that in B. He/she correctly mentioned temperature, catalyst and concentration as factors which could be adjusted to increase the yield in part (b).

2.1.10 Question 10: The Mole Concept and Related Calculations

The candidates were required to (a) determine volume of CO_2 at s.t.p that would be given out and (b) calculate mass of CO_2 produced if 2.0 g of $CaCO_3$ were reacted with excess dilute HCl acid.

The question was attempted by a total of 151,962 (99.9%) candidates. The candidates who scored from 0 to 2.0 marks were 64.89 per cent, from 2.5 to 4.5 marks were 9.31 per cent and those who scored from 5.0 to 7.0 marks were 25.80 per cent. Generally, the candidates' performance in this question was average as 35.11 per cent scored 2.5 marks or above. Figure 9 shows summary of the candidates' performance in this question.

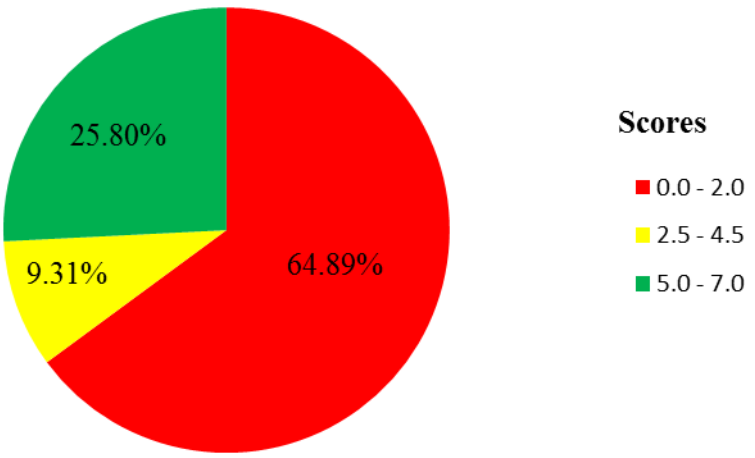


Figure 9: *Candidates' Performance in Question 10*

Analysis of candidates' responses shows that the candidates who performed well correctly wrote a balanced equation of the reacting chemicals. From the equation, they correctly applied relevant formulae and substituted the data, as a result they manipulated to get the expected results in parts (a) and (b). Extract 10.1 shows a sample of correct responses from one of candidates.

10 @. Soln

Data

Mass of $CaCO_3$ = 2g , mr =

Required volume of CO_2 at s.t.p

Calculation.

From

$2HCl_{(aq)} + CaCO_{3(s)} \rightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

From Mole = $\frac{\text{mass}}{\text{mr}}$

mole of $CaCO_3$ = $\frac{2g}{100g/mol}$

Mole = 0.02 mol

Hence $CaCO_3 \rightarrow CO_2$

$0.02 \rightarrow ?$

CO_2 = 0.02 mol

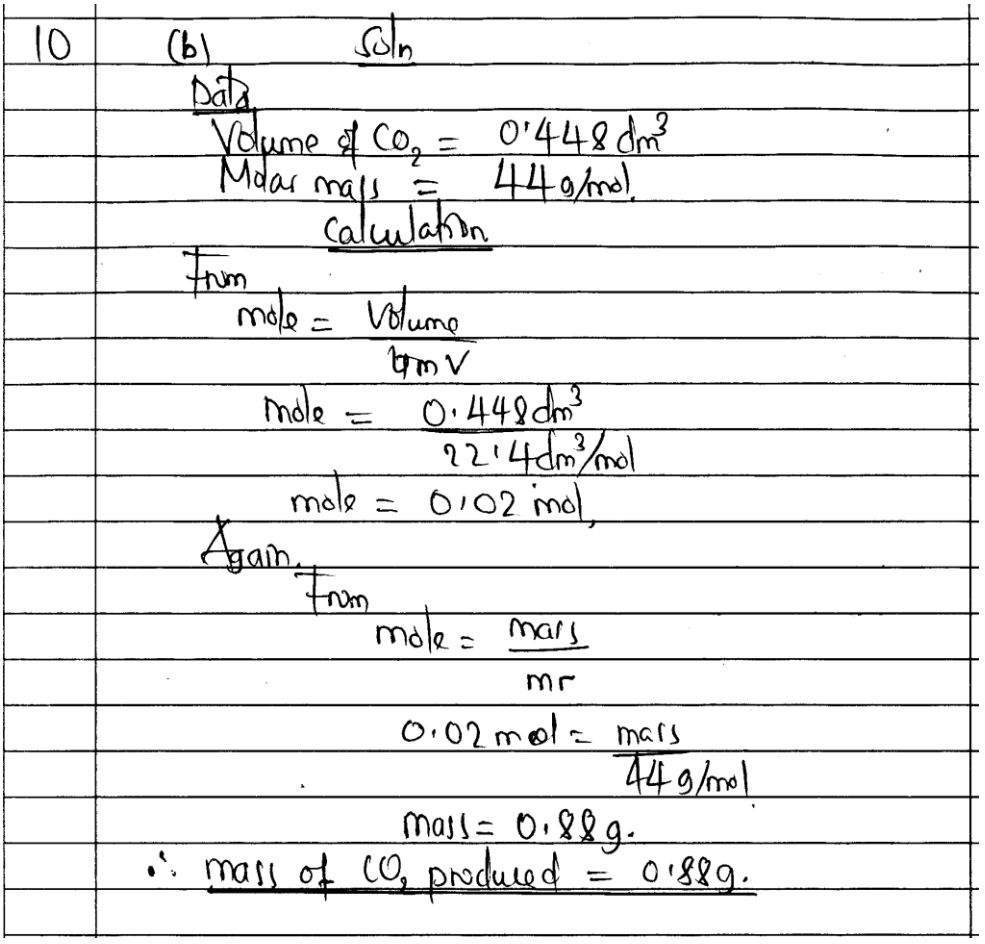
Then from

Mole = $\frac{\text{Volume}}{\text{gmv}}$

$0.02mol = \frac{\text{Volume}}{22.4 dm^3/mol}$

Volume = $0.448 dm^3$

∴ Volume of CO_2 would be given out at s.t.p = $0.448 dm^3$

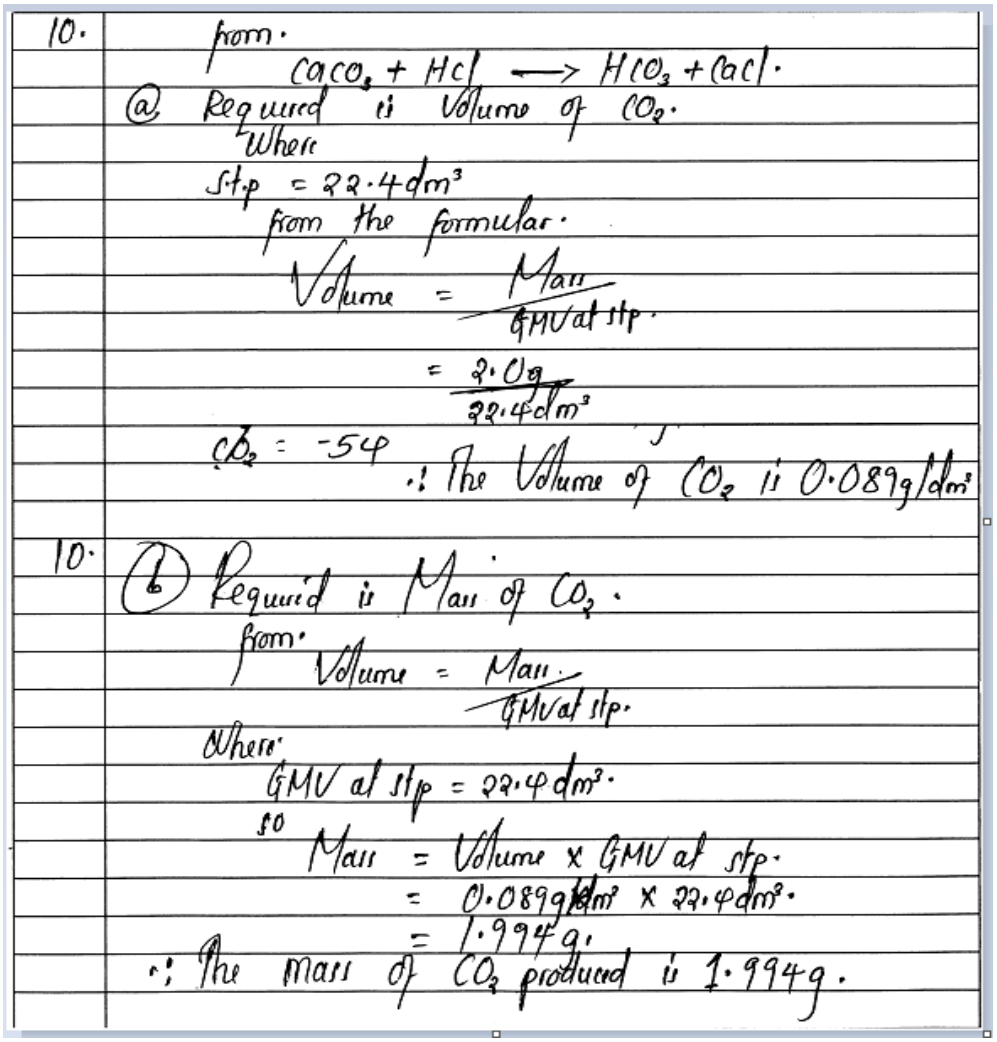


Extract 10.1: A sample of correct responses in question 10

On the other hand, candidates who scored low marks failed to write balanced chemical equation for the reaction between $CaCO_3$ and HCl which was necessary for calculations in parts (a) and (b). It was observed that some candidates obtained incorrect product(s). Others did not balance the equation while others did not attempt to write the equation. In calculating the volume of carbon dioxide in part (a), some of the candidates did not apply the molar volume of gases which is 22.4 dm^3 hence ended up with incorrect answer. Other candidates failed to carry out the calculation ended writing 22.4 dm^3 as the volume of carbon dioxide.

Similarly, in part (b), most of the candidates used incorrect formula and failed to use stoichiometric coefficients in order to relate mass of calcium carbonate and amount of carbon dioxide gas produced. Another weakness

observed was failure of candidates to indicate units of mass as some ended up with writing just bare numbers. Generally, these candidates lacked sufficient skills of carrying out stoichiometric calculations. Extract 10.2 is a sample of incorrect responses from one of the candidates.



Extract 10.2: A sample of incorrect responses in question 10

In Extract 10.2, the candidate wrote HCO_3 instead of CO_2, CaCl instead of $CaCl_2$ and failed to balance the chemical equation. He/she used a wrong formula by dividing mass over molar volume instead of multiplying number of moles and molar volume at s.t.p to get volume of CO_2 gas in part (a). In part (b), the candidate substituted the value obtained from part (a) into a wrong formula, thus getting incorrect mass of carbon dioxide.

2.1.11 Question 11: Matter

The question comprised parts (a) and (b). In part (a), candidates were required to differentiate homogeneous mixtures from heterogeneous mixtures. In part (b), they were required to give four points to justify common salt being a compound.

The question was attempted by 151,989 (99.9%) candidates. Statistics of performance indicate that candidates who scored from 0 to 2.0 marks were 66.54 per cent, from 2.5 to 4.5 marks were 19.01 per cent and from 5.0 to 7.0 marks were 14.45 per cent. Generally, the performance of candidates in this question was average with 33.46 per cent. Summary of candidates' performance is shown in Figure 10.

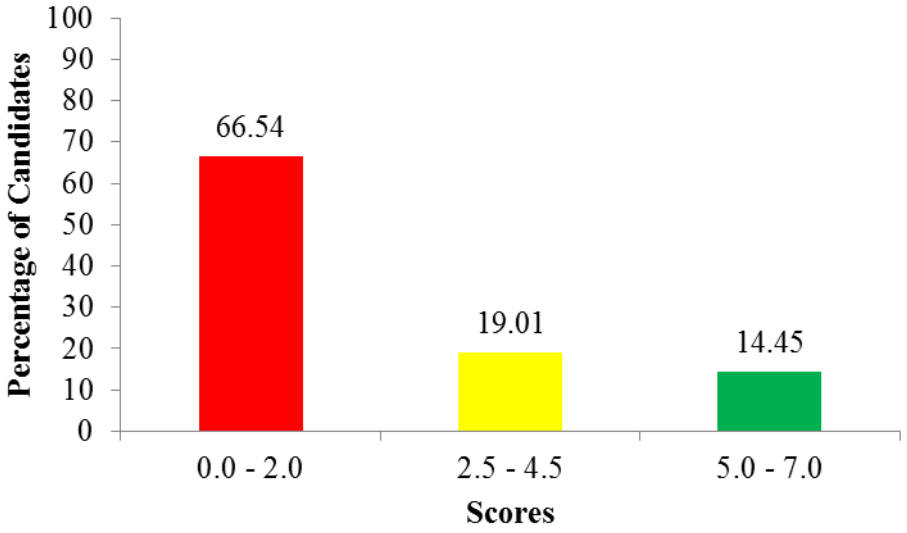
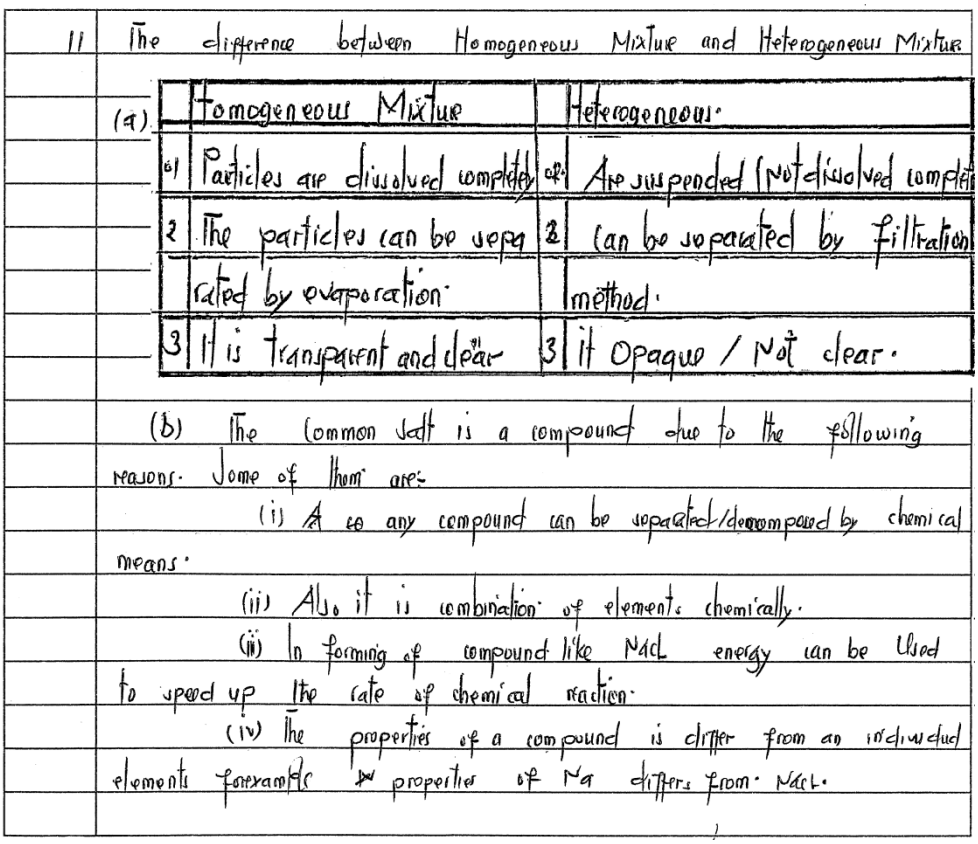


Figure 10: *Candidates' Performance in Question 11*

Analysis of candidates' responses shows that candidates who scored high marks (14.45%) differentiated homogenous mixtures from heterogeneous mixtures correctly in part (a). They also justified that common salt is a compound by giving correct points in part (b). These candidates had sufficient knowledge on mixtures and compounds. Extract 11.1 shows a sample of correct responses from one of the candidates.


11 The difference between Homogeneous Mixture and Heterogeneous Mixture

(a)

	Homogeneous Mixture	Heterogeneous.
(a)	Particles are dissolved completely	Are suspended (Not dissolved completely
2	The particles can be separated by evaporation.	can be separated by filtration method.
3	It is transparent and clear	it Opaque / Not clear.

(b) The common salt is a compound due to the following reasons. Some of them are:

(i) As we any compound can be separated/decompound by chemical means.

(ii) Also it is combination of elements chemically.

(iii) In forming of compound like NaCl energy can be Used to speed up the rate of chemical reaction.

(iv) The properties of a compound is differ from an individual elements forexample properties of Na differs from NaCl.

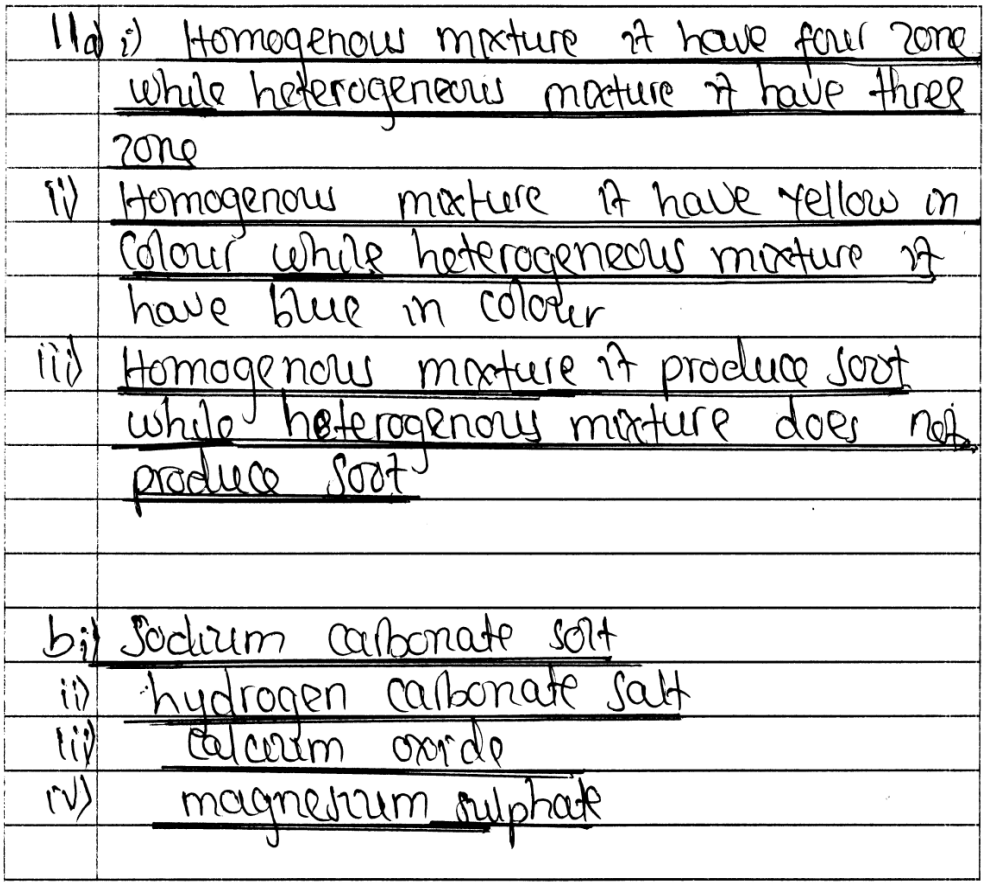
Extract 11.1: A sample of correct responses in question 11

In extract 11.1, the candidate correctly differentiated homogeneous from heterogeneous mixtures in part (a). In part (b), he/she gave reasons to justify the fact that the common salt is a compound.

On the contrary, some of the candidates who scored low marks differentiated between solute and solvent in part (a) which was not the demand of the question. Others gave differences between physical and chemical changes of matter. For instance, one candidate wrote that a change in homogeneous mixture is not permanent while a change in heterogeneous mixture is a permanent one. Similarly, some candidates gave incorrect examples of homogenous and heterogeneous mixtures instead of differentiating the two.

In part (b), some of the candidates gave points pertaining to properties of mixtures instead of compounds. Other candidates wrote scientific name of

the common salt which is sodium chloride while others gave the chemical formula which is NaCl. Likewise, some of the candidates mentioned different salts such as copper sulphate. Furthermore, there were candidates who cited domestic uses of sodium chloride such as source of ingredients in food instead of justifying common salt being a compound. Extract 11.2 shows a sample of incorrect responses from one of the candidates.



Extract 11.2: A sample of incorrect responses in question 11

In extract 11.2, the candidate wrote concepts pertaining to luminous and non-luminous flames instead of mixtures in part (a). In part (b), he/she gave names of compounds instead of stating properties of sodium chloride as a the compound.

2.1.12 Question 12: Extraction of Metals

The question comprised parts (a) and (b). In part (a), candidates were required to give three ways in which environmental destruction is likely to

occur during extraction of metals. Part (b) was not awarded because of typing error in the question.

A total of 151,981 (99.9%) candidates attempted this question. Statistics of candidates' performance indicate that 45.77 per cent of the candidates scored from 0 to 2.0 marks, 17.66 per cent scored from 2.5 to 4.5 marks and 36.57 per cent scored from 5.0 to 7.0 marks. Thus, the general performance of candidates in this question was an average as 54.23 per cent scored 2.5 marks or above. Summary of candidates' performance is shown in Figure 11.

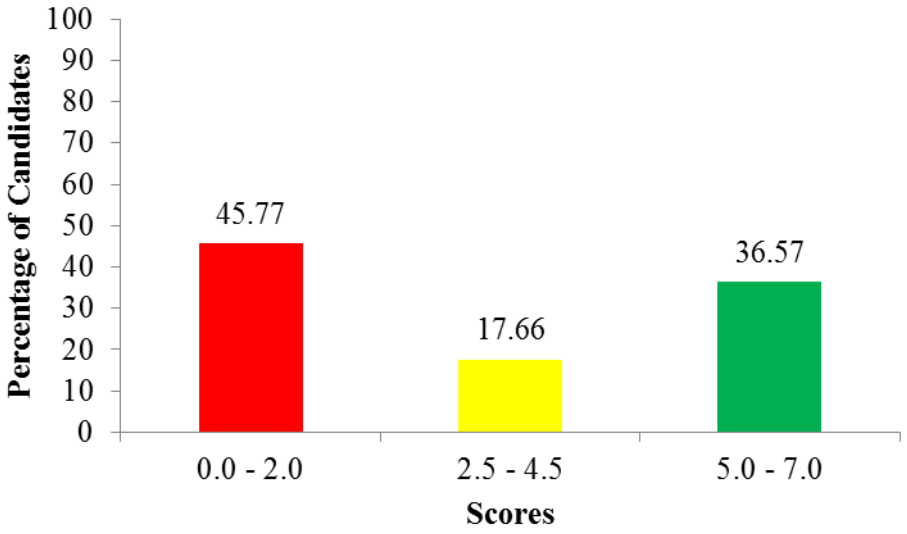


Figure 11: *Candidates' Performance in Question 12*

Analysis of candidates' responses shows that, the candidates who scored high marks pointed out three ways in which extraction of metals may cause destruction to the environment. This implies that the candidate had sufficient knowledge on the use of safe methods of extracting metals as far as environmental aspects are concerned. Extract 12.1 shows correct responses from one of the candidates.

12. (a) Environmental destruction is likely to occur during extraction of metal by.

(i) Cutting down of trees hence deforestation

(ii) Spilling of wastes in water sources thus killing of aquatic organism.

(iii) Release of harmful gas from the machine hence destruction of ozone layer.

Extract 12.1: A sample of correct responses in question 12

In extract 12.1, the candidate gave correct ways in which extraction of metals may cause environmental destruction.

Candidates who scored low marks failed to state correct ways through which extraction of metals may lead to environmental destruction. Some of them explained the concept of pollution. Others went far by pointing out three types of pollution which are terrestrial, aerial and water pollution. Yet others stages involved in extracting metals from their ores such as concentration and roasting. Similarly, few candidates listed some common ores of metals. Extract 12.2 shows incorrect responses from one of the candidates.

12 (a) (i) The environmetal destruction like Arusha

(ii) The environmetal destruction like Diomond

(iii) The environment destruction like morogoro

Extract 12.2: A sample of incorrect responses in question 12

In extract 12.2, the candidate cited Arusha and Morogoro as examples of environmental destruction. He/she also cited Diamond which is an allotropy of carbon.

2.1.13 Question 13: Soil Chemistry

This question was optional and required the candidates to explain six ways of maintaining soil fertility of a particular area.

A total of 139,107 (91.5%) candidates attempted this question. Statistics of performance indicates that 13.40 per cent of the candidates scored from 0 to 4.0 marks, 26.09 per cent scored from 4.5 to 9.5 marks whereas 60.51 per cent scored from 10.0 to 15.0 marks. The general performance was good in which 86.60 per cent of the candidates scored 4.5 marks or above. Figure 12 gives summary of candidates' performance in this question.

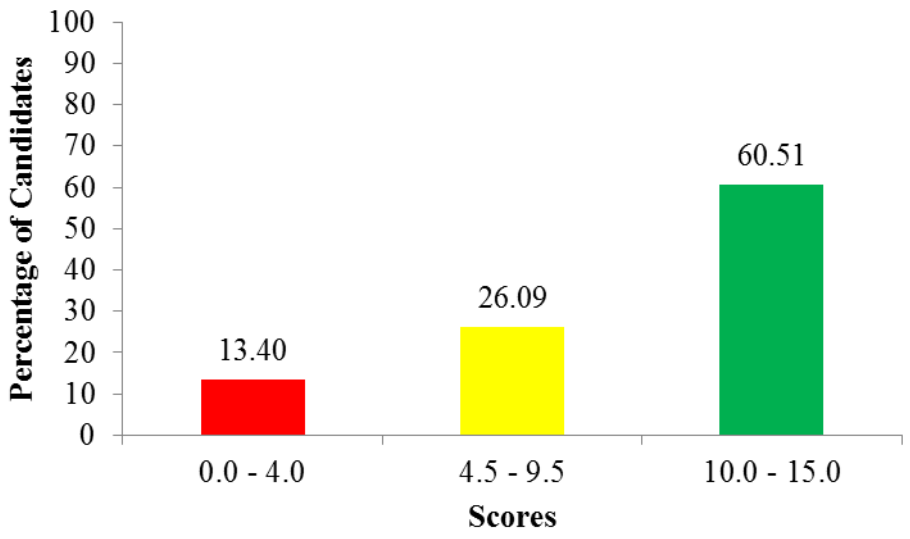


Figure 12: *Candidates' Performance in Question 13*

Candidates who scored high marks in this question gave correct points on ways to maintain soil fertility of a particular area. Those candidates started with appropriate introduction and ended the essay with commendable conclusions. Candidates in this category had adequate knowledge on soil fertility and appropriate skills of writing an essay. Extract 13.1 is one of the correct responses from one candidate.

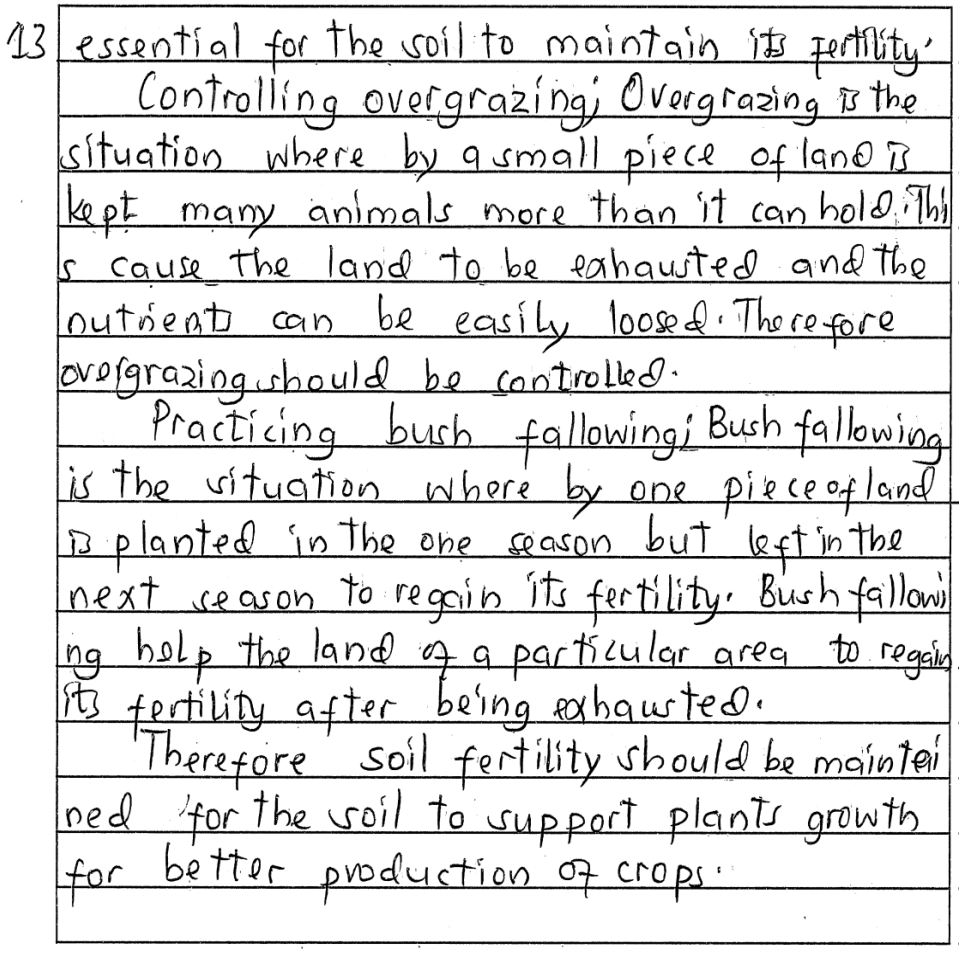
13. Soil fertility is the ability of the soil to support plants growth in relation to the nutrients contained in it. Soil fertility is the one which enable soil to plants to grow well. The following are the ways of maintaining soil fertility of a particular area:

Avoiding monocropping for a long duration; Monocropping is the practice of planting a single crop for a long period of time. In order to maintain soil fertility of a particular area people should avoid planting the same crop for a long time. Example can plant beans in one season and maize in the next season.

Controlling soil erosion; Soil erosion is the removal of upper layer of the soil by erosion agents such as wind, glacier and surface run-off. When the upper layer of the soil is removed the nutrients are lost because is the one with nutrients. So people must control soil erosion to avoid lasting of nutrients.

Using manures rather than industrial fertilizers; Manures are organic compound while fertilizers are inorganic compound containing one or more nutrients necessary for plant growth. Fertilizers hinder the activity of microorganisms in the soil which cause soil to be infertile. So people should use manures to maintain soil fertility.

Planting leguminious plants; leguminious plants are the plants which contain the bacteria in their root necessary for converting atmospheric nitrogen into nitrate which is

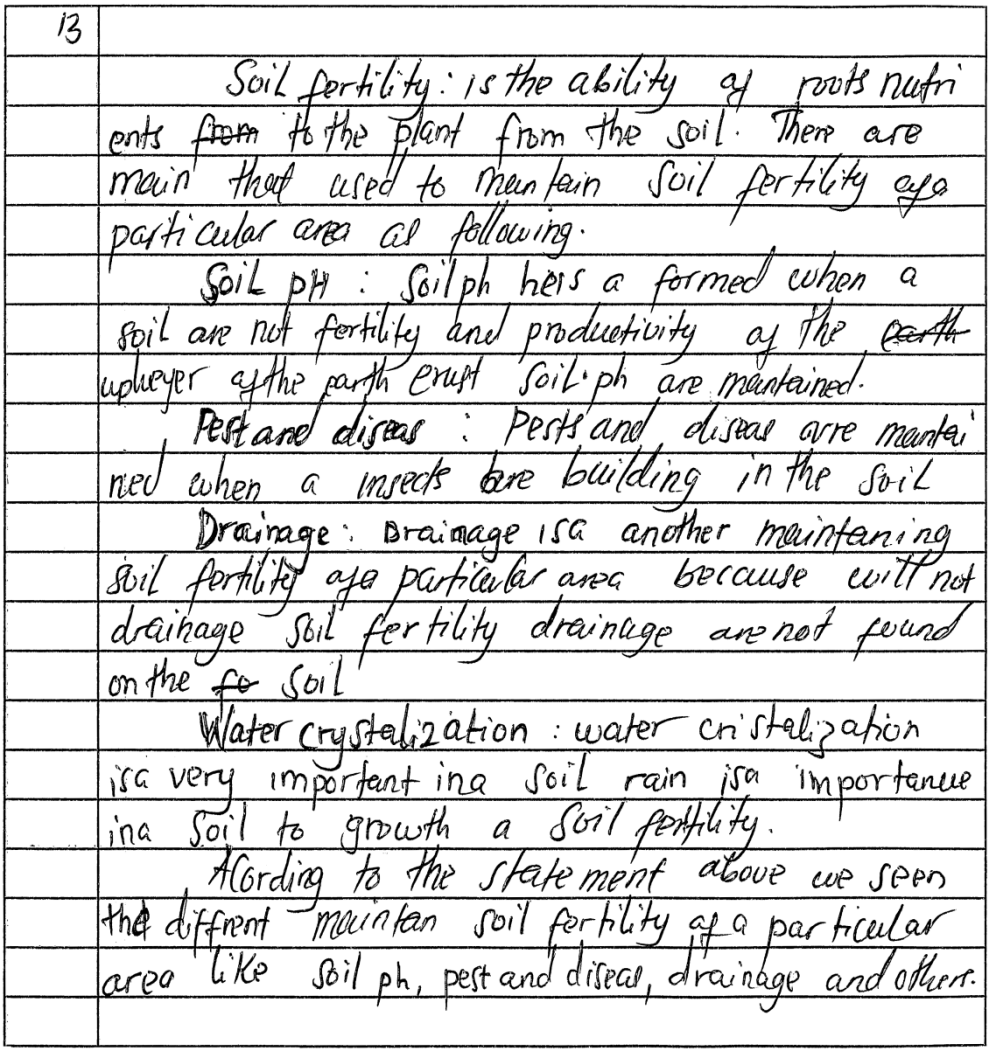

13 essential for the soil to maintain its fertility.
Controlling overgrazing; Overgrazing is the situation where by a small piece of land is kept many animals more than it can hold. This cause the land to be exhausted and the nutrients can be easily loosed. Therefore overgrazing should be controlled.
Practicing bush fallowing; Bush fallowing is the situation where by one piece of land is planted in the one season but left in the next season to regain its fertility. Bush fallowing help the land of a particular area to regain its fertility after being exhausted.
Therefore soil fertility should be maintained for the soil to support plants growth for better production of crops.

Extract 13.1: A sample of correct responses in question 13

In extract 13.1, the candidate wrote appropriate essay by correctly explaining six points on how to maintain soil fertility. He/she also wrote relevant introduction as well as conclusion.

On the contrary, candidates who scored low marks in this question lacked knowledge about soil fertility. Some of them gave explanation on formation of soil through weathering. Similarly, they explained factors which influence soil formation. Some of them explained indicators of a fertile land. There are candidates who explained ways through which soil can lose nutrients which indicates that they did not understand the requirement of the question. Few candidates incorrectly included points such as water, gravity, temperature changes and human beings, as methods of maintaining soil fertility. These candidates confused agents of

weathering with ways of maintaining soil fertility. In addition, some candidates who lacked skills of writing essay wrote their responses by numbering each point or paragraph. Generally, the candidates lacked adequate knowledge on practices that maintain soil fertility and also essay writing skills. Extract 13.2 is a sample of poor responses to question 13.


13

Soil fertility: is the ability of roots nutri ents ~~from~~ to the plant from the soil. There are main that used to mentain soil fertility aga particular area al following.

Soil pH : Soil ph heis a formed when a soil are not fertility and productivity of the ~~earth~~ upleyer of the earth crust soil ph are mantained.

Pest and diseas : Pests and diseas are mantai ned when a insects are building in the soil

Drainage: Drainage isa another maintaning soil fertility aga particular area because with not drainage soil fertility drainage are not found on the ~~fo~~ soil

Water crystalization : water cristalization isa very important ina soil rain isa importance ina soil to growth a soil fertility.

Acording to the statement above we seen the different maintan soil fertility of a particular area like soil ph, pest and diseas, drainage and others.

Extract 13.2: A sample of incorrect responses in question 13

In extract 13.1, the candidate described factors affecting yield of crops and the concept of water of crystallization instead of describing ways of maintaining soil fertility of particular area.

2.1.14 Question 14: Ionic Theory and Electrolysis

The question was optional and required candidates to describe application of electrolysis in industries by giving six points.

A total of 12,683 (8.30%) candidates attempted this question. Candidates who scored from 0 to 4.0 marks were 34.61 per cent, 4.5 marks to 9.5 marks were 33.91 per cent and 10.0 to 15.0 marks were 31.48 per cent. Generally, 65.39 per cent of candidates scored 4.5 marks and above which implies an average performance. Summary of candidates' performance is displayed in Figure 13.

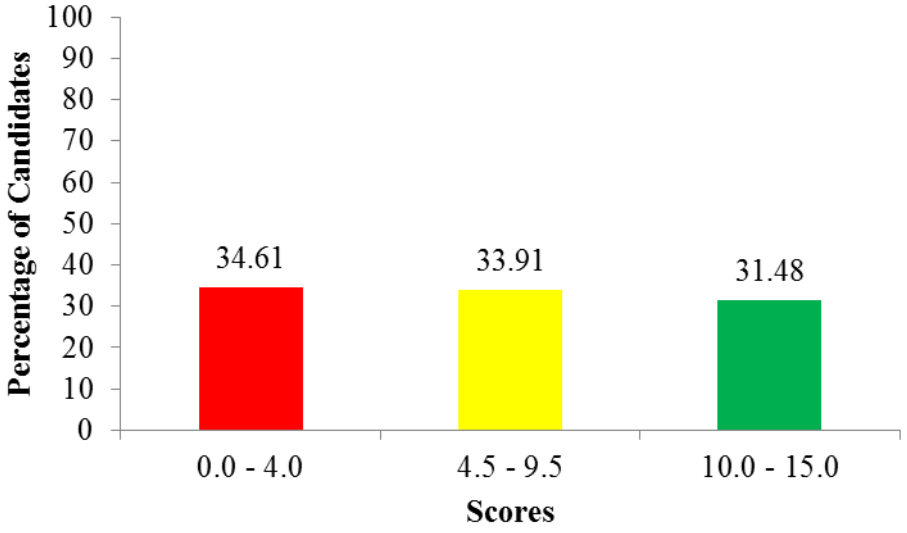


Figure 13: *Candidates' Performance in Question 14*

The analysis indicates that, candidates who scored high marks correctly described significance of electrolysis in industries. For instance, some candidates pointed out that electrolysis is used in production of gases in industries. The candidates mainly based their explanations on electroplating, purification of metals, preparation of gases and extraction of metals. The candidates had also adequate skills of writing essay by including introduction, main body and conclusion. Extract 14.1 shows correct responses from one of the candidates.

14) Electrolysis is the chemical breakdown of a compound by the use of electricity or when electricity passes through it. Electrolysis occurs ~~the~~ in an electrolytic cell. The electrolytic cell consists of an external power source, electrolyte and the electrodes (cathode and anode). The following are ways through which electrolysis is applied in industries.

Electroplating. This is the process of coating a metallic material with another metal with the use of an electric current. The material to be electroplated is fixed as the cathode of the electrolytic cell. The metal ions that dissociate into the electrolyte from the anode are then reduced at the cathode. This forms a metal coating on the material.

Production of gases. Electrolysis is used in industries to produce gases at a larger scale. Gases such as oxygen and Hydrogen can be produced through electrolysis in the Hoffmann's voltameter. The oxygen is produced at anode while hydrogen is produced at the cathode

At cathode: $2H^+(aq) + 2e^- \longrightarrow H_2(g)$

At Anode: $4OH^-(aq) \longrightarrow O_2(g) + H_2O(l) + 4e^-$

These gases can be produced by electrolysis of water or Dilute Sulphuric acid.

Production of Caustic Soda. Caustic soda/Sodium Hydroxide can be produced in industries through electrolysis of Brine (concentrated sodium chloride solution) in a special cell. This involves the discharge of Sodium Hydroxide as one of the outlets from the cell.

Purification of Metals. Electrolysis can be used in the industries to ~~produce~~ purify metals such as copper. A pure meta strip is placed as the cathode electrode while the impure metal is placed as the anode. The metal ions dissociate from the anode and are

14) are deposited on the cathode as pure metal. Example is the purification of copper by electrolysis.

At Anode: $Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$

At Cathode: $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$.

Extraction of metals. Electrolysis is applied in industries when extracting some metals especially very reactive metals that are high at the top of the reactivity series. Aluminium and Sodium are extracted by this method. Sodium is extracted by a special cell known as the down cell. Electrolysis in the down cell occurs where by Brine / molten rock salt is the electrolyte. It dissociates into Sodium and Chlorine ions. Sodium ions migrate to the cathode while chlorine ions migrate to the anode. The sodium ions are reduced to obtain sodium metal that is still in molten state.

$Na^+(aq) + e^- \longrightarrow Na(l)$.

Purification of water. Electrolysis can be used in purification of water so as to be used in research and medical facilities. When water is electrolyzed the cations apart from Hydrogen ions migrate to the cathode where they are liberated or deposited. Also the anions apart from Hydroxyl ions migrate to the anode where they are deposited or liberated thus leaving the water free of impurities.

Generally, Electrolysis is a very significant process with a wide field and range of application in both industries and other facilities.

Extract 14.1: A sample of correct responses in question 14

In extract 14.1, the candidate correctly explained six points on the application of electrolysis in industries.

On the contrary, the candidates who scored low marks failed to explain correctly the application of electrolysis in industries. Some of them wrote fields in which electrolysis is applied instead of giving the specific task being achieved through electrolysis in the industries. There are candidates who gave description of weak and strong electrolytes such as sulphuric acid, sodium hydroxide and hydrochloric acid. Other misconceptions of the candidates included explaining the mechanism of electrolysis and the preferential discharge of ions during electrolysis. Thus, the incorrect responses are an indication that the candidates lacked adequate knowledge on application of electrolysis in daily life processes. Extract 14.2 shows a sample of incorrect responses from one of the candidates.

14. Electrolysis is a mogement of the electr
cal source. The applied in industries the as
following :-

firstly; medicine : is the applied of
industries of air pullution but also is the
Chemical of the equilibrium the stymes
of the industries.

Secondly; Chlorofluro Carbonate ; is the
source of industries applied of the air
popullation in the chemical reaction of
the molecular formula.

Thardly; Carbondaoxide; Is the source
of industries to applied of the air po-
pullation in the equilibrium the chemi-
cal the industries.

fourthly; Sulphuric acid; Is the source
of industries to applied of the air popullat
tion in the equilibrium the chemica-
l industries.

fivethly; Energy; Is the source of in
dustries to applied of the air popullation
in the equilibrium the chemical ind-
ustries is the source of energy.

sixthly; Tlex industries; Is the source
of industries to applied of the air popullati
in the equilibrium the Chemical indus-
tries is the source of Tlex industries.

Extract 14.2: A sample of incorrect responses in question 14

In extract 14.2, the candidate gave incorrect responses ranging from fields, compounds and energy. The last point stated was incorrect and he/she failed to write conclusion.

2.2 032/2 CHEMISTRY 2 (PRACTICALS)

There were three alternative papers of Actual Practical, namely 032/2A Chemistry 2A, 032/2B Chemistry 2B and 032/2C Chemistry 2C. Each paper consisted of two questions weighing 25 marks each. Question 1 was derived from the topic of *Volumetric Analysis* while question 2 was derived from the topic of *Chemical Kinetics, Equilibrium and Energetics*.

2.2.1 Question 1: Volumetric Analysis

The question was attempted by 59,190 (100%) candidates. Statistics show that 15.70 per cent of the candidates scored 0 to 7.0 marks, 40.70 per cent scored 7.5 to 16.0 marks and 43.60 per cent scored from 16.5 to 25.0 marks. Generally, candidates' performance in this question was good with 84.30 per cent of the candidates scoring 7.5 marks or above. Summary of the performance is shown in Figure 14.

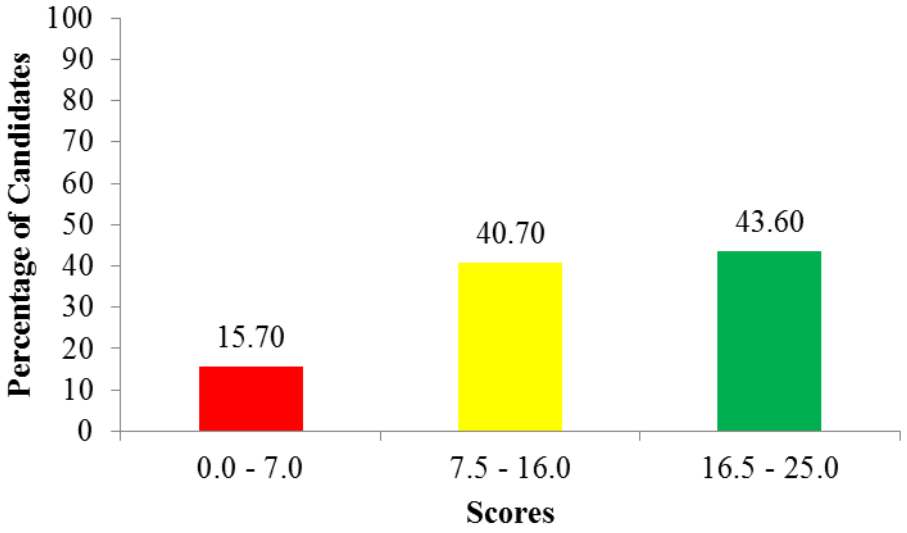


Figure 14: *Candidates' Performance in Question 1*

2.2.1.1 Alternative 2A

The candidates were provided with two beakers labeled LL containing 6.3 g of dibasic acid, $H_2C_2O_2.XH_2O$ dissolved to make 1 litre of solution and MM containing aqueous sodium hydroxide made by dissolving 4.0 g of the salt dissolved to make 1 litre of solution. The candidates were required to determine the value of X in the acid $H_2C_2O_2.XH_2O$ by the normal titration procedure where the aqueous NaOH solution in the titration flask is titrated against the dibasic acid from the burette using POP as indicator and obtain three titration volumes. They were then required to:

(a) (i) Indicate the volume of pipette used.

(ii) Complete the table of results and compute the average volume of acid used for complete neutralization of MM.

(b) Calculate the molarity of the base

(c) Write a balanced chemical equation for the reaction taking place

(d) Calculate the molarity of the acid

(e) Calculate

(i) The value of X in $H_2C_2O_4.XH_2O$

(ii) The percentage of water of crystallization in $H_2C_2O_4.XH_2O$

The candidates who scored high marks correctly filled the table of results, gave the volume of pipette used and wrote balanced chemical equation for the reaction between NaOH and $H_2C_2O_4$. They also followed the correct procedures and applied correct formulas in calculating molarity of the acid ($H_2C_2O_4$) and base (NaOH). They also managed to calculate value of X and percentage of water of crystallization in $H_2C_2O_4.XH_2O$. Extract 15.1 shows correct responses from one of the candidates.

01. (a) (i) The volume of pipette used was 25.00 cm^3

(ii)

TITRATION	1	2	3
Final volume of acid used in (cm^3)	25.20	25.00	24.80
Initial volume of acid used in (cm^3)	0.00	0.00	0.00
Volume of acid used	25.20	25.00	24.80

Average volume of acid used $= \frac{Volume_1 + Volume_2 + Volume_3}{3}$

Average volume of acid used $= \frac{25.20cm^3 + 25.00cm^3 + 24.80cm^3}{3}$

Average volume of acid used $= 25cm^3$

4. (b) Recall

Molarity of base = $\frac{\text{concentration of base}}{\text{Molar mass of base}}$

Molarity = $\frac{4\ g/dm^3}{40\ g/mol}$

Molarity = 0.1M

∴ Molarity of base is 0.1M

(c) A balanced chemical equation for the reaction is shown below

$$H_2C_2O_4(aq) + 2NaOH(aq) \rightarrow Na_2C_2O_4(aq) + 2H_2O(l)$$

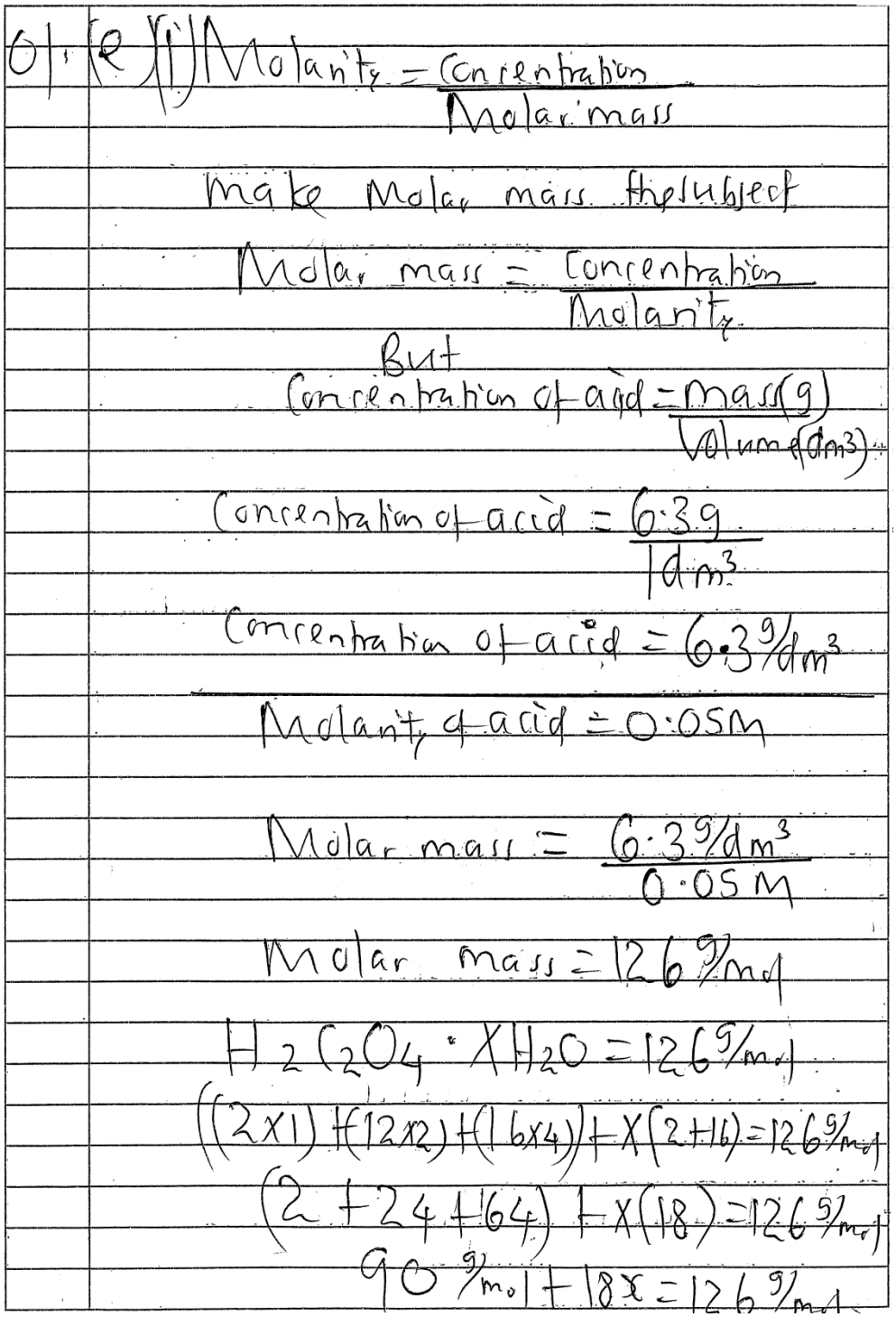
(d) Required Molarity of acid(Ma) =?

from

titration formular

$\frac{MaVa}{na} = \frac{Mb.Vb}{nb}$

make Molarity of acid the subject of the formular



Extract 15.1: A sample of correct responses in question 1 paper 2A.

In Extract 15.1, the candidate filled the table with correct data, followed correct procedure in the subsequent calculation, thus managed to determine the value of X in $H_2C_2O_2.XH_2O$ and percentage of water crystallization in the acid.

On the other hand, the candidates who scored low marks (7.8%) attempted most parts of the question incorrectly. Analysis of candidates' responses showed that some of them recorded incomplete data by filling the table of results partially. For instance, others did not adhere to filling data in two decimal places. There were also candidates who filled only two columns of the table instead of three. Others failed to indicate the unit of volume which is cm^3 and the volume of the pipette used. In this case, results obtained by using a pipette marked 20 cm^3 were expected to be in the range of $20 \pm 01\ cm^3$ which is different from those obtained by using a pipette marked 25 cm^3 which ranged from $25 \pm 01\ cm^3$. However, some candidates obtained inaccurate volumes with a deviation greater than $1\ cm^3$.

In calculating molarity of base in part (b), some candidates did not consider to divide concentration by molar mass. For example, one candidate wrote that *molarity = molar mass/concentration*. Similarly, these candidates failed to write a balanced chemical equation between $H_2C_2O_4$ and NaOH in part (c). For instance, one candidate wrote $NaOH + H_2C_2O_4 \rightarrow HCl$. The candidate wrote incorrect product and failed to indicate both state symbols and reaction coefficients. Consequently, failure to balance the equation led to incorrect mole ratios. Thus, in part (d) candidates used incorrect mole ratio to calculate molarity of the acid. In part (e), the candidates used incorrect formulas in calculating the value of X in $H_2C_2O_2.XH_2O$ and the percentage of water of crystallization. For instance, some candidates divided molarity over concentration to get molar mass of the impure acid. Also, in equating $H_2C_2O_4.XH_2O = 126$, some candidates substituted atomic masses while omitting the molar mass of water mistakenly. In this way, they got incorrect number of water of crystallization and the subsequent water of crystallization. Extract 15.2 shows examples of incorrect responses in this question.

		1	2	3	
1@	Burret reading	25.00	25.00	25.00	
	Initial Volume	0.00	0.00	0.00	
	Volume of HCl	22.7	23.3	23.4	

b) Molarity

Formular

$$\left\{\text{Molarity} = \frac{MAVA}{MbVb}\right\} \left\{\frac{MaVa}{MbVb}\right\}$$

⇒ Solution

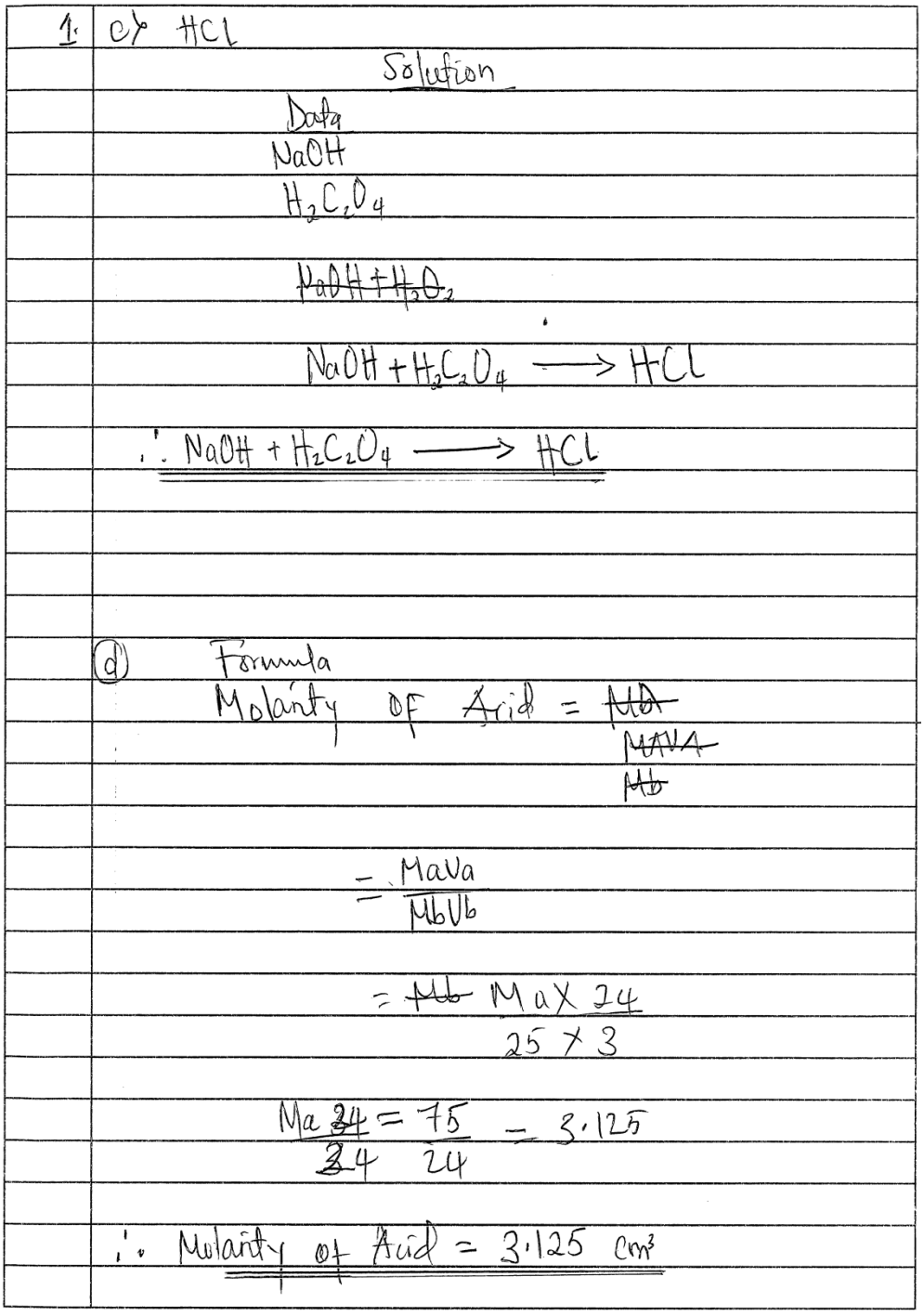
$$\left\{\text{Molarity} = \frac{MAVA}{MbVb}\right\} \left\{\frac{MaVa}{MbVb}\right\}$$

$$= \frac{25 \times 24}{25 \times 3}$$

$$= \frac{400}{75}$$

$$= 5.3$$

∴ The molarity of the Base = 5.3 cm^3



Extract 15.2: A sample of incorrect responses in question 1 paper 2A

In Extract 15.2, the candidate filled the table of results with data which are out of range and without indicating unit of volume. He/she calculated

molarity of base using inappropriate formula and ended up using incorrect unit (cm^3) in part (b). In part (c), the candidate wrote incorrect chemical equation for the reaction. In part (d), the candidate used wrong formula and incorrect unit in calculating molarity of the acid.

2.2.1.2 Alternative 2B

The candidates were given two unlabeled beakers containing solution of an acid and an alkali. They were then required to identify the solutions (acid and alkali) by pouring about 2 cm^3 of each solution into separate test tubes and adding few drops of phenolphthalein indicator (POP) in both test tubes.

The candidates were then required to label the identified alkali as **A** and the acid as **C**. They were given the information that, solution **A** contained 5.6 g of pure potassium hydroxide in 1 dm^3 of solution and solution **C** had 6.0 g of an impure sulphuric acid in 1 dm^3. They were then required to answer the following questions:

(a) *What was the colour of phenolphthalein indicator (POP) indicator in solution **A** and **C**, respectively?*

(b) *Titrate the acid (in a burette) against the alkali (in a conical flask) using two drops of phenolphthalein indicator (POP) as an indicator. Repeat the process and obtain three titre values. Record the results in a tabular form.*

(c) *What was the volume of the pipette used?*

(d) *What was the colour change at the end point?*

(e) *Calculate the average volume of the acid used.*

(f) *Showing your procedures clearly, determine the percentage purity of the sulphuric acid.*

Candidates who scored high marks in this question correctly identified the two solutions as acid and base. Also, they properly followed all the procedures during the titration as they indicated correct volume of the pipette used. They also gave correct colour of phenolphthalein indicator (POP) in each of the two solutions given in part (a). In part (b), they obtained the correct titre volume of the acid and wrote balanced chemical equation of the reaction between KOH and H_2SO_4 from which they obtained correct mole ratios. Finally, they used correct formulas and applied appropriate mathematical skills to determine the percentage purity of sulphuric acid. Extract 16.1 shows a sample of the correct responses.

4. TABLE OF RESULTS.

TITRATION	PILOT	1	2	3
Final volume (cm^3) reading	26.40	25.10	25.00	24.90
Initial volume (cm^3) reading	0.00	0.00	0.00	0.00
Volume used (cm^3)	26.40	25.10	25.00	24.90

(c) 25 cm^3 was the volume of the pipette used.

(d) Colourless was the colour change at the end point

(e) The average volume of the acid used —?

$$\text{Average volume} = \frac{25.10 + 25.00 + 24.90}{3}$$

$$= \frac{75.00}{3}$$

∴ Average volume of acid = 25.00 cm^3.

∴ 25.00 cm^3 was the average volume of the acid used.

(f) Determining the Percentage purity of the sulphuric acid-?

Solution

Data given:

Mass of Pure KOH = 5.6 g

Volume of Pure KOH = 1 dm^3

Mass of Impure acid H_2SO_4 = 6.0 g

Volume of Impure acid H_2SO_4 = 1 dm^3

Percentage purity of acid H_2SO_4 — ?

1. (f) From;

Percentage Purity of an acid $= \frac{\text{Concentration of Pure acid}}{\text{Concentration of Impure acid}} \times 100$

But;

The concentration of Impure $= \frac{\text{Mass of acid (g)}}{\text{Volume of acid (dm}^3\text{)}}$

$= \frac{6.0\ g}{1\ dm^3}$

∴ Concentration of Impure acid $= 6g/dm^3$

∴ $6g/dm^3$ is the concentration of impure acid (H_2SO_4)

Where;

The concentration of Pure acid obtained from;

$\frac{M_a V_a}{M_b V_b} = \frac{n_a}{n_b}$

$M_a = \frac{M_b V_b \times n_a}{V_a \times n_b}$

n_a and n_b obtained from a balanced chemical equation between acid (H_2SO_4) and base (KOH).

Equation;

$$H_2SO_{4(aq)} + 2KOH_{(aq)} \longrightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}$$

$n_a : n_b$

$1 : 2$

But;

Molarity of base $= \frac{\text{Concentration (g/dm}^3\text{)}}{\text{Molar mass (g/mol)}}$

Then; Concentration of base $= \frac{\text{Mass (g)}}{\text{Volume (dm}^3\text{)}}$

1. (f) Concentration of base = $\frac{5.6\,g}{1\,dm^3}$

∴ Concentration of base (KOH) = $5.6\,g/dm^3$

Where;

Molar mass of KOH = 39 + 16 + 1

∴ Molar mass of KOH is 56 g/mol.

Recalling;

Molarity of base (mol/dm³) = $\frac{\text{Concentration } (g/dm^3)}{\text{Molar mass } (g/mol)}$

$= \frac{5.6\,g/dm^3}{56\,g/mol}$

∴ Molarity of base KOH = $0.1\ mol/dm^3$

Then;

Recalling;

$\frac{MaVa}{MbVb} = \frac{na}{nb}$

$Ma = \frac{MbVb \times na}{MaVa \times nb}$

$Ma = \frac{0.1 \times 25 \times 1}{25 \times 2}$

$Ma = \frac{2.5}{50}$

∴ $Ma = 0.05\ M$

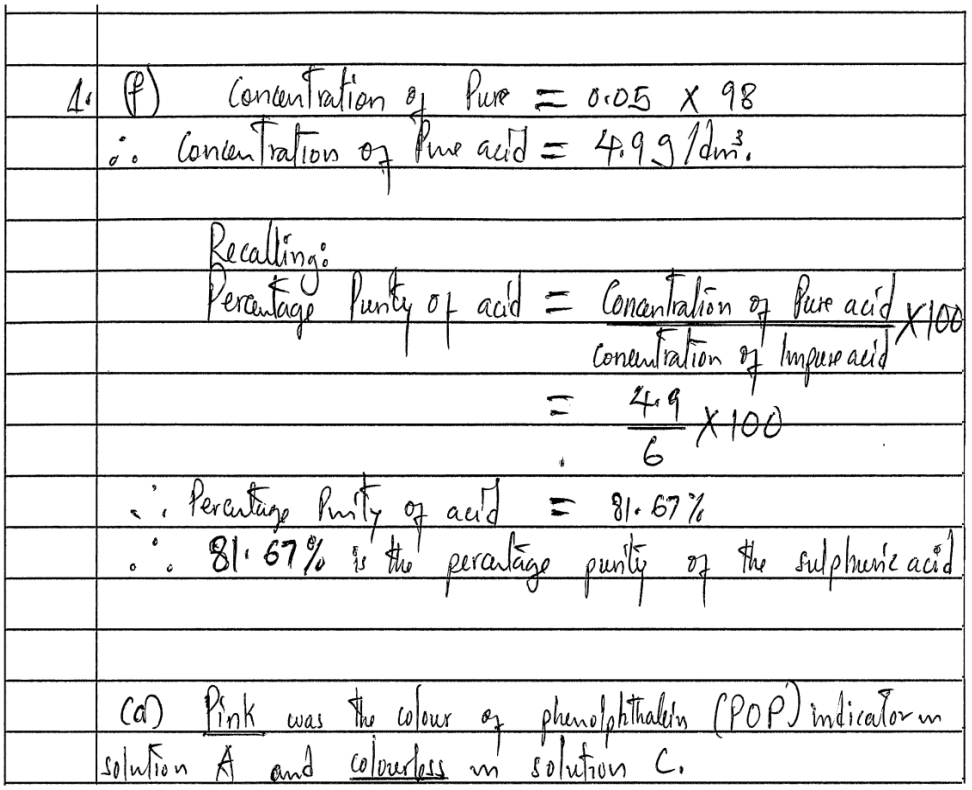
∴ The molarity of acid (H_2SO_4) is 0.05 M.

Where;

Concentration of pure acid = Molarity × Molar mass

But;

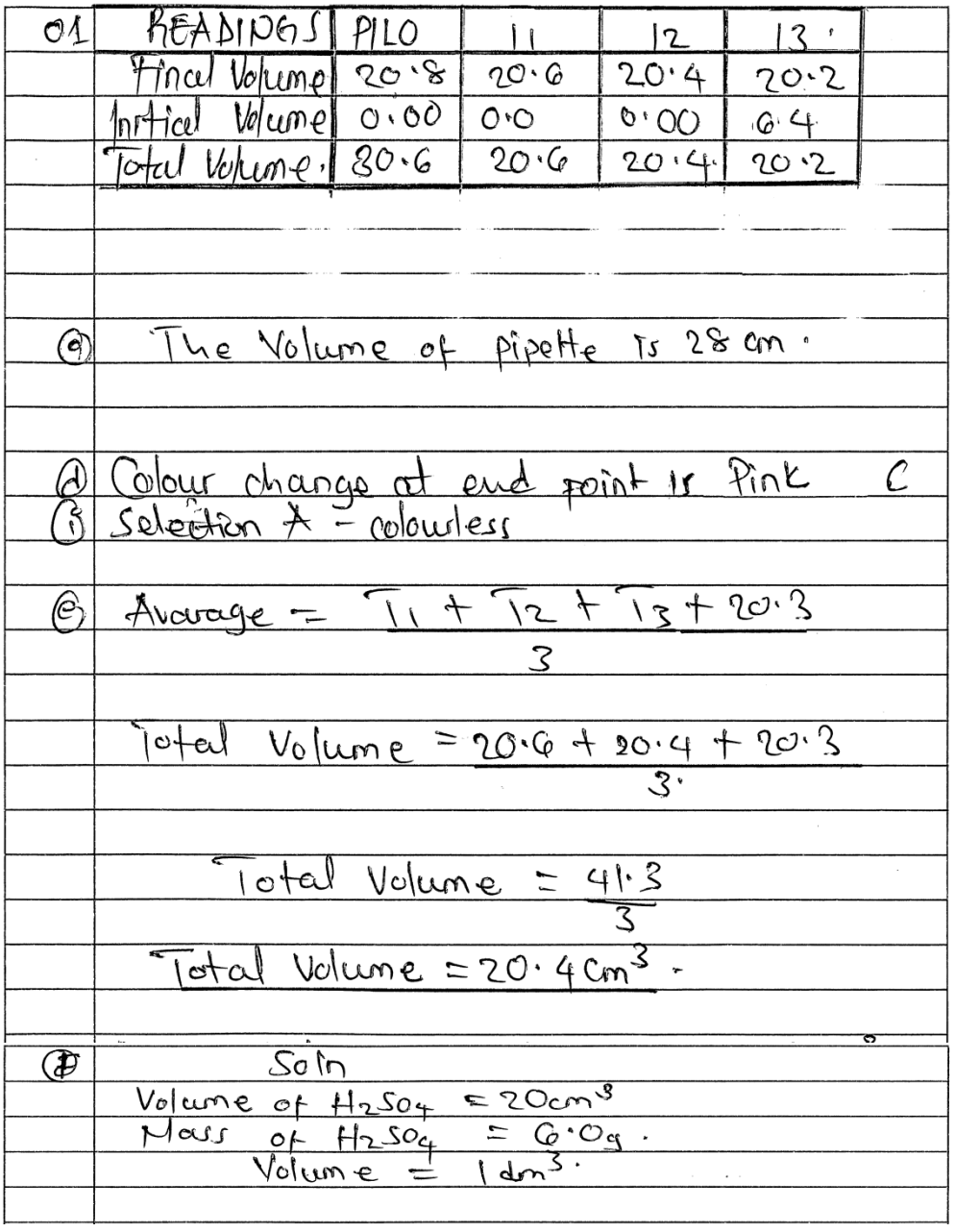
Molar mass of H_2SO_4 = (1)2 + 32 + (16)4 = 98 g/mol



Extract 16.1: A sample of correct responses in question 1 paper 2B

In Extract 16.1, the candidate correctly identified the acid and base in the unlabeled beakers. Then, he/she correctly filled the table of results and carried out the subsequent calculations, thus obtained correct percentage purity of H_2SO_4.

On the other hand, candidates who scored low marks failed to give correct identity of the acid and base hence failed to correctly proceed on the remaining part of the question. Some indicated incorrect volume of the pipette used. For example, some candidates claimed to use pipettes of 25 cm^3 while their data seemed more close to pipettes of 20 cm^3 and vice versa. The candidates also gave incorrect colour of phenolphthalein indicator (POP) in each of the two solutions given in part (a). In part (b), they obtained incorrect titre volume of the acid and wrote inappropriate chemical equations for the reaction between KOH and H_2SO_4. Consequently, the candidates obtained incorrect mole ratios. They also used incorrect formulas and showed inadequate mathematical skills in the process of determining the percentage purity of sulphuric acid. For instance, one candidate got a percentage purity amounting to 100% which was not appropriate. Extract 16.2 shows a sample of incorrect responses.



Extract 16.2: A sample of incorrect responses in question 1 paper 2B

In Extract 16.2, the candidate incorrectly filled the table of results by not indicating the unit of volume. He/she also gave a wrong volume of pipette (28 cm^3) and interchanged colours of the indicator in the two solutions. He/she used a wrong formula to calculate titre volume and did not carried out the calculation for concentration of the impure acid.

2.2.1.3 Alternative 2C

The aim of the experiment was to determine water of crystallization in sodium carbonate. The candidates were provided with the following solutions:

K: 1.825 g of hydrochloric acid in a 0.50 dm^3 solution.

L: 3.575 g of pure hydrated sodium carbonate ($Na_2CO_3.10H_2O$) in a 0.25 dm^3 of solution.

The candidates were required to titrate the acid (in the burette) against the alkali (in the conical flask) using methyl orange (MO) indicator. Next they had to repeat the procedure to obtain three more titre values and record the results in a tabular form. They were then asked the following questions:

(a) What was the volume of pipette used?

(b) What was the colour change at the end point of titration?

(c) Calculate the average volume of the acid used.

*(d) Showing your procedure clearly, determine the value of **X** (the number of molecules of water of crystallization) in the formula ($Na_2CO_3.XH_2O$).*

The candidates who scored high marks in this question managed to correctly tabulate the data collected. They also properly indicated the volume of the pipette used which was either 20 cm^3 or 25 cm^3. Likewise, they managed to write a correct balanced chemical equation for the neutralization between HCl acid and Na_2CO_3. They also carried out the subsequent calculations and determined molecules of water of crystallization in the impure sodium carbonate. Basically, the candidates had adequate practical skills to determine water of crystallization in a compound such as sodium carbonate. Extract 17.1 shows correct responses from one of the candidates in this question.

1. Given that:
K; 1·825g of hydrochloric acid in 0·50 dm³ of Solution
L; 3·575g of pure hydrated $Na_2CO_3 \cdot XH_2O$ in 0·25 dm³ of Solution

PROCEDURE.
⇒ The acid (in a burette) was titrated against Alkali (in a conical flask) using two drops of Methyl Orange (MO). The procedure was repeated to obtain three more titre value and results was recorded in a tabular form.

Table of result.

Burette reading (cm^3)	PILOT	1	2	3
Final reading (cm^3)	24:90	34:80	45:00	25:20
Initial reading (cm^3)	00:00	10:00	20:00	00:00
Volume of Acid used (cm^3)	24:90	24·80	25:00	25:20

$$\text{Average Volume} = \frac{V_1 + V_2 + V_3}{3}$$

$$= \frac{(24·8 + 25 + 25·2)cm^3}{3}$$

$$= 25\,cm^3$$

∴ Volume of Acid used = $25cm^3$.

ANSWERS
a/ The Volume of Pipette used was $25cm^3$

b/ The colour change at end point of titration
⇒ The colour change from Yellow to Pink

1. ii/ To calculate Molarity of $Na_2CO_3 \cdot XH_2O$.

Solution.

~~Data~~ Eqn for Reaction;

$$Na_2CO_{3(aq)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

$n_a = 2$, $n_b = 1$,

Data; $M_a = 0.1\,M$.

$V_a = 25\,cm^3$

$V_b = 25\,cm^3$

$M_b = ?$

$n_a : n_b = 1 : 2$.

From; $\frac{M_a V_a}{M_b V_b} = \frac{n_a}{n_b}$

$$M_b = \frac{M_a V_a n_b}{V_b n_a}$$

$$M_b = \frac{0.1\,M \times 25\,cm^3 \times 1}{25\,cm^3 \times 2}$$

$M_b = 0.05\,M$ of Na_2CO_3.

iii/ To calculate Molar Mass of $Na_2CO_3 \cdot XH_2O$.

From; $Molarity = \frac{Conc\ g/dm^3}{Mr}$

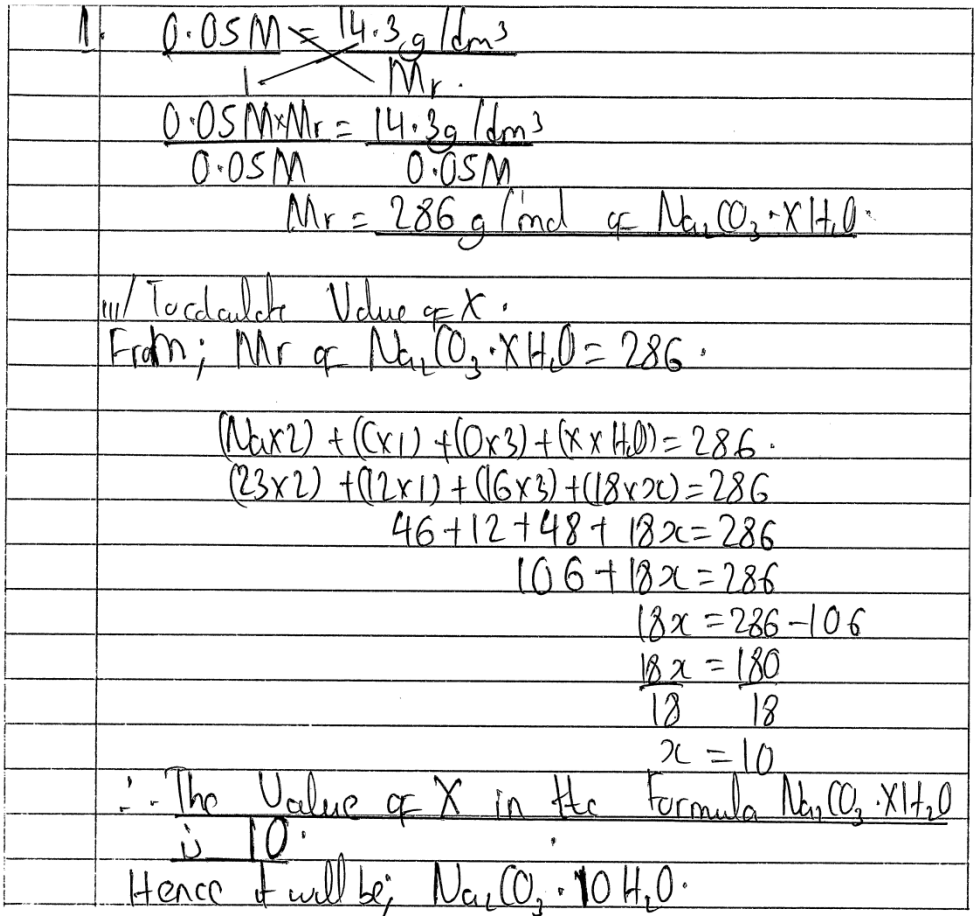
Also; $Conc\ g/dm^3 = \frac{Mass}{Volume}$

$$= \frac{3.575\,g}{0.25\,dm^3}$$

$Conc\ g/dm^3 = 14.3\,g/dm^3$ of $Na_2CO_3 \cdot XH_2O$.

Hence; $Molarity = \frac{Conc\ g/dm^3}{Mr}$

$$0.05\,M = \frac{14.3\,g/dm^3}{Mr}$$

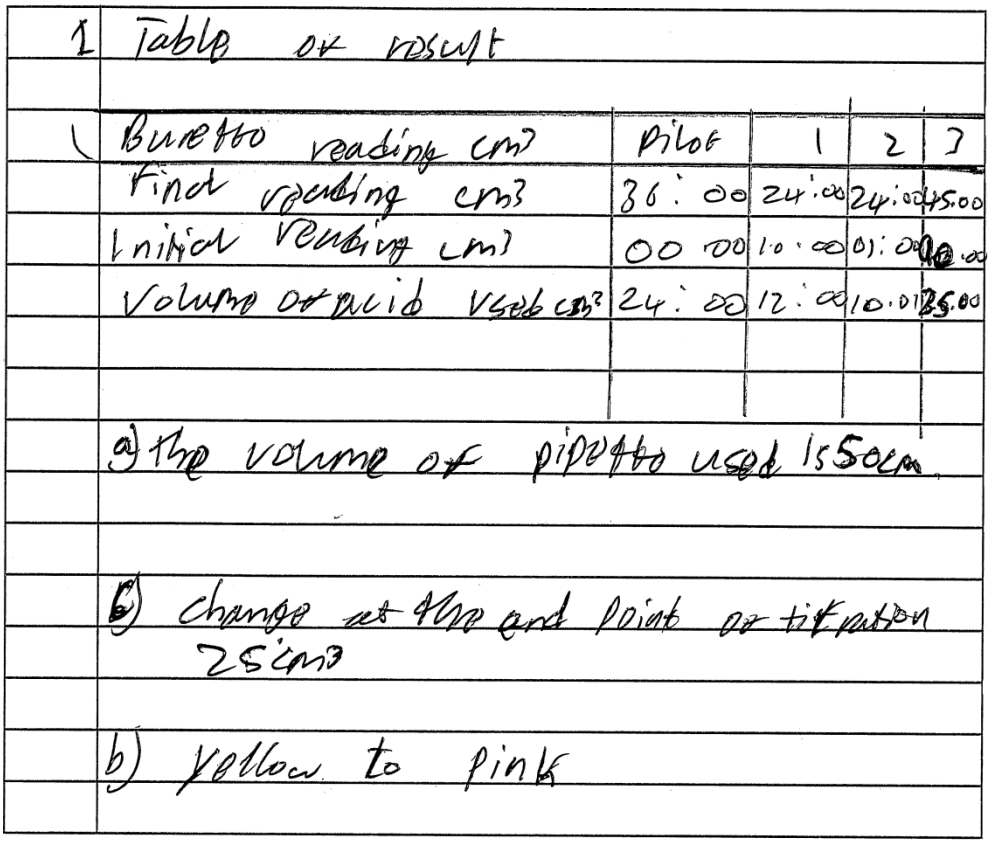


Extract 17.1: A sample of correct responses in question 1 paper 2C

In Extract 17.1, the candidate managed to correctly identify the acid and base. He/she filled the table with correct data and obtained titre volume of the acid used. This enhanced getting the correct value of **X** in the formula $Na_2CO_3.XH_2O$ which was 10.

The candidates who scored low marks failed to attempt most parts of the question correctly. In filling the table of results, some of them wrote the data without indicating two decimal places. Others did not name the columns of the table of results. Also candidates failed to indicate the volume of pipette used and most of the data in the table deviated much from the expected volume. A considerable number of the candidates failed to write correct balanced chemical equation between HCl (acid) and Na_2CO_3 (base) which led to wrong mole ratios. Some of the candidates also used incorrect formulas and demonstrated insufficient mathematical skills in the process of determining the value of **X** in **(**$Na_2CO_3.XH_2O$). For

instance, one candidate calculated the value of X by taking *X = molar mass/mass of the compound* which is the reciprocal of number of moles of the compound. Extract 17.2 shows a sample of incorrect responses in this question.


1 Table of result

Burette reading cm³	Pilot	1	2	3
Final reading cm³	36.00	24.00	24.00	45.00
Initial reading cm³	00.00	10.00	01.00	20.00
Volume of acid used cm³	24.00	12.00	10.01	25.00

a) The volume of pipette used is 50cm

b) Change at the end point of titration 25cm³

b) Yellow to pink

Extract 17.2: A sample of incorrect responses in question 1 paper 2C

In Extract 17.2, the candidate failed to correctly identify the acid and base. He/she filled the table of results using data with significant deviation from the expected ones. Also, the candidate indicated pipette volume of 50 cm instead of either 20 cm^3 or 25 cm^3. Similarly, the candidate failed to perform the subsequent calculations to determine the value of **X** in the formula $Na_2CO_3.XH_2O$. Finally, he/she indicated incorrect colour change of the indicator.

2.2.2 Question 2: Chemical Kinetics, Equilibrium and Energetics

The question was attempted by 59,190 (100%) candidates. Statistics of performance show that 6.50 per cent of the candidates scored from 0 to 7.0 marks, 24.28 per cent scored from 8.0 to 16.0 marks and 69.22 per cent

scored from 16.5 to 25.0 marks. Generally, performance in this question was good with 93.50 per cent of the candidates scoring 8.0 marks or above. Summary of the performance is shown in Figure 15.

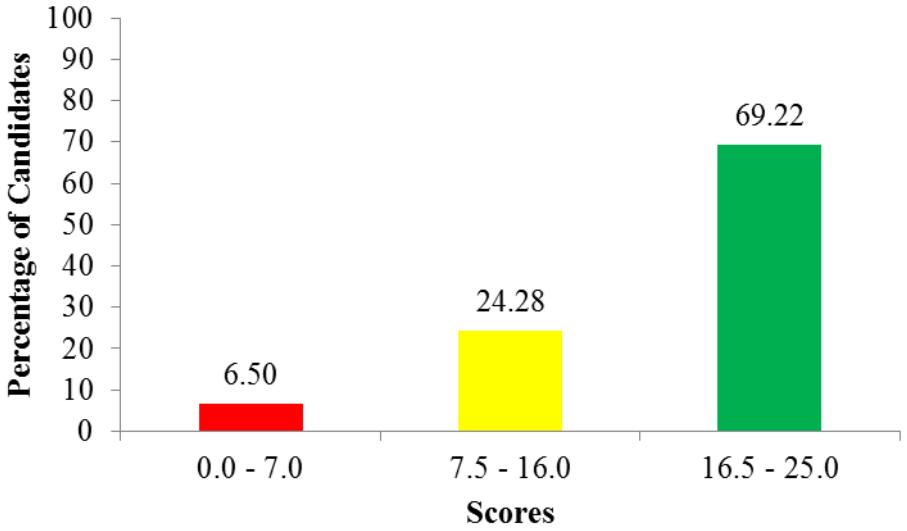


Figure 15: *Candidates' Performance in Question 2*

2.2.2.1 Alternative 2A

The aim of the experiment was to determine the effect of temperature on the rate of chemical reaction. The candidates were required to study the reaction between sodium thiosulphate and nitric acid. The chemicals provided were labeled as **L1** and **L2** containing 0.05 M sodium thiosulphate and 1.0 M nitric acid respectively.

Candidates were provided with the following procedures:

(i) Place a 100 cm^3 beaker on top of letter X in such a way that letter X is visible when viewed from above.

(ii) Measure 20 cm^3 of solution L2 and put it into a 100 cm^3 beaker placed on top of a sheet of paper marked letter X.

(iii) Measure 40 cm^3 of solution L1, put it into boiling test tube and heat it on a water bath until it reaches as a temperature of 40 ℃.

(iv) Pour the heated content of solution L1, into a 100 cm^3 beaker placed on top of the sheet of paper marked letter X, and immediately start the stopwatch.

(v) Swirl the content and look through it from above. Record the time taken for the letter X to disappear.

(vi) Repeat the procedures (i) to (v) using similar solutions at 50°C, 60°C, 70°C, 80°C as indicated in the following table of experimental data.

Table: Experimental Data

Volume ofL1 (cm^3)	***Volume ofL2 (cm^3)***	***Temperature of L1 (°C)***	***Time (s)***	***Rate of reaction (1/t) (s^{-1})***
40	*20*	*40*		
40	*20*	*50*		
40	*20*	*60*		
40	*20*	*70*		
40	*20*	*80*		

The candidates were then asked the following questions;

(a) What is the aim of the experiment?

(b) Complete filling in the data in the table.

(c) Plot a graph of temperature (°C), Y-axis against Rate (s^{-1}), X-axis.

(d) What does the shape of the graph indicate?

*(e) Write the ionic equation for the reaction between **L1** and **L2**.*

*(f) Why did the letter **X** disappear?*

The candidates who scored high marks in this question managed to write the appropriate aim of the experiment as required in part (a). In part (b), they filled in the table correct data of time which was decreasing with increase in temperature of **L1**. That means that the temperature was inversely proportional to temperature. Correspondingly, the candidates accurately plotted the graph (obtaining a line of best fit) as required in part (c) and commented on its nature in part (d). Furthermore, in parts (e) and (f) these candidates wrote correctly well balanced ionic equation between **L1** and **L2** and gave an explicit explanation about why letter **X** disappeared. Extract 18.1 shows correct responses from one of the candidates.

2 a The aim of the experiment is to Demostrate the effect of Temperature on the rate of Chemical reaction.

b

Volume of L_1 cm^3	volume of L_2 cm^3	Temperature of L_1 (°C)	Time (s)	Rate $\frac{1}{t}$ s^{-1}
40	20	40	33.59	0.03
40	20	50	27.30	0.04
40	20	60	19.22	0.05
40	20	70	16.93	0.06
40	20	80	13.50	0.07

d The shape of a graph is a straight line which indicates that the rate of reaction is directly proportional to the Temperature of the reactants.

e $Na_2S_2O_3{}_{(aq)} + 2HNO_3{}_{(aq)} \longrightarrow 2NaNO_3{}_{(aq)} + H_2O_{(l)} + S_{(s)} + SO_2{}_{(g)}$

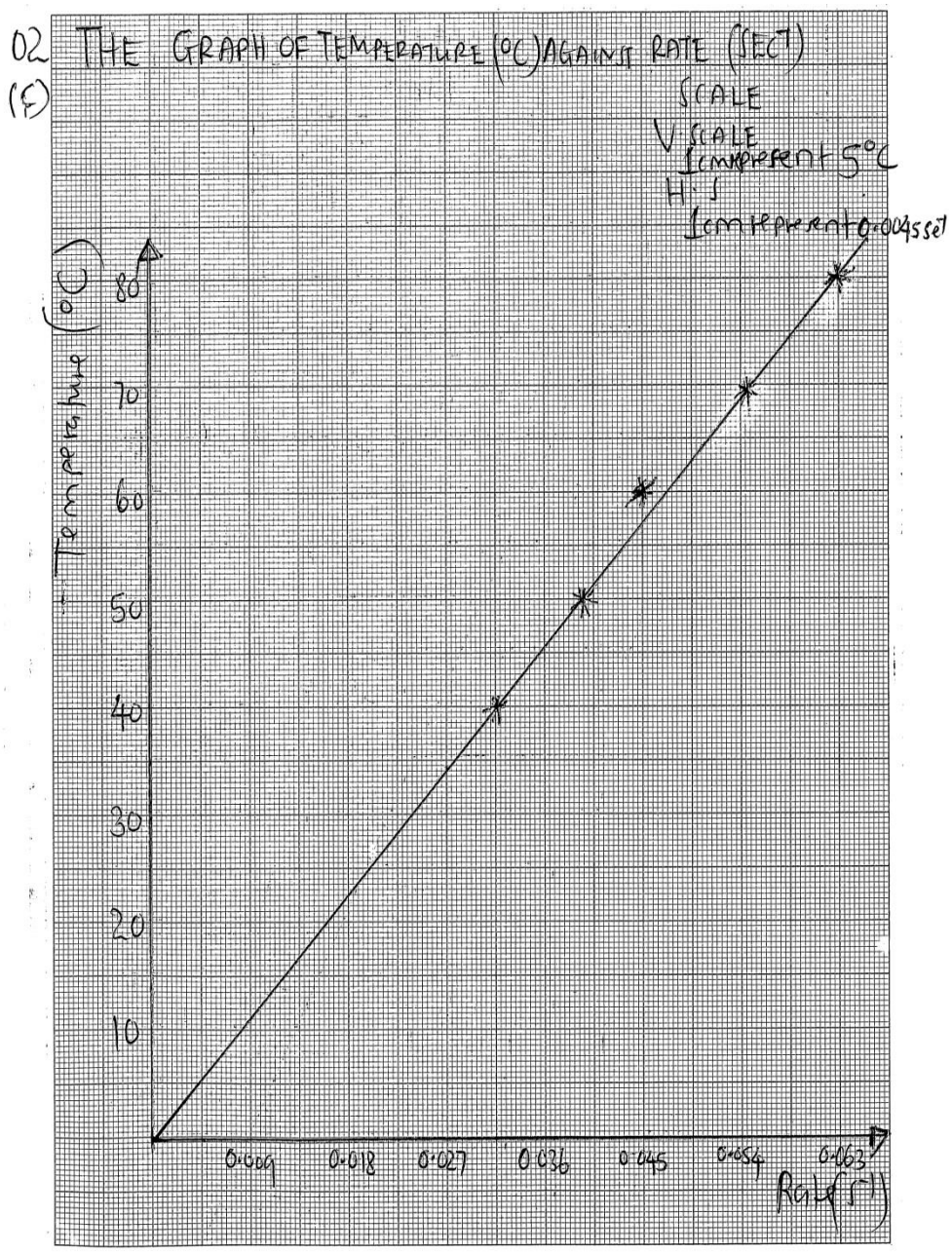
$2Na^+ + S_2O_3^{2-} + 2H^+ + 2NO_3^- \longrightarrow 2Na^+ + 2NO_3^- + H_2O + S + SO_2$

$S_2O_3^{2-} + 2H^+ \longrightarrow H_2O + S + SO_2$

The ionic equation is

$S_2O_3^{2-}{}_{(aq)} + 2H^+{}_{(aq)} \longrightarrow H_2O_{(l)} + S_{(s)} + SO_2{}_{(g)}$

2 f	letter x disappears due to the formation of
2	Sulphur which is ~~a~~ ~~white~~ solid and obscure
	visibility of letter x.



Extract 18.1: A sample of correct responses in question 2 paper 2A

In Extract 18.1, the candidate recorded expected data of reaction time as temperature is increased at intervals. The candidate used the data to accurately draw the graph and gave correct interpretation based on the shape of the graph. Furthermore, he/she also wrote correct chemical equation for the reaction between HNO_3 acid and $Na_2S_2O_3$ in which sulfur was produced causing letter X to disappear.

Candidates who scored low marks failed to attempt most parts of the question correctly. In part (b), they recorded individual data of time with greater range from each other than expected. Others filled the column for the rate of reaction by using fractions instead of decimals while others left some gaps in the table.

In plotting the graph in part (c), there were candidates who failed to label the axes of the graph while others did not indicate the title of the graph. Likewise, other candidates interchanged labeling the axes. Some of the candidates used inappropriate vertical and horizontal scales while others plotted the graph using wrong data or failed to draw the best line.

In part (d), majority of the candidates who scored low marks gave inappropriate comments, an indication that they lacked knowledge of the effects of temperature on the rate of chemical reaction.

In part (e), the candidates failed to write the ionic chemical equation by not indicating the state symbols and some of them did not balance the chemical equation. Other candidates responded by writing the complete chemical equation which is different from the ionic equation. Hence, they were not able to identify the cause of disappearance of letter X which was sulphur. Extract 18.2 shows incorrect responses from one of the candidates.

2 B

Volume of Li_2 (cm^3)	Volume of L_2 (cm^3)	Temperature of Licq	Time (s)	Rate ($1/t$) (s^{-1})
40	20	40	00.38	8×10^3
40	20	50	00.39	9×10^3
40	20	60	00.40	10×10^3
40	20	70	00.41	11×10^2
40	20	80	00.43	12×10^3

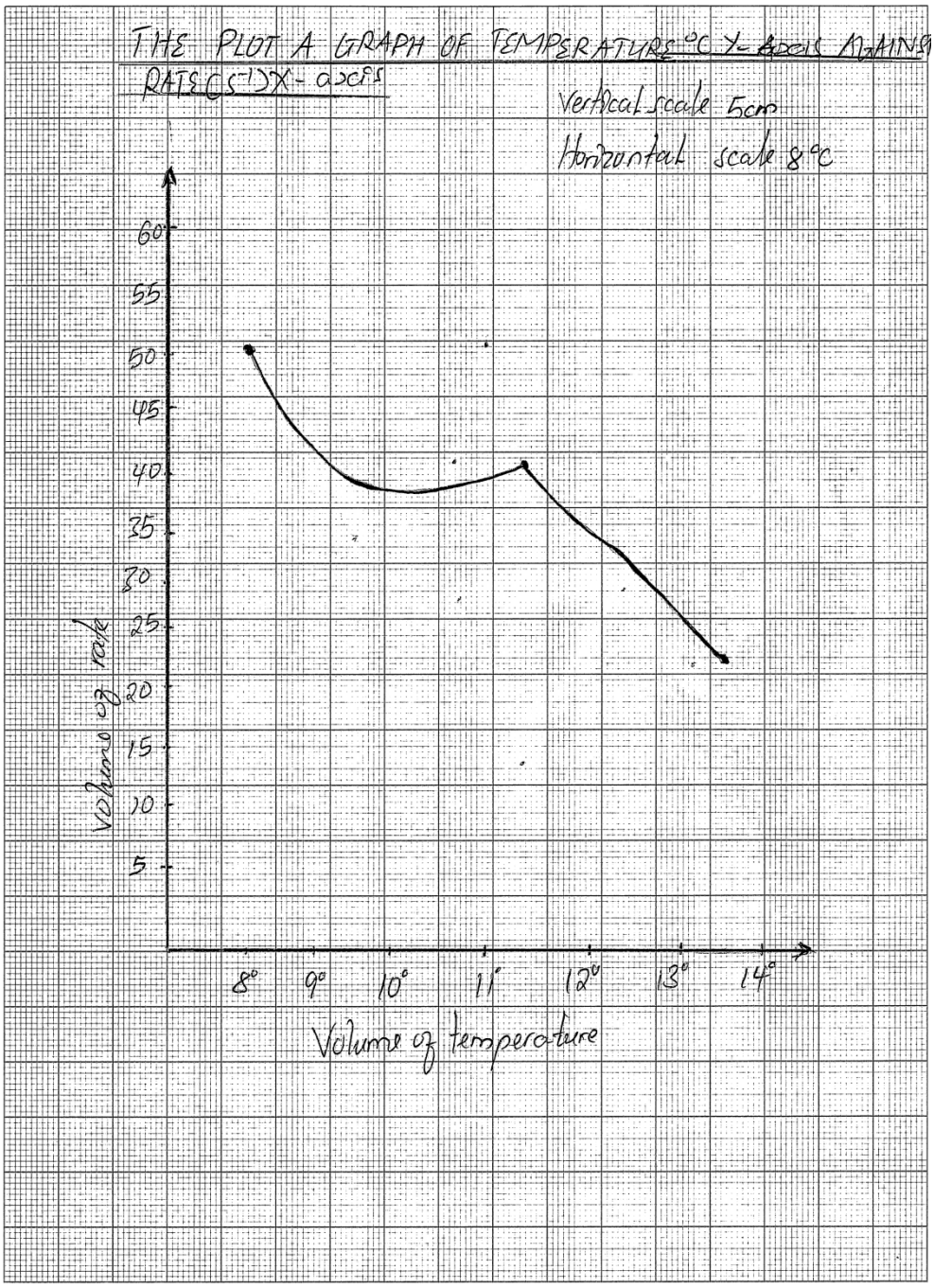
A. The aim of the experiment is To find temperature also it was heat

D. The shape of the graph it indicate Triangle which are the °C temperature

E. The ionic equation for the reaction between Li and L_2

$2Na_{(g)} \rightarrow NaCl_{(s)}$

F. The letter X it is not disappear
Because of reaction also heat so is disappear



Extract 18.2: A sample of incorrect responses in question 1 paper 2A

In Extract 18.2, the candidate failed to record accurate data of reaction time as temperature was being increased at intervals. The candidate used the incorrect data to plot the graph which led to incorrect interpretation based

on the shape of the graph. Furthermore, he/she wrote incorrect chemical equation for the reaction between HNO_3 acid and $Na_2S_2O_3$ solution.

2.2.2.2 Alternative 2B

The aim of experiment was to determine the effect of concentration on the rate of chemical reaction. The candidates were required to study the reaction between sodium thiosulphate and hydrochloric acid. The chemicals provided were labelled as **QQ** containing 3.16 g/dm^3 sodium thiosulphate solution, **TT** containing 7.3 g/dm^3 hydrochloric acid solution, and distilled water. The candidates were also provided with a stop watch and a piece of white paper marked **X** on which a 100 cm^3 beaker containing the reaction mixture was supposed to be placed during the experiment.

Candidates were provided with the following procedure:

*(i) Place 100 cm^3 beaker on top of the sheet labelled by letter **X** in such a way that the letter **X** is visible when viewed from above.*

*(ii) Using measuring cylinder, measure 50 cm^3 of solution **QQ** and pour it into a 100 cm^3 beaker placed on the top of a sheet of paper marked letter **X**.*

*(iii) Measure 10 cm^3 of solution **TT** and put it into a 100 cm^3 beaker containing a solution **QQ** and immediately start a stopwatch.*

(iv) Swirl the contents in the 100 cm^3 beaker and stop the stopwatch.

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

(vi) Repeat the experiment using the data in the following table:

Table: Experimental Data

Conc. Of QQ after adding water (g/dm^3)	***Volume of QQ (cm^3)***	***Volume of distilled water (cm^3)***	***Volume of TT (cm^3)***	***Time taken for the mark X to disappear in sec.***
20.066	*50*	*00*	*10*	
16.432	*40*	*10*	*10*	
12.324	*30*	*20*	*10*	
8.216	*20*	*30*	*10*	
4.108	*10*	*40*	*10*	

The candidates were then asked the following questions:

(a) Complete the table by filling the empty column.

(b) Write a balanced chemical equation for the reaction between sodium thiosulphate and hydrochloric acid.

*(c) Which substance from the chemical reaction in part (b) produced obscured the mark **X**?*

(d) Use the data in the experiment table to draw a concentration-time graph, by allocating time on x-axis and concentration on the y-axis.

*(e) What conclusion can you draw from the concentration-time graph and regarding the disappearance of mark **X**.*

The candidates who scored high marks in this question managed to fill in the table the correct data of time which was increasing with decrease in concentration of **QQ** correspondingly as required in part (a). In parts (b) and (c) the candidates wrote correctly well balanced chemical equation between **QQ** and **TT** and identified what caused the mark **X** to obscure. The candidates accurately plotted the graph (obtaining a curve) as required in part (d) and commented on its nature in part (e) that the decrease in concentration led to decrease in rate of reaction. Extract 19.1 shows one of the correct responses in question 2.

2. (a) TABLE OF RESULTS.

Conc. of QQ after adding Water (g/dm³)	Volume of QQ (cm³)	Volume of distilled water (cm³)	Time taken for the mark X to dissappear in sec
20.066	50	00	30
16.432	40	10	40
12.324	30	20	50
8.216	20	30	80
4.108	10	40	180

(b) A balanced chemical equation for the reaction between sodium thiosulphate and hydrochloric acid

Sodium thiosulphate : $Na_2SO_2O_{3(aq)}$

Hydrochloric acid : $HCl_{(aq)}$.

Equation:

$$2HCl_{(aq)} + Na_2SO_2O_{3(aq)} \longrightarrow 2NaCl_{(aq)} + 2H_2O_{(aq)} + SO_{2(g)} + S_{(s)}$$

(c) From the chemical reaction

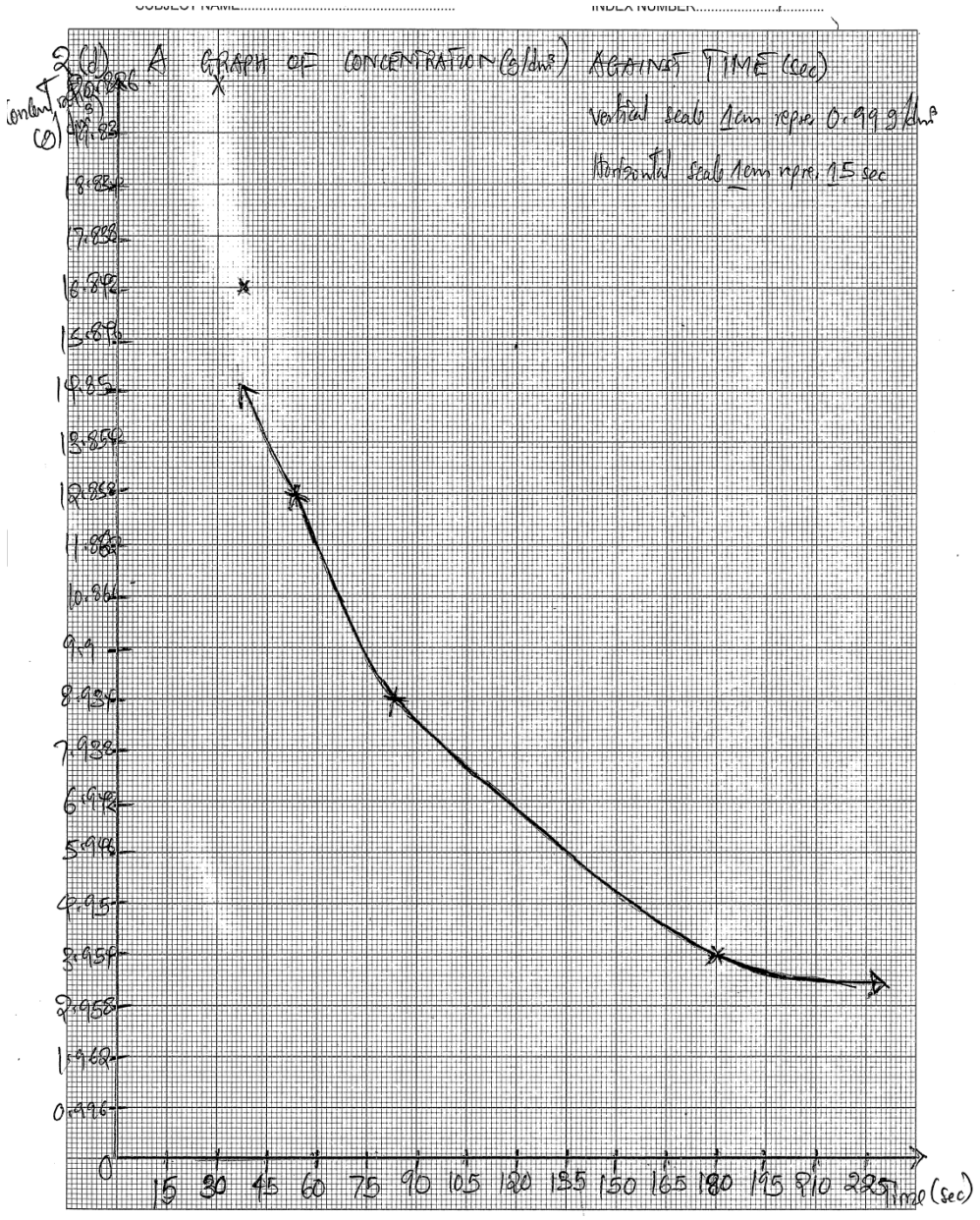
$$2HCl_{(aq)} + Na_2SO_2O_{3(aq)} \longrightarrow 2NaCl_{(aq)} + 2H_2O_{(l)} + SO_{2(g)} + S_{(s)}$$

the substance $S_{(s)}$ which is sulphur obscured the mark X.

(d) a graph of concentration against time taken for X to dissappear.

2 (e) The conclusion is that:

From the concentration – time graph; The graph is curved, that is concentration is inversely to the time taken this is due to the lowering of concentration increasing the time and increasing the concentration, reducing the time for X mark to dissappear. (When concentration is high, disappearance of mark X takes little time, but when the concentration is low, its disappearance (X) takes more time, hence a graph become curved).



Extract 19.1: A sample of correct responses in question 2 paper 2B

In Extract 19.1, the candidate correctly filled the table in part (a), wrote balanced chemical equation in part (b) and stated sulfur as the obscuring substance in part (c). He/she plotted the graph correctly in part (d) and commented on the nature of the graph as required in part (e).

Candidates who scored low marks failed to attempt most parts of the

question correctly. In part (a), some of them filled the table with incorrect data of time. They recorded individual data of time which were out of range. This means that the candidates had insufficient skills of data collection. In part (b) and (c), the candidates failed to write the correct balanced chemical equation between sodium thiosulphate and dilute hydrochloric acid. Some of them wrote incomplete chemical equations while others indicated incorrect products. For example, there were some candidates who wrote either Na_2SO_4 or $NaSO_4$ among the products. Some of them also gave partial equations lacking stoichiometric ratios and state symbols. As a result, they stated other substances instead of sulfur which was the reason for the obscureness or disappearance of letter **X**.

In plotting the graph as required in part (d), there were candidates who failed to label the axes of the graph while others did not indicate the title of the graph. Some of the candidates used inappropriate vertical and horizontal scales while others plotted the graph using wrong data or failed to draw the curve. For instance, some candidates drew linear graphs instead of curves.

In part (e), majority of the candidates who scored low marks gave inappropriate comments, which shows that they lacked knowledge of the effects of concentration on the rate of chemical reaction. Extract 19.2 shows sample of incorrect responses in this question.

2 (a)

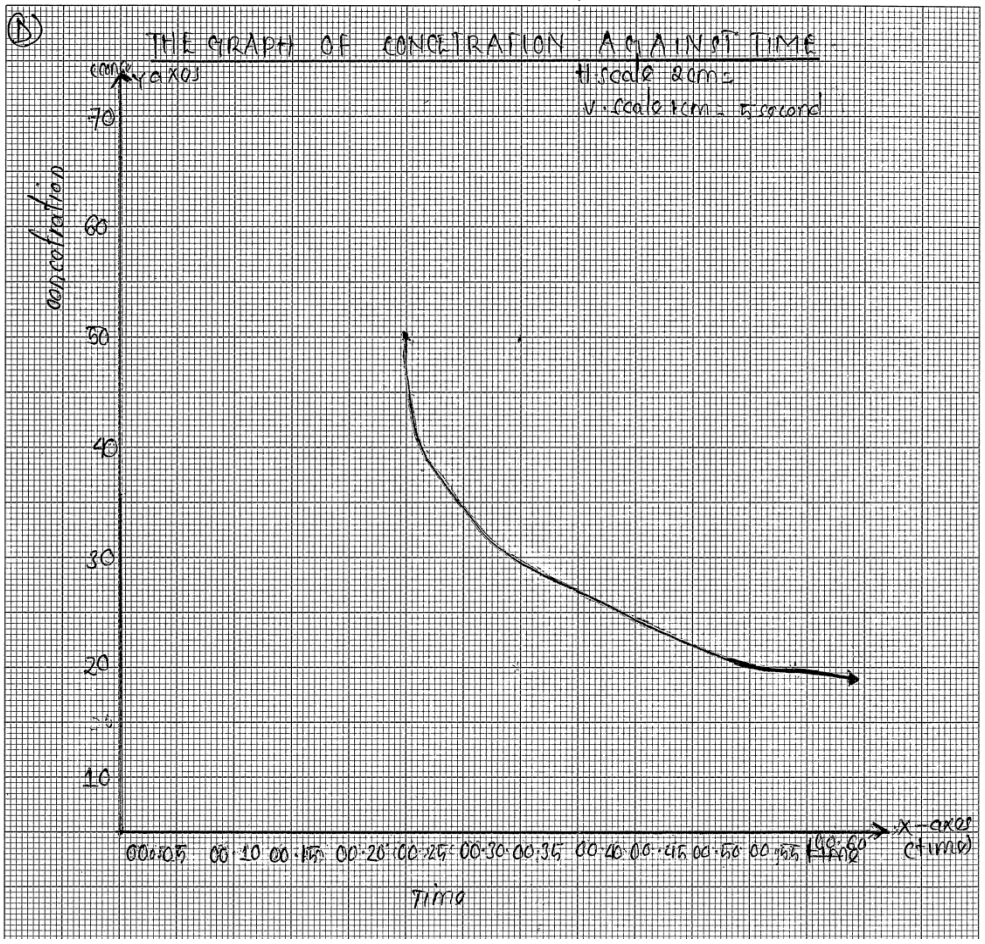
conc. of Qq after adding water (g/dm³)	volume of Qq (cm³)	volume of distilled water (cm³)	volume of TT (cm³)	Time taken for the mark x to disappear
20.066	50	00	10	00:25
16.432	40	10	10	00:26
12.324	30	20	10	00:34
8.216	20	30	10	00:58
4.108	10	40	10	1:52

(B) chemical equation for sodium sulphate and hydrochrolic acid

$$Na_2SO_{3(s)} + HCl_{(l)} \longrightarrow NaCl_{(s)} + SO_{2(g)} + H_2O_{(l)}$$

∴ The balanced chemical equation is $Na_2SO_{3(s)} + HCl_{(l)} \longrightarrow NaCl_{(s)} + SO_{2(g)} + H_2O_{(l)}$

(C) The chemical reaction in reaction (b) which produce observed is (S) sulphate



Extract 19.2: A sample of incorrect responses in question 1 paper 2B

In Extract 19.2, the candidate recorded time in an incorrect style in part (a) and wrote chemical reaction with wrong reactants and products in part (b). He/she mentioned sulphate instead of sulphur as the substance which

caused obscuring of letter X in part (c). Furthermore, the candidate plotted graph using incorrect data and scales in part (d).

2.2.2.3 Alternative 2C

The aim of experiment was to determine the effect of concentration on the rate of chemical reaction. The chemicals provided were labelled as **W** containing 79.0 g of sodium thiosulphate in 0.5 litre of solution and **V** containing 6.3 g/dm^3 nitric acid solution. The candidates were also provided with a stopwatch and a piece of white paper marked **X** on which a 50 cm^3 beaker containing the reaction mixture was supposed to be placed during the experiment.

*(i) Place a 50 cm^3 beaker on top of letter **X** in such a way that the letter **X** is visible when viewed from above.*

*(ii) Using measuring cylinder, measure 2 cm^3 of solution **W** and pour it into a 50 cm^3 beaker. Add 3 cm^3 of distilled water.*

*(iii) Measure 5 cm^3 of solution **V** and put it into a 50 cm^3 beaker containing solution **W** and distilled water and immediately start a stopwatch.*

*(iv) Swirl the contents in the 50 cm^3 beaker and stop the stopwatch when the letter **X** disappears.*

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

*(vi) Repeat the experiment by varying the volume of **W** and distilled water as shown in the following table of experimental data.*

Table: Experimental Data

Experiment	***Volume of W(cm^3)***	***Volume of V (cm^3)***	***Volume of Distilled water (cm^3)***	***Time taken for the letter X to disappear in sec.***
(i)	*2*	*5*	*3*	
(ii)	*3*	*5*	*2*	
(iii)	*4*	*5*	*1*	
(iv)	*5*	*5*	*0*	

The candidates were instructed to perform experiment by doing the following procedures:

(a) Complete the table by filling the empty column.

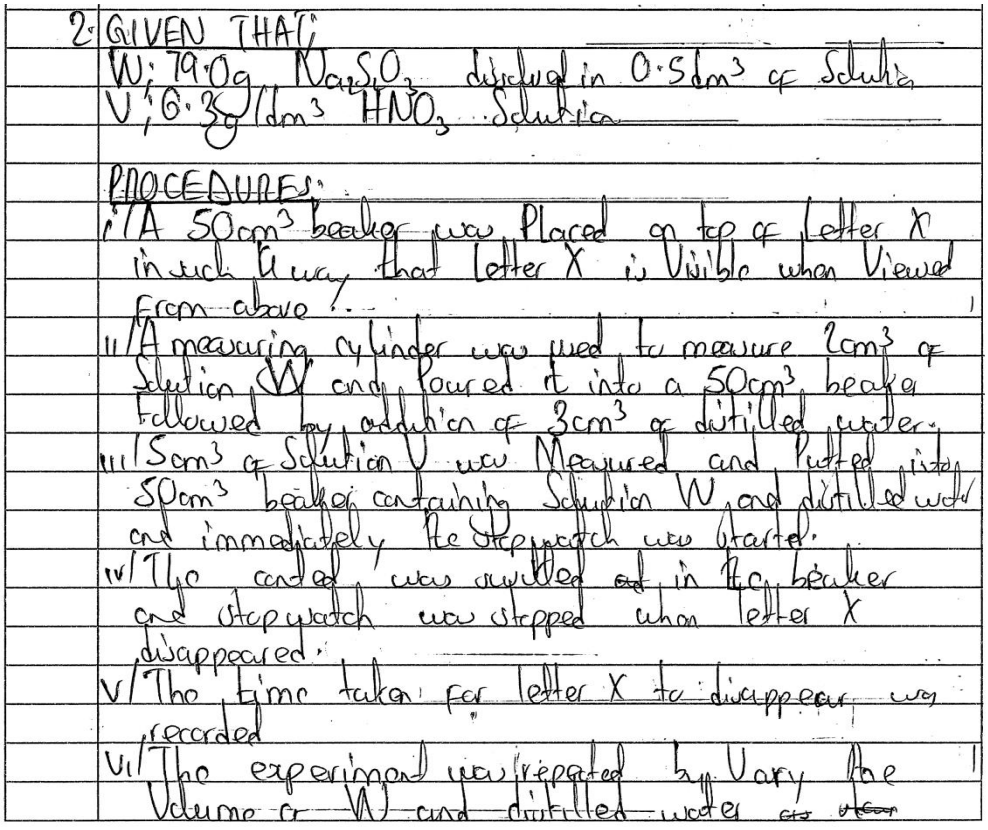
(b) *Write a balanced chemical equation for the reaction between sodium thiosulphate and nitric acid.*

(c) *What substance caused the letter **X** to disappear in experiment?*

(d) *Plot a graph of the volume of $Na_2S_2O_3$ (cm^3), y-axis against time (s), x-axis.*

(e) *What conclusion can you draw from the graph regarding the disappearance of the letter **X**?*

The candidates who scored high marks in this question managed to fill in the correct data of time which was decreasing with increase in concentration of **W** correspondingly as required in part (a). In parts (b) and (c) these candidates wrote correctly well balanced chemical equation between **W** and **V** and identified what caused the mark **X** to obscure. The candidates accurately plotted the graph (obtaining a curve) as required in part (d) and commented on its nature in part (e) that the decrease in concentration led to decrease in rate of reaction. Extract 20.1 shows one of the correct responses in question 2.


2. GIVEN THAT;
W; 79.0g $Na_2S_2O_3$ dissolved in 0.5dm^3 of Solution
V; 6.3g/dm^3 HNO_3 Solution

PROCEDURES;
i/ A 50cm^3 beaker was Placed on top of Letter X in such a way that letter X is visible when Viewed from above.
ii/ A measuring cylinder was used to measure 2cm^3 of Solution W and poured it into a 50cm^3 beaker followed by addition of 3cm^3 of distilled water.
iii/ 5cm^3 of Solution V was Measured and Putted into 50cm^3 beaker containing Solution W and distilled water and immediately the stopwatch was started.
iv/ The content was swirled at in the beaker and stopwatch was stopped when letter X disappeared.
v/ The time taken for letter X to disappear was recorded
vi/ The experiment was repeated by Vary the Volume of W and distilled water ~~etc~~

2. ANSWERS:

a) To complete the table by filling the empty Columns.

EXPERIMENT	Volume of W (cm^3)	Volume of V (cm^3)	Volume of distilled Water (cm^3)	Time for the letter X to disappear in sec
(i)	2	5	3	27
(ii)	3	5	2	19
(iii)	4	5	1	14
(iv)	5	5	0	11

b) To write a balanced chemical equation for reaction between Sodium thiosulphate and Nitric acid.

Equation for reaction:

$$Na_2S_2O_{3(aq)} + 2HNO_{3(aq)} \longrightarrow 2NaNO_{3(aq)} + H_2O_{(l)} + SO_{2(g)} + S_{(s)}$$

(reddish ppt)

c) The substance caused the letter X to disappear in the experiment.

⇒ The yellow Precipitate of Sulphur which was formed, led letter X to disappear in the experiment.

2. d) To Plot the graph of Volume of $Na_2S_2O_3$ (cm³), Y-axis Against time(s) X-axis)

Solution:-

The table of Value.

Volume of $Na_2S_2O_3$ (cm³)	Time (sec)
2	27
3	191
4	14
5	11

To calculate scale.

From; SCALE = Maximum Value / Maximum No room.

Vs; $\frac{5cm^3}{20} = 0.25 cm^3$

Vs; 1cm represent $0.25 cm^3$

Hs; $\frac{27_{sec}}{15} = 1.8$ sec.

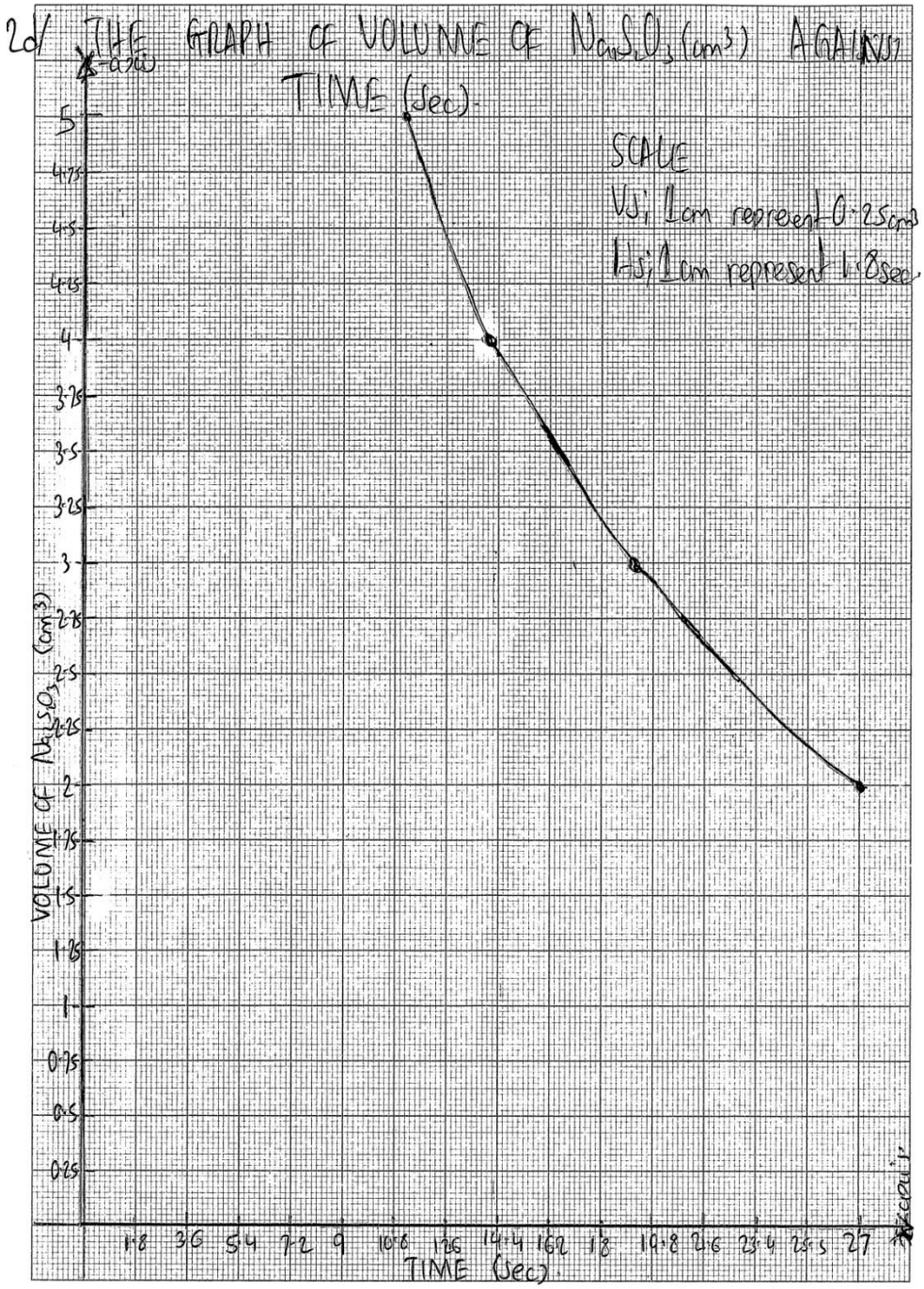
Hs; 1 cm represent 1.8 sec.

2 e) The conclusion drawn from the graph regarding the disappearance of letter X.

⇒ From the graph;

When time(s) for disappearance of letter X decreases, the Volume of concentration was increases.

Hence; The time for disappearance of letter X is inversely proportional to the Volume of concentration. ie; $t \propto \frac{1}{V}$.



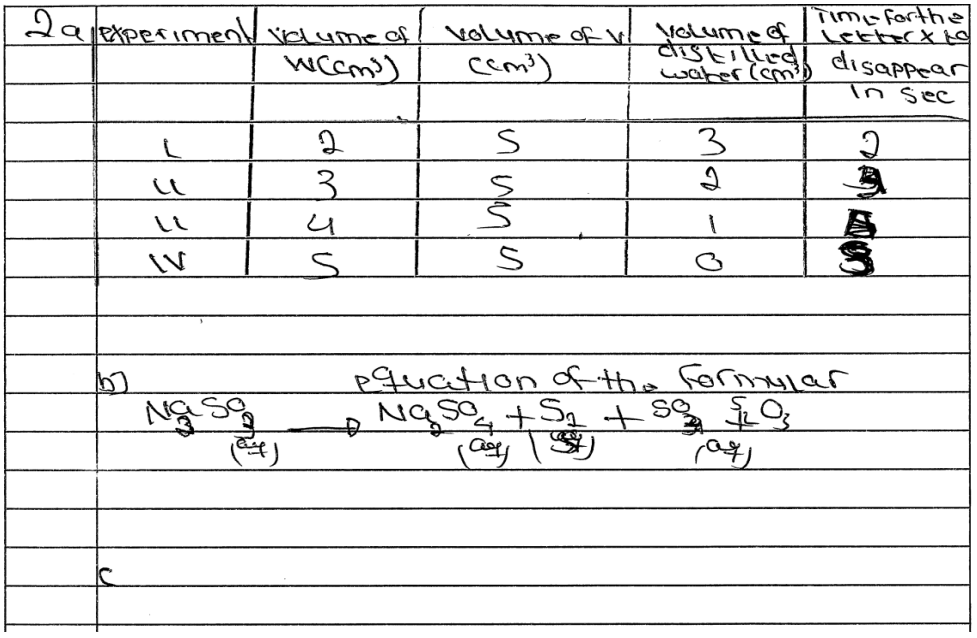
Extract 20.1: A sample of correct responses in question 2 paper 2C

In Extract 20.1, the candidate correctly filled the table in part (a) and answered the remaining parts.

The candidates who scored low marks failed to attempt most parts of the question correctly. In part (a), most of them filled the table with incorrect data of time. They recorded individual data of time which were out of expected range. For instance, there were few candidates who gave data in which the time ranged between 0 and 50 seconds. In part (b) and (c), the candidates failed to write the correct balanced chemical equation between $Na_2S_2O_3$ and dilute HNO_3. They also did not indicate the state symbols, hence were not able to identify the cause of obscureness of letter **X** which was sulphur.

In plotting the graph in part (d), there were candidates who failed to label the axes of the graph while others did not indicate the title of the graph. Some of the candidates used inappropriate vertical and horizontal scales while others plotted the graph using wrong data or failed to draw the curve.

In part (e), majority of the candidates who scored low marks gave inappropriate comments on the nature of the graph. This shows that candidates lacked the knowledge of the effects of concentration on the rate of chemical reaction. Extract 20.2 shows sample of incorrect responses in this question.



d] Volume of the $Na_2S_2O_3$ (cm^3)

$m_a = 23cm^3$

$V_a = ?$

$m_b = 16cm^3$

$V_b = 5$

$n_a = 1$

$n_b = 2$

$\frac{m_a V_a}{m_b V_b} = \frac{n_a}{n_b}$

$\frac{23+16+1+2}{25 \times 5}$

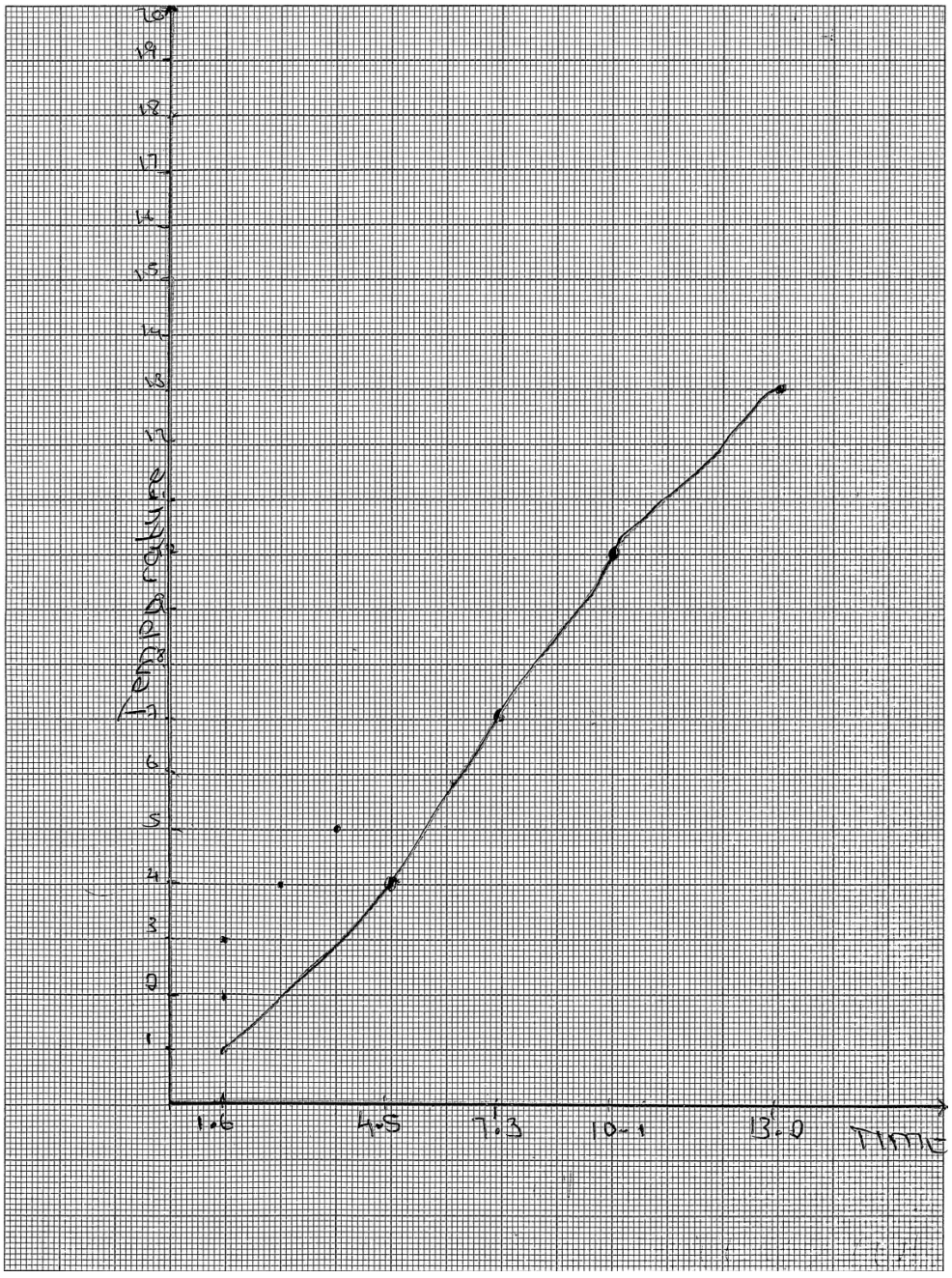
$= 40.4$

Volume of $\frac{\text{molarity}}{\text{mass}}$

$40.4 \div 25 = 1.6$

time X-axis $= 1.6$

$140 \div 25 = 5.6$



Extract 20.2: A sample of incorrect responses to question 1 paper 2C

In Extract 20.2, the candidate filled the table in part (a), wrote incorrect chemical equation in part (b) and skipped part (c). He/she carried out inappropriate calculation in part (d) and sketched the graph without indicating title and scale.

3.0 THE ANALYSIS OF THE CANDIDATES' PERFORMANCE ON EACH TOPIC

The Chemistry paper 1 (theory) and paper 2 (practical) consisted of a total of 16 questions which covered 18 topics. The analysis shows that, question 1 in paper 1 on multiple choice items had the best performance of 94.21 per cent. Topics which were examined in question 1 are: *Hardness of Water; Fuels and Energy; Air, Combustion, Rusting and Firefighting; Organic Chemistry; Laboratory Techniques and Safety; The Scientific Procedures; Oxygen and Hydrogen;* and *The Mole Concept and Related Calculations*.

The analysis also revealed that 4 topics had good performance. The topics were: *Volumetric Analysis (84.30%)* which was examined in question 1 (practical), *Water (77.23%)* in question 7, *The Scientific Procedures (70.33%)* in question 6 and *Ionic Theory and Electrolysis (65.39%)* which was examined in questions 14, all in the theory paper.

A total of 7 topics had average performance. The topics are: *Laboratory Techniques and Safety (61.70%)* examined in question 2, *Fuels and Energy (59.14%)* examined in question 5, *Chemical Kinetics, Equilibrium and Energetics (56.70%)* examined in questions 9 and 2 (practical), *Extraction of Metals (54.23%)* examined in question 12, *Formulae, Bonding and Nomenclature (35.20%)* examined in question 4, *The Mole Concept and Related Calculations (35.11%)* examined in question 10 and *Matter (33.46%)* examined in question 11.

Topics in which candidates had weak performance were: *Oxygen and Hydrogen (16.01%)* examined in question 8, *Soil Chemistry (13.40%)* examined in question 13 and *Compounds of Metals (2.50%)* examined in question 3. The weak performance in the three topics was caused by inadequate knowledge of the candidates about the tested concepts, failure to identify demand of the respective questions, inadequate graph sketching skills, poor English Language proficiency and lack of sufficient mathematical skills. The performance of the candidates in different topics is summarized in the attached appendix.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Generally, the candidates' performance in Chemistry subject CSEE 2021 was good in which 92.02 per cent of the candidates passed. The analysis of the candidates' performance revealed that the candidates had good performance on 4 topics which are: *Volumetric Analysis*, *Water*, *The Scientific Procedures* and *Ionic Theory and Electrolysis*. The topics which had average performance were: *Laboratory Techniques and Safety*, *Fuels and Energy*, *Chemical Kinetics*, *Equilibrium and Energetics*, *Extraction of Metals*, *Formulae*, *Bonding and Nomenclature*, *The Mole Concept and Related Calculations* and *Matter*. Candidates poor performance was observed on the topics of *Oxygen and Hydrogen*, *Soil Chemistry* and *Compounds of Metals.*

The candidates who had good performance in candidates in Chemistry subject in CSEE 2021 had adequate knowledge of concepts, ability to write chemical formulas/equations and demands of the questions. On the other hand, some of the candidates had weak performance due to the following reasons:

(a) Inability to apply skills of writing chemical equations to justify chemical properties of elements/compounds.

(b) Failure to integrate classroom lessons with the real life situations. For instance, some of the candidates failed to give ways of maintaining soil fertility.

(c) Poor English Language proficiency which made some of the candidates to give unclear explanations.

(d) Lack of basic skills of carrying out calculations in Chemistry.

4.2 Recommendations

The following recommendations are given in order to improve the candidates' performance in future examinations:

(a) Teachers are advised to use *charts/models* of various chemical reactions in the topic of *Compounds of Metals* to lead students on the chemical properties of compounds of metals. In addition, teachers are advised to provide students with exercises on predicting products of chemical reactions.

(b) In teaching *Soil Chemistry*, teachers are advised to use wall charts and pictures showing different ways of maintaining soil fertility. Candidates can be lead to use practical ways of maintaining soil fertility in the school farm or garden. Similarly, the teacher may organize a study tour by visiting a nearby farm to observe ways that farmers use to maintain soil fertility.

(c) In conducting lessons pertaining to *Oxygen* and *Hydrogen*, teachers are advised to guide students practically to identify properties of oxygen and hydrogen gases. This can be achieved through conducting simple experiments such as lowering a glowing splint into a test tube of oxygen gas. Also experiment can be conducted by lowering a burning stick into a test tube containing hydrogen gas.

Appendix

ANALYSIS OF CANDIDATES' PERFORMANCE PER TOPIC

S/N	Topic	Question	% of Candidates who scored 30 marks or above	Average	Remarks
1	*Hardness of Water; Fuels and Energy; Air, Combustion, Rusting and Firefighting; Organic Chemistry; Laboratory Techniques and Safety; The Scientific Procedures; Oxygen and Hydrogen;* and *The Mole Concept and Related Calculations.*	1	94.21	94.21	Good
2	*Volumetric Analysis*	1 Practical	84.30	84.30	Good
3	*Water*	7	77.23	77.23	Good
4	*The Scientific Procedures*	6	70.33	70.33	Good
5	*Ionic Theory and Electrolysis*	14	65.39	65.39	Good
6	*Laboratory Techniques and Safety*	2	61.70	61.70	Average
7	*Fuels and Energy*	5	59.14	59.14	Average
8	*Chemical Kinetics, Equilibrium and Energetics*	9	19.89	56.70	Average
		2 Practical	93.5		
8	*Extraction of Metals*	12	54.23	54.23	Average
9	*Formulae, Bonding and Nomenclature*	4	35.20	35.20	Average
10	*The Mole Concept and Related Calculations*	10	35.11	35.11	Average
11	*Matter*	11	33.46	33.46	Average
12	*Oxygen and Hydrogen*	8	16.01	16.01	Weak
13	*Soil Chemistry*	13	13.40	13.40	Weak
14	*Compounds of Metals*	3	2.50	2.50	Weak