THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEM RESPONSE ANALYSIS REPORT ON THE FORM TWO NATIONAL ASSESSMENT (FTNA) 2023

PHYSICS

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031 PHYSICS

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FOREWORD

The National Examinations Council of Tanzania (NECTA) is authorized to administer Examinations and Assessments at a national level. The Form Two National Assessment (FTNA) aims to assess the competencies needed to be acquired by the students after two years of study at the Ordinary Secondary Education level. The competencies required in FTNA 2023 are well stipulated in the Physics of syllabus 2010 for secondary education.

The Students' Items Response Analysis (SIRA) report on the Form Two National Assessment (FTNA) 2023 in Physics subject has been prepared to provide feedback to education stakeholders about strenghs and weaknesses of the students in responding to the assessment items. The report helps understanding some of the reasons for the particular performance of students in the Physics Assessment.

The performance in Physics assessment was generally weak. The factors that contributed to the students' weak performance includes, inadequate knowledge about the concepts assessed, confusion among different concepts assessed, insufficient skills in solving numerical problems, inability to understand demands of the questions, failure to follow instructions and poor English proficiency.

The Council expects that, the recommendations provided in this report will enable the policymakers, education administrators, school managers, teachers and students to identify proper measures to be taken to improve students' performance in future assessments and examinations.

Finally, NECTA extends its gratitude to examination officers who participated in preparing this report.

Dr. Said Ally Mohamed
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report analyses and discusses the performance of the students who sat for the Form Two National Assessment (FTNA) 2023 in Physics. FTNA is intended to assess the competencies acquired by the students after two years of their study at the secondary school level. This FTNA examination covered the topics which are stipulated in the 2010 Physics syllabus for secondary school.

The assessment comprised ten (10) questions, grouped into three sections, namely sections A, B and C. Section A had two (2) objective questions with a total of 15 marks. Question 1 comprised ten (10) multiple-choice items. The items were constructed based on 10 physics topics that included; *Introduction to Physics; Introduction to Laboratory Practice; Measurement; Archimedes' Principle and Law of Flotation; Force; Structure and Properties of Matter; Pressure; Light; Work, Energy and Power; and Static Electricity.* Each item in this question carried one (1) mark, making a total of ten (10) marks. Question 2 comprised a total of five (5) homogenous matching items which were constructed from the topic of *Measurement*. Each item in this question carried one (1) mark, making a total of five (5) marks. Section B comprised seven (7) short answer questions structured from the topics of *magnetism; Temperature; Newton's Laws of Motion; Motion in a Straight Line; Simple Machines; Forces in Equilibrium; and Sustainable Energy Sources*. Each question in this section carried 10 marks, making a total of 70 marks. Section C had one (1) short answer question constructed from the topic of *Current Electricity* which carried a total of 15 marks. Thus, the whole assessment had a total of 100 marks. The students were supposed to attempt all the questions in each section.

Students who sat for the year 2023 FTNA assessment were 691,924 out of 757,843 who were registered. Considering students' performance, in the year 2023, out of 691,924 who sat for FTNA, 132,561 (19.16%) passed while 559,363 (80.84%) failed. In comparison to the 2022 FTNA assessment, the number of students who sat for the assessment was 632,152 and among them, 116,418 (18.42%) passed and 515,734 (81.58%) failed. This indicates that the students' performance in 2023 has increased by 0.74 per cent. The performance in terms of grades shows that there was a slight

increase of performance in 2023 as 132,561 (19.16 %) students scored grades from A to D while in 2022 116,418 (18.42)%) scored the same range of grades. On the other hand, F grade decreased from 515,734 (81.58%) in 2022 to 559,363 (80.84%) in 2023. Students' performance in Different grades from 2021 to 2023 is shown in Table 1.

Table 1: Students' Performance in Terms of Grades from 2021 to 2023 in Physics Subject.

Year	No. of students	A		B		C		D		F	
		No.	%	No.	%	No.	%	No.	%	No.	%
2021	600,229	12,740	2.12	16,328	2.72	58,819	9.80	98,104	16.34	413,403	68.87
2022	632,152	2,519	0.40	4,874	0.77	29,851	4.72	77,586	12.27	515,734	81.58
2023	691,924	5,038	0.73	7,380	1.07	37,727	5.45	81,547	11.79	559,363	80.84

Table 1 shows that , majority of the students scored grade F for three consecutive years. The number of students who scored A was alternately varying for consecutive three years where it was highest (2.12%) in 2021 and lowest (0.40%) in 2022. The data further show that the number of students who scored B and C alternately raised and dropped for consecutive three years and were maximum in 2021 and minimum in 2022. However, a decreasing trend was noted for the students who scored grade D from 16.34 per cent in 2021 to 11.79 in 2023.

2.0 ANALYSIS OF STUDENTS' PERFORMANCE IN EACH QUESTION

This section presents a detailed analysis of the students' performance on each question. It covers the type of the questions, their requirements, the topic from which the questions were constructed, and the status of the questions' performance as seen from students' scripts. The students' performance have been categorized as good, average and weak. Good performance ranges from 65 to 100 per cent, average performance ranges from 30 to 64 per cent and weak performance range from 0 to 29 per cent. In addition, green, yellow and red colours are used in charts or graphs to represent these categories respectively.

2.1 Section A: Objective Questions

This section consisted of two objective questions. A multiple-choice question with ten (10) items where each carried 1 mark, making a total of 10 marks and matching items with five items in list A and seven responses in list B. Each item was awarded 1 mark, making a total of 5 marks. The whole section had 15 marks.

2.1.1 Question 1: Multiple-choice items

This question comprised ten (10) multiple-choice items numbered from (i) - (x). Each item had four alternatives (A, B, C and D). The students were required to choose the most correct answer among the given four alternatives and write the correct letter against the corresponding item in the answer booklet provided. The items were constructed from ten (10) Physics topics which include: Introduction to Physics, *Introduction to Laboratory Practice, Archimedes Principles and the Law of Floatation, Force, Measurements, Structure and Properties of Matter, Pressure, Light, Work, Energy and Power, and Static Electricity.*

A total of 691,924 (100%) students attempted the question and their scores were as follows: 256,598 (37.08%) students scored from 0.0 to 2.0 marks, 419,926 (60.69%) scored from 3.0 to 6.0 marks and 15,400 (2.23%) scored from 7.0 to 10.0 marks. These scores indicate that students' performance in this question was average as 435,326 (62.92%) scored from 3.0 to 10.0 marks out of 10.0 marks allocated to this question. Figure 1 summarizes the performance of the students in Question 1.

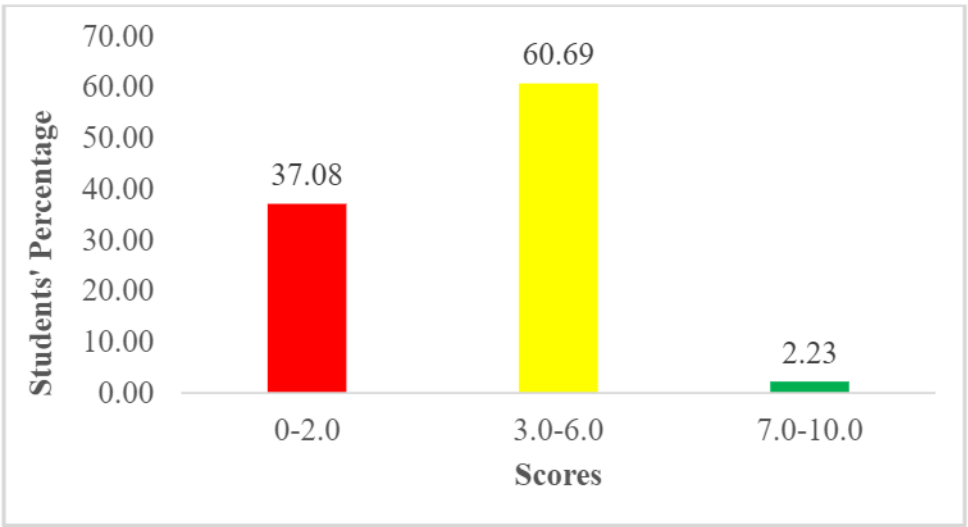


Figure 1: *The performance of the students in Question 1.*

Item (i) of question 1 was constructed from the topic of *Introduction to Physics*. The students were required to identify the statement that described the correct application of physics in sending messages far from school. The item stated, "*A student has an urgent message to send to his/ her parents from far from school. Which means can be the best?"*. The alternatives were: A. *Landline and mobile phone* B. *Microphone and telephone* C. *Megaphone and mobile phone* D. *Megaphone and microphone.* Looking at item (i), has been constructed with the motivation of testing students' ability to link physics with technological advancement in communication.

The correct alternative for this Item was A (*Landline and Mobile Phone*). Few students opted for the correct alternative and most of the students chose an incorrect response, mostly alternative B (*Microphone and telephone*) and D (*Megaphone and microphone*). Generally, students who failed to choose the correct alternative had insufficient knowledge and skill in integrating physics with communication and identifying the basic principles behind those devices. They were supposed to realize that the devices mentioned in the given alternatives are used to convey information in different contexts. For instance:

- Landlines receive and send information over a long distance using wire, for example, TTCL landline phones.
- Mobile phones such as NOKIA, INFINIX, TECNO, and SAMSUNG are wireless phones which can convey a message over long distances through a wireless electromagnetic system.
- A microphone is just a device within a system used as a transducer to change sound to electrical signals.
- A megaphone is a device used to project a louder sound from low sound, which can be recorded or spoken directly.

Item (ii) was structured from the topic of *Introduction to Laboratory Practice*. The students were required to identify the importance of laboratory rules in the Physics laboratory. The item stated, "*What is the usefulness of laboratory rules when carrying out experiments in the physics laboratory?"*. The given alternatives were: A. *Making students enjoy science* B. *Helping students conduct experiments freely* C. *Ensuring safety in the laboratory* D. *Enhancing communication with other techniques.* The item was constructed to test the ability of a student to describe the importance of Physics laboratory rules. The correct response was C

(*Ensuring safety in the laboratory*). Most of the students answered correctly this item, indicating that they had enough competence in the topic of *Introduction to Laboratory Practice* particularly to the importance of laboratory rules. Few students chose alternatives A, B, and D, indicating that they had failed to master well the competencies of the topic of *Introduction to Laboratory Practice.*

Item (iii) was structured from the topic of *Archimedes' Principles and the Law of Flotation*. The item states "*Why does a piece of steel sink in water but a steel ship floats?"* The alternatives were: A. *The density of the steel ship is less than the density of water* B. *Steel is denser than the steel ship* C. *Steel ship has the same density as that of steel* D. *The average density of the steel ship is less than the density of water.* The correct response was D (*The average density of the steel ship is less than the density of water*). In this item, students were provided with two objects: (i) a steel ship and (ii) a piece of steel. The students were required to identify which object has a lower average density than that of water and to apply the law of flotation and conditions for an object to float to describe why steel ship floats in water. The item intended to measure the ability of students to apply the concepts of density and relative density, Archimedes' principle, the law of flotation and conditions for an object to float in our daily lives. Few of the students answered correctly this item. Those who selected alternative D suggested that they have adequate knowledge and skills in the concepts of density and relative density, Archimedes' principle and the law of floatation. Most of the students chose alternative A (*The density of the steel ship is less than the density of water*). Students who chose this alternative had some ideas about the law of flotation and the conditions for an object to float. They failed to understand that the average density of an object is what determines whether an object will float or not. Those who chose alternatives B and C failed to interpret the conditions for an object to float.

Item (iv) was constructed from the topic of *force*. The item was designed such that for the students to select the correct alternative should have the ability to identify sets of the effects of forces that are exerted while riding a bicycle. The item stated as follows, "*Which of the following is a set of effects of forces exerted when you are riding a bicycle?"*. The given alternatives were: A. *Compressional, attraction and stretching* B. *Torsional, attraction and couple* C. *Frictional, couple and pulling* D.

Attraction, friction and restoring. The correct response was C (*Frictional, couple and pulling*). Some of the students selected the correct response. Those who selected the correct response suggested that they had adequate competencies on the topic of *force,* particularly to the concepts of the types of forces and their effects. They had the ability to interpret the effects of forces exerted on the moving bicycle. Some of the students chose alternative A. Other students selected alternative B which was an incorrect response. Some of the students chose response C which was an incorrect response. Those students in this category had little knowledge and skills on the topic.

The item (v) was intended to measure students' competencies in the topic of *measurements*, particularly the concepts of density and relative density and their relations to buoyancy. The item was constructed such that for the students to select the correct response should have the ability to apply concepts of density, relative density and buoyancy to describe the relationship between the size of the stem of the hydrometer and the change in physical quantity (length). The item states that "*Hydrometer is an instrument for measuring the density or relative density of a liquid. What are you supposed to do in order to increase its sensitivity?"*. The given alternatives were: A. *Increase the size of the large bulb* B. *Make the stem narrower* C. *Reducing the lead shots in the weighted bulb* D. *Increasing the length of the stem.* The correct response was B (*Making the stem narrower*). Few of the students selected the correct response suggesting that they had enough knowledge and skills related to the working principle of the hydrometer as well as principles of improving its sensitivity. The hydrometer measures the densities of liquids by floating its height which can be determined by using Buoyant law. A hydrometer with a narrow stem sinks deeper than a wider stem, making it very sensitive to a small change in density. Some of the students chose alternatives A and C which were incorrect. Those students failed to interpret the role of the bulb and lead shots in the hydrometer concerning the sensitivity. The larger the bulb means the higher the buoyance. Moreover, fewer lead shots make the bottom of the hydrometer to be less heavy and, thus will not float vertically.

The item (vi) was constructed from the topic of *structure and properties of matter*. The item was designed with the purpose of measuring students' knowledge and skills in the estimation of the size of a molecule through a

simple experiment. The item stated, "*How can you make a rough measure of the size of a molecule?"*. Students were required to choose one of the following alternatives: A. *By measuring the height to which water rises in a narrow capillary tube* B. *By finding the speed with which Brownian vapour spreads in air* C. *By observing Brownian motion of smoke particles* D. *By measuring the area of the cycle in which a small drop spreads in water.* Few students chose alternative D (*By measuring the area of the cycle in which a small drop spreads in water*) which is the correct response. Those who selected response D revealed that they had adequate knowledge and skills of the topic of *structure and properties of matter* particularly on the experimental approach of a rough estimation of the size of molecule. Some of the students selected alternative B (*By finding the speed with which Brownian vapour spreads in the air*) or alternative C (*By observing the Brownian motion of smoke particles*) which were incorrect. Those who selected these alternatives suggested that they had enough knowledge and skill on this topic but failed to interpret the need for the item. As per the item, students were supposed to propose an experiment which could roughly estimate the size of the molecule. The Brownian motion could be used to measure the precise size of the molecule. Those who selected alternative A suggested that they had little knowledge and skill of the topic of *structure and properties of matter*. The selected alternative describes the capillarity properties which are governed by cohesive and adhesive forces.

Item (vii) was constructed from the topic of *pressure.* The item intended to measure the ability of the students to relate pressure and area, and its applicability in daily life. The item stated, "*A boy wants to lift a bucket full of water using a handle of metal. Which form of handle should he use to lift the bucket comfortably?"*. The given alternatives were: A. *Thick handle* B. *Thin handle* C. *Long handle* D. *Sharp handle.* An alternative A (*Thick handle*) was the correct response. Few of the students chose alternative A suggesting that they could relate the effect of surface area on the pressure of a solid. Some of the students who chose alternative B (*Thin handle*) suggested that they failed to interpret the relationship between pressure and surface area, mathematically, Pressure, $P = \frac{\text{Normal Force}}{\text{Area}} = \frac{F}{A}$. At constant normal force, pressure is inversely proportional to the area, it can be interpreted such that an increase in the surface area of a handle of the metal decrease the pressure exerted on the boys' hand. Some of the students selected response C (*Long handle*). Those who chose alternative C

suggested that had little knowledge and skills on the topic of *pressure,* especially, the effects of surface area on pressure . Very few of the students selected response D.

Item (viii) assessed competencies of the students about the topic of *light*. The item was designed such that, for the students to select the correct response must have the ability to differentiate between natural sources of light and artificial sources of light. The item stated, "*Which of the following is a set of natural sources of light?"*. The given alternatives were: A. *Sun, star and fluorescence light* B. *Sun, star and lightning* C. *Star, candle and bioluminescence fly* D. *Star, lightning and wood fire*. The correct response was B (*Sun, star and lightning*). Most of the students who selected alternative B suggested that they had adequate knowledge of the concepts of the sources of light. Few students chose response A (*Sun, star and fluorescence light*). Those who chose response A revealed that they had little knowledge of the concepts of the sources of light, and probably they had little knowledge of fluorescent light. Some of the students chose response C (*Star, candle and bioluminescence fly*) or D (*Star, lightning and wood fire*). These students in these categories failed to identify that candle and wood fires are artificial sources of light. Generally, it can be said that those students who selected alternatives A, C, and D had little knowledge of identifying natural sources and artificial sources of light.

In item (ix), the students were assessed on the topic of *Work, Energy, and Power*. The students were required to apply the law of conservation of mechanical energy to the motion of a freely falling ball. The item stated, "*Which statement is true about a ball falling freely from a height of 10 m?"*. The given alternatives were as follows: A. *Its potential energy increases but kinetic energy decreases* B. *Its potential energy is equal to the kinetic energy* C. *Its potential energy is zero and its kinetic energy is maximum* D. *Its potential energy decreases and its kinetic energy increases.* The correct response was D. Few of the students selected response D, which suggested that they had adequate knowledge and skills on the topic of *Work, Energy, and Power* particularly the law of conservation of mechanical energy. Some of the students chose response A (*Its potential energy increases but kinetic energy decreases*) which was incorrect. Those students who chose response A know that the potential energy of an object depends on the location from the reference level.

However, they failed to choose an appropriate reference level. As per the item, the reference level was supposed to be the ground, and 10 m was measured from the ground. This indicated that the potential energy decreases as the ball freely falls to the ground. On the other hand, any free-fall object is in a state of acceleration. They are accelerating with an acceleration that is equal to the acceleration due to gravity (g = 9.8 m/s^2). This means that the speed of the free-fall object changes by 9.8 m/s every second. This is to say that the speed of the ball is increasing by 9.8 m/s every second. It can be concluded that the kinetic energy is not decreasing as a ball freely falls from 10 m above the ground. Some of the students selected response B which was incorrect. This alternative is a sub-set of alternative D which is regarded as the most correct response. The response B (*its potential energy is equal to the kinetic energy*) holds only to a particular location i.e., when a ball is a distance, $d = (0.5 \times g)\,\mathrm{m}$ from the top (10 m). Those who selected response C (*Its potential energy is zero and kinetic energy is maximum*) failed to interpret the item (ix). As per the item, "*a ball falling freely*" was the keyword, indicating that the ball is in a state of continuous falling. However, as per alternative C, implies the ball reached the ground (reference level).

The item (x) was constructed from the topic of *Static Electricity*. The item intended to assess the ability of the students to distinguish types of charging uncharged body, positively. The item stated, "*Which method is preferred to use if a student wishes to charge an uncharged body by using a positively charged body to make it acquire a positive charge?"*. The given alternatives were as follows: A. *Friction* B. *Contact* C. *Induction* D. *Heating.* The correct response was B (*Contact*). Those who selected response B suggested to have enough knowledge and skills to charge the uncharged body positively. Some of the students selected alternative A (*Friction*) which was an incorrect response. They failed to identify that this process is used to charge uncharged bodies negatively. Some of the students chose alternative C (*Induction*). Those who selected response C had little knowledge of the concepts of charge and laws of charge. The positively charged body induces a negative charge to the uncharged body because like charge repels and unlike charge attract each other. Very few of the students selected response D suggested that they had no knowledge and skills of the concepts of charging

2.1.2 Question 2: Matching items

This question comprised five (5) items constructed from the topic of *Measurements*. In this question, each item carried a weight of one (1) mark, making a total of five (5) marks. The students were required to match the uses of instruments in List A with the corresponding correct name of the instrument in List B by writing a letter of the response in the box provided below. The matching item was as follows:

List A	List B
(i) An instrument used to measure density of the liquid	A Density bottle
(ii) An instrument used to determine the volume of irregular substance.	B Hydrometer
(iii) An instrument used to transfer specific volume of liquid from one container to another.	C Eureka can
(iv) An instrument used to determine the volume of displaced water.	D Pipette
(v) An instrument used to determine the density of insoluble granules	E Measuring cylinder
	F Burette
	G Test tube

Answers

List A	(i)	(ii)	(iii)	(iv)	(v)
List B					

A total of 691,924 (100%) students attempted the question and their scores were as follows: 307,733(44.48%) students scored from 0.0 to 1.0 mark, 298,576 (43.15%) scored from 2.0 to 3.0 marks and 85,615 (12.57%) scored from 4.0 to 5.0 marks. These scores indicate that students' performance in this question was average as 384,191 (55.52%) scored from 2.0 to 5.0 marks out of 5.0 marks allocated to this question. Figure 2 summarizes the performance of the students in Question 2.

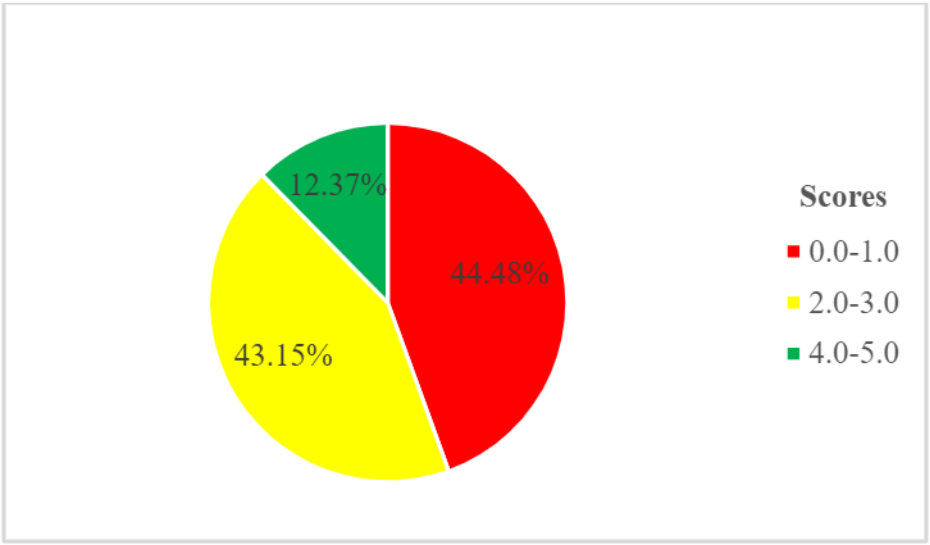


Figure 2: *The performance of the students in Question 2.*

In Item (i), the students were required to provide the correct response that matched the instrument description "*An instrument used to measure density of the liquid*". The correct response was B (*hydrometer*). Most of the students selected incorrect responses. Some of the students selected E (*Measuring cylinder*) which was incorrect. The students in this category failed to realize that a measuring cylinder was used to measure the volume of liquid. This is an indication that some of the students had little knowledge and skills in identifying appropriate instruments to measure the density of a liquid. Those who matched it correctly suggested that they had adequate knowledge and skills in selecting appropriate instruments to measure the density of a liquid.

An item (ii) was constructed such that the students were supposed to select the response which matched correctly with the statement "*An instrument used to determine the volume of irregular substance*" The correct response was C (*Eureka can*). Most of the students failed to choose the correct response. Some of the students selected response E (*Measuring cylinder*) which was incorrect. Those students were supposed to realize that a measuring cylinder is used to measure the volume of small irregular substances. If an irregular substance is larger to fit into a measuring cylinder, Eureka can be used as an alternative method. As per item (ii), the size of an irregular substance is not specified, the most appropriate instrument that can accommodate any size of an irregular substance is the *Eureka can*. Some of the students chose response A (*Density bottle*) which

was an incorrect response. Other students selected B (*Hydrometer*) which was an incorrect response. They failed to realize that a hydrometer is used to determine the density of a liquid. Some of the students picked response F (*Burette*). This was also an incorrect response. Those students were supposed to know that a burette is used to dispense and measure variable amounts of liquid in the laboratory. Some of the students selected response G (*Test tube*), it was an incorrect response. A test tube is not graduated and it is used to hold and mix smaller quantities of substances in the laboratory. Those students who failed to select the correct response had inadequate experimental knowledge and skills in the determination of the volume of irregular objects.

In Item (iii), the students were required to provide the correct response that matched with the following instrument description "*An instrument used to transfer specific volume of liquid from one container to another*". The correct response was D (*pipette*). Most of the students matched this item correctly. A few of the students failed to select the correct response. Some of the students selected A (*Density bottle*). Some students selected response B (*Hydrometer*). Others selected response E (*Measuring cylinder*). Some of them chose response F (*Burette*). Few selected G (*Test tube*). Those students lacked enough knowledge and skills on this topic. On the other hand, those who matched the item correctly demonstrated enough knowledge and skills in the use of pipettes that is accurately measure and dispense small quantities of liquids in the laboratory.

Item (iv) was constructed such that the students were supposed to select the response which matched correctly with the following statement "*An instrument used to determine the volume of displaced water*". The correct response was E (*Measuring cylinder*). Most of the students failed to choose the correct response. Some of the students selected response C (*Eureka can*) which was incorrect. Those students who failed to realize that it is not possible to directly measure the volume of irregular substances by Eureka can. They were supposed to know that Eureka can be used to determine the volume of irregular substances by displacement method. The following are procedures to be used to measure the volume of the irregular substance by displacement or immersion method.

- Fill the Eureka can with water up to the level of the spout.
- Place a beaker under the spout.

- Tie an irregular substance with a massless string and gently immerse it. The irregular substance will displace water.
- Collect the displaced water using a beaker.
- Transfer water to the measuring cylinder and record the volume of displaced water.

As per the experimental procedure, the measuring cylinder will ultimately measure the volume of liquid. Those who selected response C (Eureka can) failed to realize that it is not graduated and it has a spout which allows overflow of water displaced. In addition, it can be said that they failed to interpret item (iv) precisely. The item was somewhat similar to the item (ii). With item (ii) the students were required to match the item with an instrument which can be used to determine the volume of an irregular substance.

Item (v) was constructed such that the students were supposed to select the response which matched correctly with the following statement "*An instrument used to determine the density of insoluble granules*". The correct response was A (*Density bottle*). Most of the students selected the correct response suggesting that they had a good understanding of the method that can be used to determine the density of granules. Few of the students selected incorrect responses. Extract 1.1 shows one of the students who selected B (*Hydrometer*) as an instrument used to determine the density of granules. This student was supposed to realize that the hydrometer measures the density of liquid and not solid substances. Extract 1.1 shows a sample of a correct responses in Question 2 and a sample of an incorrect responses for Question 2 is displayed in extract 1.2.

Answers

List A	(i)	(ii)	(iii)	(iv)	(v)
List B	B	C	D	E	A

Extract 1.1: A sample of the correct response in Question 2.

Answers

List A	(i)	(ii)	(iii)	(iv)	(v)
List B	E	D	A	B	C

Extract 1.2: A sample of incorrect responses in Question 2.

2.2 Section B: Short Answer Questions

This section comprised of seven (7) short answer questions set from seven topics. The topics included *Magnetism, Temperature, Newton's Laws of Motion, Motion in a Straight Line, Simple Machines, Forces in Equilibrium* and *Sustainable Energy Sources.* Each question carried ten (10) marks.

2.2.1 Question 3: Magnetism

This question had two parts, namely (a) and (b). Part (a) assessed the ability of students to apply the methods by which the magnets can be demagnetized. The students were required to describe three ways in which magnets can be destroyed. In part (b), the students were required to identify four applications of magnets in daily life by giving vivid examples.

The question was attempted by 691,924 (100%) students out of whom 456,275 (65.94%) scored from 0.0 to 2.5 marks, 168,276 (24.32%) scored from 3.0 to 6.0 marks and 67,373 (9.74%) scored from 6.5 to 10.0 marks. This data shows that the performance of students in this question was average since 235,649 (34.06%) of students who attempted this question scored from 3.0 to 10.0 marks. Figure 3 summarizes the performance of the students in Question 3.

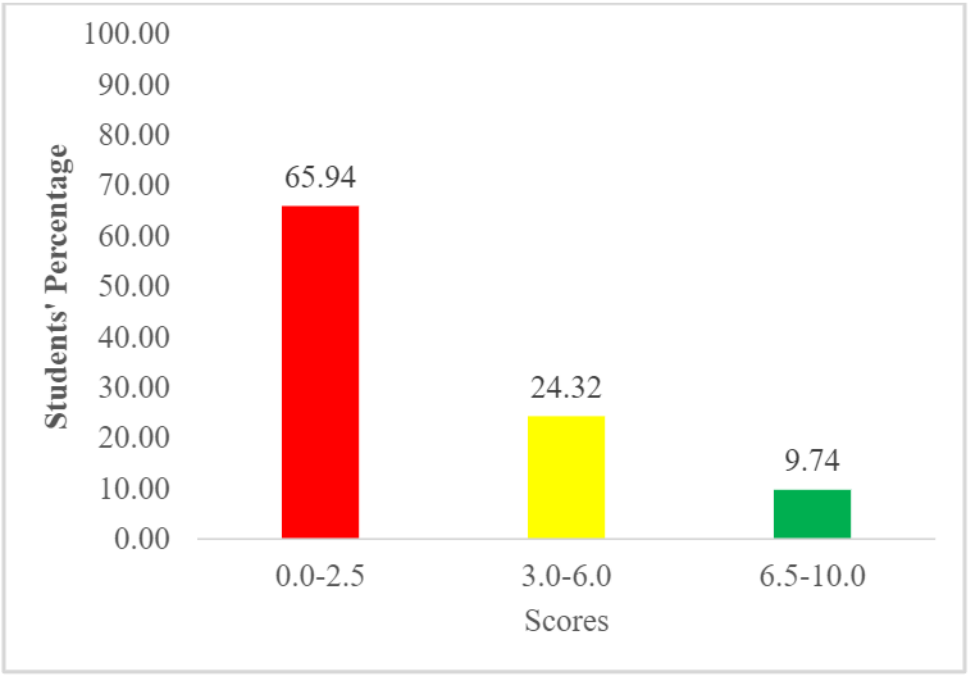
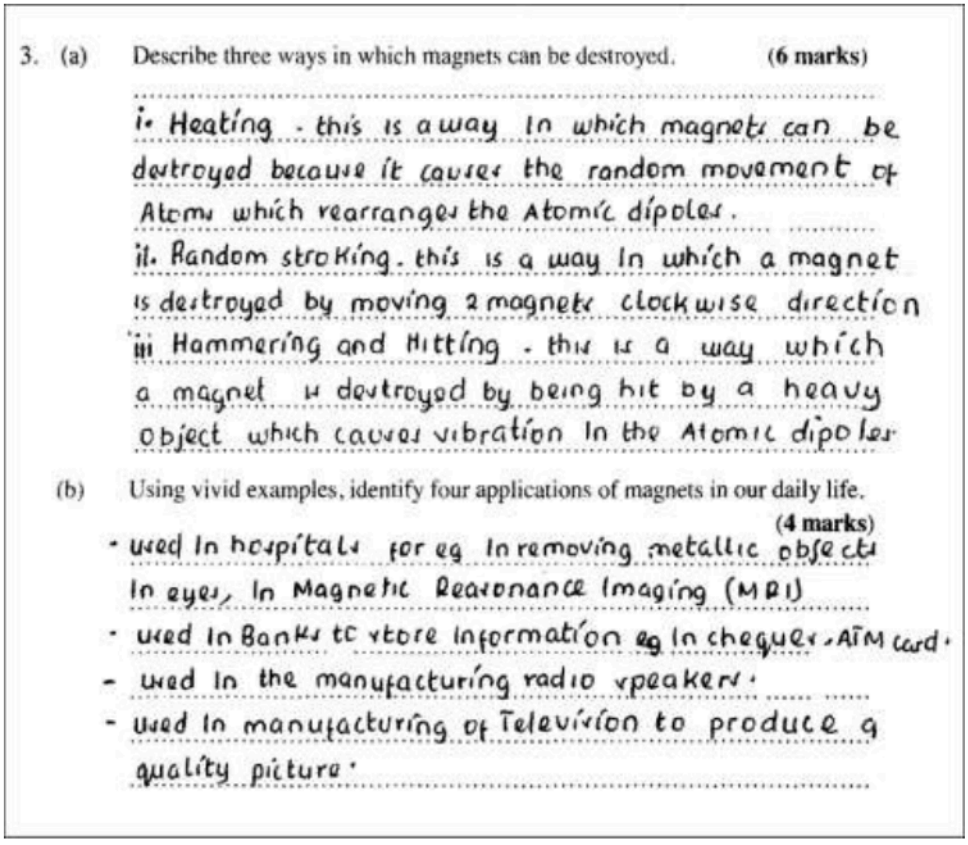


Figure 3: *Students' performance in Question 3.*

The question was popular with the majority of the students. The students who managed to score full marks had sufficient knowledge of the concept of magnetism. Having knowledge about magnetism they managed to give correct methods in which magnets can be destroyed. They also had a deep understanding of applications of magnets in daily life which enabled them to provide correct responses as per question demand. Extract 2.1 is a sample of correct responses from one of the students in Question 3.



3. (a) Describe three ways in which magnets can be destroyed. **(6 marks)**

i. Heating . this is a way In which magnets can be destroyed because it causes the random movement of Atoms which rearranges the Atomic dipoles.

ii. Random stroking. this is a way In which a magnet is destroyed by moving 2 magnets clockwise direction

iii Hammering and Hitting . this is a way which a magnet is destroyed by being hit by a heavy object which causes vibration In the Atomic dipoles

(b) Using vivid examples, identify four applications of magnets in our daily life. **(4 marks)**

- used In hospitals for eg In removing metallic objects In eyes, In Magnetic Resonance Imaging (MRI)
- used In Banks to store information eg In cheques, ATM card.
- used In the manufacturing radio speakers.
- used In manufacturing of Television to produce a quality picture.

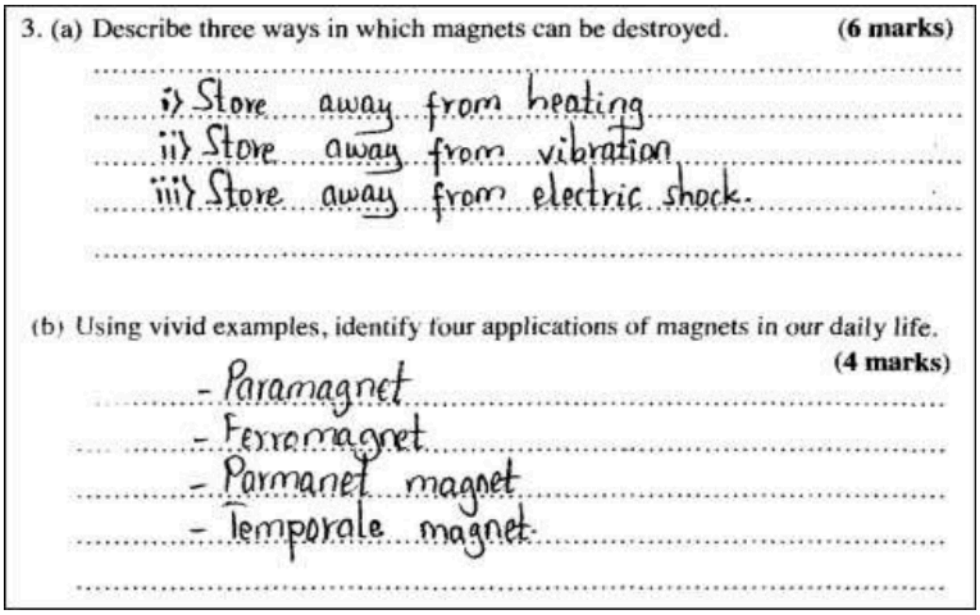
Extract 2.1: A sample of the correct responses in Question 3

On the other hand, the candidates who scored lower marks (0.0 – 2.5) lacked the basic concepts of demagnetization in the topic of *Magnetism*. In part (a), most of the students who responded incorrectly failed to differentiate between the concepts of demagnetization and the best practice for the storage of magnets. For instance, one of the students stated "Store *away from heating, Store away from vibration, Store away from electric shock* as the ways of demagnetization. The student was supposed to realize that these are the best practices for the storage of magnets. Some students responded to part (a) with the concepts of light and work, energy and

power suggesting that they had no knowledge and skills on the topic of magnetism. In order to describe the ways of demagnetizing magnets correctly, students were supposed to know that distraction from the arrangement of the atomic dipole causes demagnetization by doing one or some of the following:

- Heating magnet to very high temperature.
- Dropping the magnet frequently.
- Hammering the magnet repeatedly.
- Bringing the magnet in contact with the like poles of other magnets repeatedly.
- Passing the electric current through magnet

In part (b), students who responded incorrectly were not familiar with the application of magnets in their daily lives. For instance, one of the students stated "*Paramagnet, Ferromagnet, Permanet magnet, Temporale magnet*" Such responses from this student suggested that they have no idea about the application of magnets in our daily life. The student was supposed to realize *Paramagnet and ferromagnet* are types of magnetic materials. Some of the students were able to identify the applications of the magnets but failed to provide vivid examples. Some students who failed were not able to give correct applications and some listed applications without giving explanations and examples. Also, some of them were completely out of question requirements as they mentioned wrong uses of magnets, for example, some wrote:- "*Magnets are used to light, magnets are used to energy, magnets are used to heat and some wrote magnets are used in machines without being specific.*" Some students also mentioned the place where they have seen magnets or devices that use magnets, for example *"in hospital, in the laboratory, in the industries, and at home."* Extract 2.2 is a sample of incorrect responses from one of the students in question 3.


3. (a) Describe three ways in which magnets can be destroyed. **(6 marks)**

i) Store away from heating

ii) Store away from vibration

iii) Store away from electric shock.

(b) Using vivid examples, identify four applications of magnets in our daily life. **(4 marks)**

- Paramagnet
- Ferromagnet
- Parmanet magnet
- Temporale magnet

Extract 2.2: A sample of incorrect response in Question 3.

In extract 2.2, the students presented the best ways of storing magnets as the methods which can be used to destroy magnets and hence, scored no marks. Also, the students failed to give four applications of magnets in our daily lives.

2.2.2 Question 4: Temperature

This question had three parts (a), (b) and (c). In part (a), students were required to explain the function of the constriction in a clinical thermometer. In part (b) students were required to explain the principle on which a liquid-in-glass thermometer works. In part (c) students were supposed to identify the temperature at which Fahrenheit and Celsius scales give the same reading.

The question was attempted by 691,924 (100%) students out of which 683,405 (98.77%) scores from 0.0 to 2.5 marks, 7,159 (1.03%) scored from 3.0 to 6.0 marks and 1,360 (0.20%) scored from 6.5 to 10.0 marks. This data shows that the performance of students in this question was weak since 683,405 (98.77%) of students who attempted this question scored from 0.0 to 2.5 marks. Figure 4 summarizes the performance of students in this question.

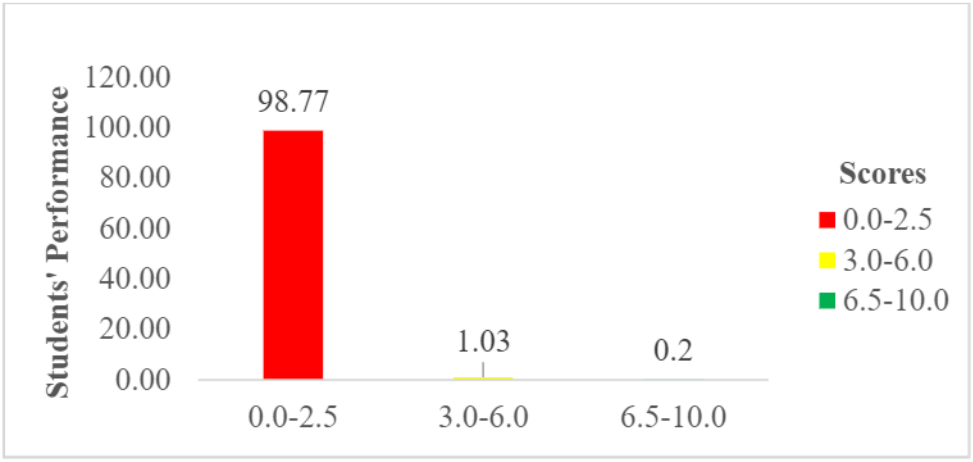


Figure 4: *Students' performance in Question 4.*

The statistical analysis of the student's responses indicated that those who scored low marks (0.0-2.5) lacked knowledge of the concepts of thermometric properties and the overall working principle of a liquid in a glass thermometer, and integrated with the function of the constriction in clinical thermometer.

In part (a) some of the students wrote incorrect responses. For instance, one of the students stated that *it is used to measure temperature*. This was incorrect because it describes the function of the thermometer. Some students wrote irrelevant responses such as "*It is used to understand laboratory and Archimedes' principle*" Those who wrote irrelevant responses suggested that they did not understand the topic of temperature. Students were supposed to know that as the temperature rises, the force of expansion, forces the mercury up through the constriction to the capillary tube. When the temperature falls the column breaks at the constriction and mercury cannot drop back (return) to the bulb (i.e., it remains stationary in the tube). This allows an accurate measurement of body temperature after the thermometer is removed.

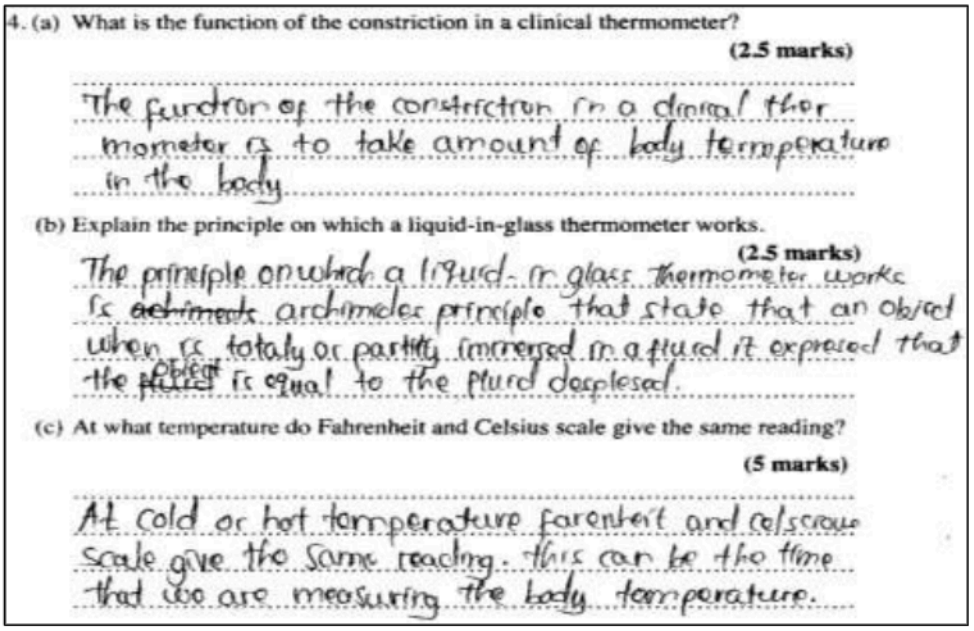
In part (b), some of the students failed to describe the working principle of a liquid in a glass thermometer. This suggests that those students had no insight into the working principle behind liquid in glass thermometers. Some of the students wrote incorrect responses. For instance, one of the students responded to this part by stating the Archimedes' Principe. This is an indication that some of the students had very little knowledge of the

concepts of thermometric properties and thermometers. They were supposed to understand that a liquid–in–glass thermometer works on the principle that, as the temperature of a liquid changes, the liquid expands or contracts. Also, the volume of liquid increases with an increase in temperature, and vice versa.

In part (c), for students to respond to this part they should have a deeper understanding of the two temperature scales, namely Celsius and Fahrenheit scale. However, there is a point on both scales where the temperature in degrees Celsius is equal to the degrees Fahrenheit. To establish this point, that is -40 ˚C and -40 ˚F, students must perform calculations to find this answer.

The students who provided incorrect responses suggested that they had little mathematical skills. Some of the students applied the wrong formula for converting degrees Celsius to degrees Fahrenheit and vice versa. For example, one of the students defined degree of ˚F as $^\circ F = \frac{9}{5}(^0\text{C} + 72)$ instead of $^\circ F = \frac{9}{5} \times ^\circ C + 32$ and that for degree of ˚C as $^\circ C = \frac{9}{5}(^\circ F - 72)$ instead of $^\circ C = \frac{5}{9}(^\circ F - 32)$.

This is an indication that those students had knowledge about the subject matter but failed to recall the correct expression. Some of the students provided wrong responses suggesting they had little knowledge regarding this matter. They were supposed to recall any of the correct formulas above and substitute $^\circ F = ^\circ C$. Thus, taking $^\circ C = \frac{5}{9}(^\circ F - 32)$, it follows that: $^\circ C = \frac{5}{9}(^\circ C - 32)$. Upon evaluating this equation, the value of degree of ˚C is found to be -40° which is also the value of degrees in fahreinheit implying that $^\circ F = -40^\circ$. Extract 3.1 is a sample of incorrect responses for Question 4



4. (a) What is the function of the constriction in a clinical thermometer?

(2.5 marks)

The function of the constriction in a clinical thermometer is to take amount of body temperature in the body

(b) Explain the principle on which a liquid-in-glass thermometer works.

(2.5 marks)

The principle on which a liquid-in glass thermometer works is ~~archimedes~~ archimedes principle that state that an object when is totaly or partly immersed in a fluid it expresed that the ~~fluid~~ object is equal to the fluid displesed.

(c) At what temperature do Fahrenheit and Celsius scale give the same reading?

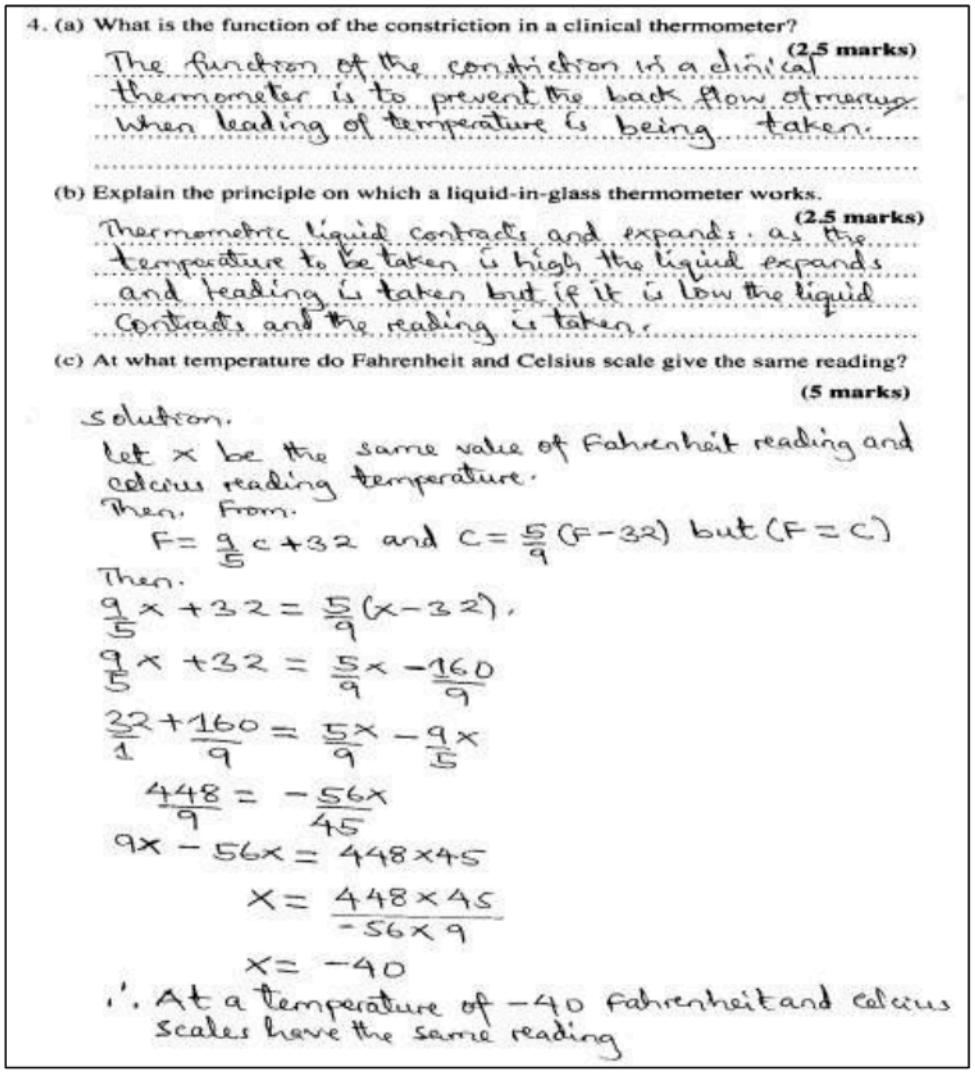
(5 marks)

At cold or hot temperature farenheit and celsious scale give the same reading. this can be the time that we are measuring the body temperature.

Extract 3.1: A sample of incorrect responses in Question 4.

In extract 3.1, a student failed to state the correct function of constriction but also incorrectly wrote the principle of Archimedes as the principle on which the liquid in glass works. Moreover, the student failed to establish the expressions for fahrenheit and Celsius scales in part(c) as a result, he/she provided incorrect responses.

The students who performed well in this question had good knowledge of the topic of temperature, this holds particularly to the thermometers and temperature scales. Furthermore, they demonstrated good mathematical skills. Those students applied correct formulas and algebraic processes to establish one point in which degree Fahrenheit is equal to degree Celsius. Extract 3.2 is a sample for a student who responded well to the Question 4.



4. (a) What is the function of the constriction in a clinical thermometer? (2.5 marks)

The function of the constriction in a clinical thermometer is to prevent the back flow of mercury when leading of temperature is being taken.

(b) Explain the principle on which a liquid-in-glass thermometer works. (2.5 marks)

Thermometric liquid contracts and expands. as the temperature to be taken is high the liquid expands and leading is taken but if it is low the liquid contracts and the reading is taken.

(c) At what temperature do Fahrenheit and Celsius scale give the same reading? (5 marks)

Solution.

Let x be the same value of Fahrenheit reading and celcius reading temperature.

Then. From.

$F = \frac{9}{5}c + 32$ and $C = \frac{5}{9}(F - 32)$ but $(F = C)$

Then.

$\frac{9}{5}x + 32 = \frac{5}{9}(x - 32)$.

$\frac{9}{5}x + 32 = \frac{5}{9}x - \frac{160}{9}$

$\frac{32}{1} + \frac{160}{9} = \frac{5}{9}x - \frac{9}{5}x$

$\frac{448}{9} = -\frac{56x}{45}$

$9x - 56x = 448 \times 45$

$x = \frac{448 \times 45}{-56 \times 9}$

$x = -40$

∴ At a temperature of −40 Fahrenheit and celcius scales have the same reading

Extract 3.2: A sample of correct responses in Question 4.

2.2.3 Question 5: Newton's Laws of Motion

This question is comprised of three parts that are part (a), (b) and (c). Part (a) consisted of items (i) and (ii). In part (a) (i), the students were required to provide an argument to respond to a given scenario and task as to why a man pushing a motor cycle made it to accelerate but the same man failed to move a car. In part (a), the scenario and task were constructed such that the students must apply Newton's laws of motion to describe the cause of motion. Part (b) was a numerical question based on the concept of linear momentum. The question was designed such that it assessed both physics and mathematical skills. The question required the students to determine the momentum of a car with a mass of 350 kg, moving from Kondoa to

Babati at a speed of 120 km/hr that overtakes a bus with a mass of 1000 kg, moving with a speed of 40 km/hr. The students were required to use an appropriate formula to deduce which car had a high momentum. Part (c) was also a numerical question which required the students to determine the acceleration acquired by the body when a boy of mass 50 kg was pushed by a constant force of 20 N for 3 seconds.

The question was attempted by 691,924 (100%) students out of which 653,911 (94.51%) scored from 0.0 to 2.5 marks, 30,623 (4.42%) scored from 3.0 to 6.0 marks and 7,390 (1.07%) scored from 6.5 to 10 marks. This data shows that the performance of students in this question was weak since 653,911 (94.51%) of students who attempted this question scored from 0.0 to 2.5 marks. Figure 5 summarizes the performance of students in this question.

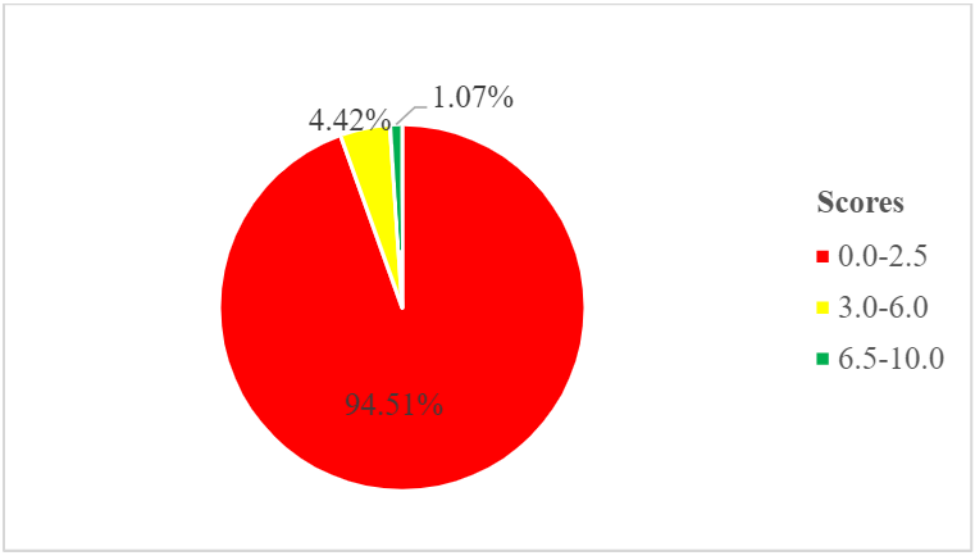


Figure 5: *Students' performance in Question 5.*

The statistical analysis of students' performance revealed that those who scored low marks had inadequate knowledge of Newton's laws of motion and mathematical skills. The analysis of students' performance indicated that most of the students failed to provide correct responses in part (a). Those students who failed to provide correct responses had little knowledge and skills in Newton's first law and second law of motion. It is suggested that those students in this category failed to grasp the core concepts and applications of Newton's laws of motion to describe various scenarios. They were supposed to realize that the inertia of the car is larger

than that of the motorcycle therefore more force is needed to overcome it. In part (a) (i), some of the students provided irrelevant reasons concerning the context of the item. For instance, one of the students wrote that "*due to high moment and perpendicular distance',* another student wrote that *"high pressure"*. These responses are not related to the context of the item but pertain to the concepts of *Forces in Equilibrium* and *Pressure* respectively. Extract 5.1 shows the student who used the concept of the moment to provide an answer for part (a) (i). Some of the students wrote unclear responses such as *due to state of motion of motorcycle*. One of the students wrote that "*due to inertia of motion and direction*". This student had an idea but failed to apply it to real-world situations. This is to say that most of the students are good at memorizing Newton's laws of motion and poorly at applying them to solve real-world situations.

Students who gave incorrect responses in part (a) (ii) applied the concepts of *moment of force*, *pressure*, *work and energy* instead of *Newton's laws of motion* to argue against the given statement. For example, some of the students wrote that "*because no work is done"*. This was an incorrect and irrelevant response. Other students responded to the item by citing Newton's third law of motion. This was wrong because Newton's third law practically analyzed the origin of forces and not the state of the moving body. However, it may describe the direction of the moving body. One of the students wrote that "*there is no force acting due to the law of inertia".* The students failed to clearly understand the law of inertia which states that "a body will continue to be in its state of rest or uniform motion unless an external force acts on it". Some of the students wrote that "*no force acting on the stationary and moving body"* which was also an incorrect argument. The student was required to realize that when a body is in uniform motion it is acted by balanced forces.

The students who failed to provide the correct response in part (b), were also not familiar with the concept of linear momentum as a result they applied an incorrect formula. For instance, one of the students defined momentum mathematically as $\text{momentum} = \text{Force} \times \text{acceleration}$. Another student responded to the item by writing $\text{momentum} = \text{Force} \times \text{distance}$. Some of the students wrote as, $\text{momentum} = \dfrac{\text{mass (m)}}{\text{velocity (v)}}$. These relations are incorrect mathematical formulas and are not used in Physics and they have no physical meaning. Others lacked enough knowledge and skills in

the conversion of units. They failed to convert km/hr to m/s. Other students computed total momentum. They sum masses of moving cars as well as their corresponding velocities. This was an incorrect approach. In extract 5.1 a student used the wrong formula to compute the momentum of a moving body.

A student defined momentum as, $\text{momentum} = \dfrac{350\,\text{kg} + 1000\,\text{kg}}{120\,\text{km/hr} + 40\,\text{km/hr}}$. This was an incorrect approach. Those students failed to realize that momentum is the product of mass and velocity. They were supposed to express momentum as follows $\text{momentum}, p = \text{mass} \times \text{velocity}$. In addition, they were supposed to work with the SI unit. They were supposed to change km/hr to m/s. In this regard, 120 km/hr is equivalent to 33.33 m/s, and 40 km/hr is 11.11 m/s. For the students to execute the item perfectly, they must have very good skills of mathematics.

For the students to respond to part (c) of this question should have the ability to demonstrate mastery of basic concepts and laws of motion, particularly Newton's second law. The students should have the ability to apply an appropriate mathematical formula to evaluate the acceleration of the body when 20 N was applied for 3 seconds. The analysis revealed that some of the students who scored low marks used the wrong formula. For instance, one of the students used the following formula $a = \dfrac{u - v}{t}$ to evaluate the acceleration of the body when 20 N was applied for 3 seconds. Another student used a formula $a = \dfrac{v}{t}$. Those were incorrect expressions. Some of the responses make no sense. For example, one of the students responded to this part as follows:

$$a = \frac{50\,\text{kg} - 20\text{N}}{3\,\text{sec}}$$
$$a = 10\,\text{kgN/s}.$$

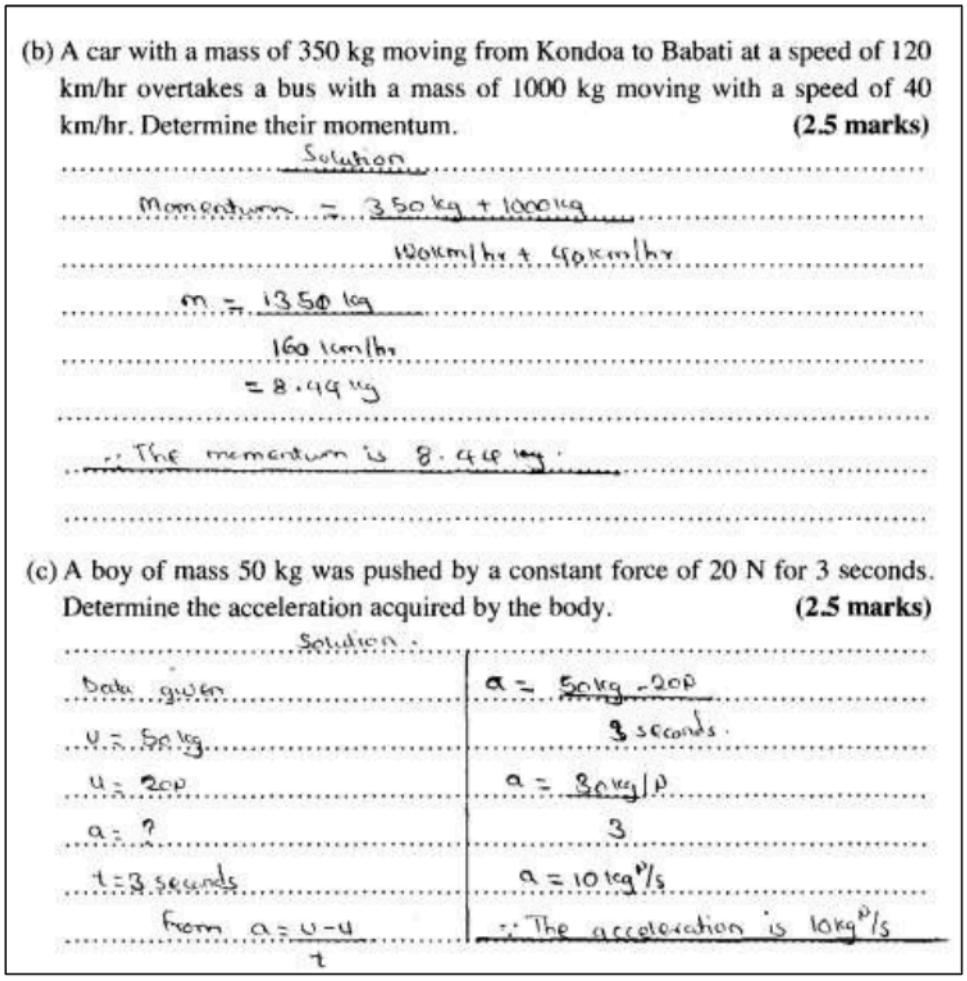
Students were supposed to know that the acceleration of a body when a constant force of 20 N is applied for 3 seconds is given as $a = \dfrac{F}{m}$. Extract 4.1 shows the incorrect responses from one of the students.

5. (a) (i) Suppose you find a man along the road pushing a motor cycle and it accelerated, but the same man pushed a car and failed to move it. Why the man failed to push the car? Briefly explain. **(2.5 marks)**

This is because moment of a force to provide anticlockwise moments is equal to clockwise moments and the pull or push experienced by an object of the body of the force applied.

(ii) An object in a state of rest or moving with uniform motion has no forces acting on it. Argue against this statement. **(2.5 marks)**

This is because the force was product the distance and pull experienced by an object anticlockwise moments to the clockwise moments of a body.



(b) A car with a mass of 350 kg moving from Kondoa to Babati at a speed of 120 km/hr overtakes a bus with a mass of 1000 kg moving with a speed of 40 km/hr. Determine their momentum. **(2.5 marks)**

Solution

Momentum = 350 kg + 1000 kg

120 km/hr + 40 km/hr

m = 1350 kg

160 km/hr

= 8.44 kg

∴ The momentum is 8.44 kg.

(c) A boy of mass 50 kg was pushed by a constant force of 20 N for 3 seconds. Determine the acceleration acquired by the body. **(2.5 marks)**

Solution:

Data given

u = 50 kg

u = 20P

a = ?

t = 3 seconds

From $a = \frac{v-u}{t}$

a = 50 kg - 20P

3 seconds.

a = 30 kg/P

3

a = 10 kgP/s

∴ The acceleration is 10 kgP/s

Extract 4.1: A sample of incorrect responses in Question 5.

Extract 4.1, shows that a student failed to recall or establish the formula for finding the momentum of the moving car and a bus in part (b). The student lacked the knowledge of conservation of linear momentum. In part (a) (i), the student had no insight about the concept of inertia which is a function of mass where as in part (c), he/she was not familiar with Newton's second law of motion.

The students who managed to provide correct responses had enough knowledge and skills about Newton's laws of motion. They were able to demonstrate mastery of basic concepts of force and motion and linked them with real-life situations. In addition, they demonstrated mastery of Newton's first law of motion and applied it to describe the state of a moving body. That is to say that they did not memorize the laws of motion.

Those who scored high marks in part (b) had good knowledge of the laws of motion and mathematics skills. The demonstrated ability to apply appropriate mathematical formulas to determine the momentum of each car. They correctly defined momentum , $p = \text{mass} \times \text{velocity}$. They demonstrated mastery of handling units in physics because they correctly converted km/hr to m/s.

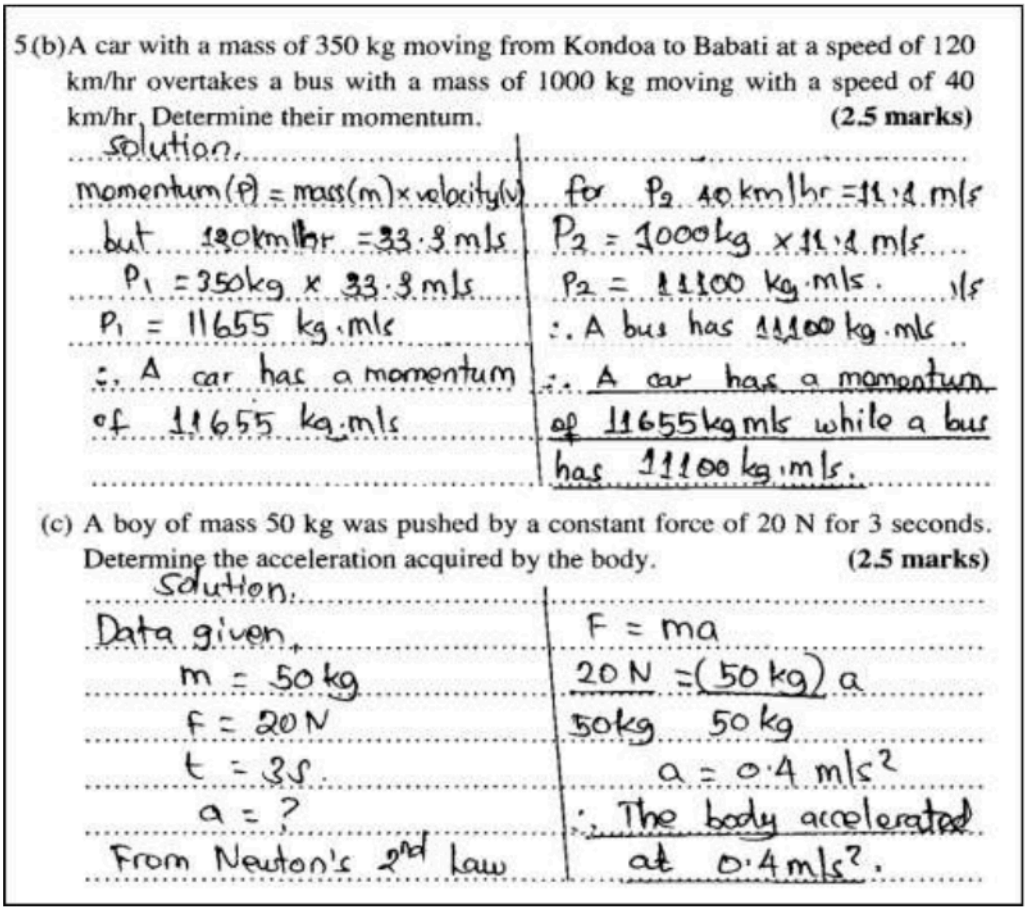
Students who scored high marks in part (c) had sufficient knowledge and skills to relate three physical quantities, that are acceleration and mass of the body and applied force. They relate these physical quantities as $a = \frac{F}{m}$. Extract 4.2 is a sample of correct responses from one of the students in Question 5.

5. (a) (i) Suppose you find a man along the road pushing a motor cycle and it accelerated, but the same man pushed a car and failed to move it. Why the man failed to push the car? Briefly explain. **(2.5 marks)**

This is due to Inertia of rest. The car has large mass thus it requires a large force to be moved. It does not move because the man has exerted a smaller force that the car is able to resist. Inertia of rest is the resistance of a body to change its state of rest that means the car has resisted from being moved while the motor cycle did not manage to resist due to its smaller mass.

(ii) An object in a state of rest or moving with uniform motion has no forces acting on it. Argue against this statement. **(2.5 marks)**

There must be forces acting on it but the net force remains zero that lead a body to be in state of rest or at constant velocity without any acceleration. It has been proved that an object at rest or moving with uniform motion has forces that acts on it but no acceleration since no resultant forces.



5(b) A car with a mass of 350 kg moving from Kondoa to Babati at a speed of 120 km/hr overtakes a bus with a mass of 1000 kg moving with a speed of 40 km/hr. Determine their momentum. **(2.5 marks)**

Solution.

momentum (p) = mass (m) × velocity (v)

but 120 km/hr = 33.3 m/s

P_1 = 350 kg × 33.3 m/s

P_1 = 11655 kg.m/s

∴ A car has a momentum of 11655 kg.m/s

for P_2 40 km/hr = 11.1 m/s

P_2 = 1000 kg × 11.1 m/s

P_2 = 11100 kg.m/s.

∴ A bus has 11100 kg.m/s

∴ A car has a momentum of 11655 kg m/s while a bus has 11100 kg.m/s.

(c) A boy of mass 50 kg was pushed by a constant force of 20 N for 3 seconds. Determine the acceleration acquired by the body. **(2.5 marks)**

Solution.

Data given,

m = 50 kg

F = 20 N

t = 3 s.

a = ?

From Newton's 2nd law

F = ma

$\frac{20\ N}{50\ kg} = \frac{(50\ kg)\ a}{50\ kg}$

$a = 0.4\ m/s^2$

∴ The body accelerated at $0.4\ m/s^2$.

Extract 4.2: A sample of correct responses in Question 5.

2.2.4 Question 6: Motion in a Straight line

This question was constructed from the topic of *Motion in a Straight Line*. It was structured with the aim of assessing the student's ability to apply all three (3) equations of motion to evaluate the distance covered by the car. This implies that the question is aimed at assessing both physics knowledge as well as mathematical skills.

The question was attempted by 691,924 (100%) students out of which 630,067 (91.06%) scores from 0 to 2.5 marks, 42,232 (6.10%) scored from 3.0 to 6.0 marks and 19,625 (2.84%) scored from 6.5 to 10 marks. This data shows that the performance of students in this question was weak since 630,067 (91.06%) of students who attempted this question scored from 0.0 to 2.5 out of 10.0 marks. Figure 6 portrays the performance of students in this question.

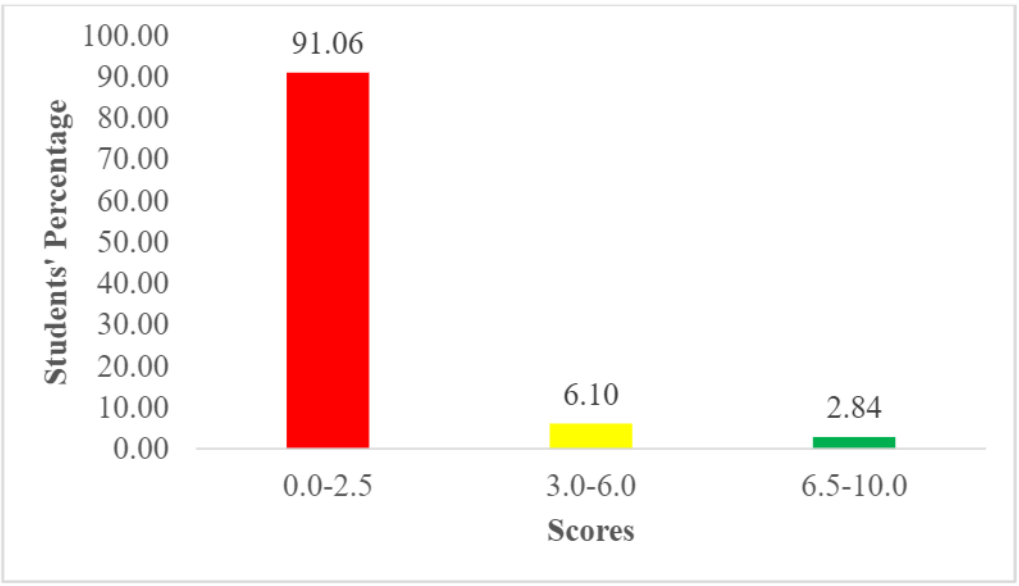
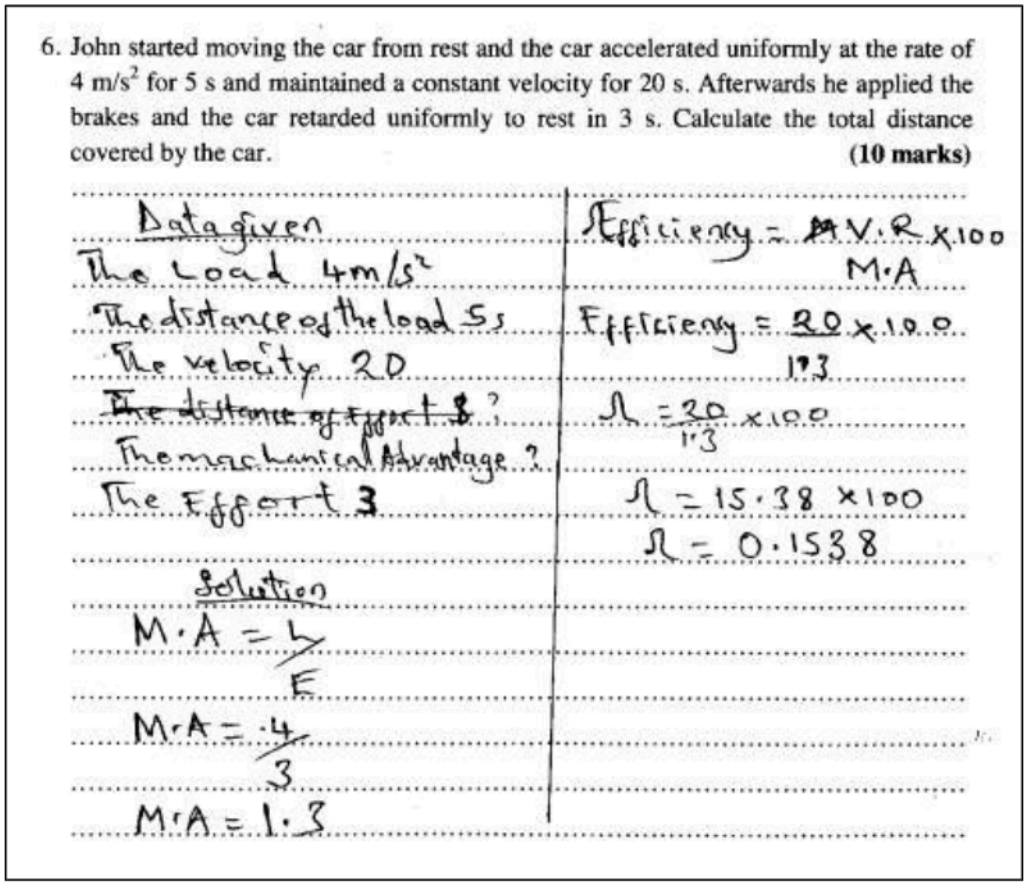


Figure 6: *Students' performance in Question 6.*

The analysis of student's performance revealed that majority (91.06%) of the students failed to respond to this question correctly. Those who failed to respond to this question had little knowledge about the concept of motion in a straight line. Looking at the nature of the question, two approaches can be used to evaluate the total distance covered by the car: (i) graphical method and (ii) numerical method. Those who opted for numerical methods failed to differentiate acceleration and final velocity. They regarded a given acceleration of 4 m/s^2 as the final velocity.

Those who opted for the graphical method failed to plot the velocity-time graph. One of the students used the concepts or ideas of different topics which are irrelevant to the desired anticipation to evaluate the total distance covered by the car. Extract 5.1 is a sample of incorrect responses from one of the students in question 6.


6. John started moving the car from rest and the car accelerated uniformly at the rate of 4 m/s^2 for 5 s and maintained a constant velocity for 20 s. Afterwards he applied the brakes and the car retarded uniformly to rest in 3 s. Calculate the total distance covered by the car. **(10 marks)**

Data given
The Load 4m/s²
The distance of the load 5s
The velocity 20
~~The distance of effort 8~~ ?
The mechanical Advantage ?
The Effort 3

Solution
M·A = L/E
M·A = 4/3
M·A = 1·3

Efficiency = M.V.R x100 / M·A
Efficiency = 20 x 100 / 1·3
η = 20/1·3 x100
η = 15·38 x100
η = 0·1538

Extract 5.1: A sample of incorrect responses in Question 6.

Extract 5.1, shows the student who used the concept of simple machines to evaluate the total distance covered by the car instead of using graphical method or equations of motions. The student lacked the knowledge of the concept of motion in a straight line.

A few students responded correctly to this question. Those who responded correctly to this question had enough knowledge and skills of the concept of motion in a straight line. Most of them opted to use a graphical method to tsolve the question. In addition, those students demonstrated good mathematical skills. Extract 5.2 shows the student's correct response to Question 6.

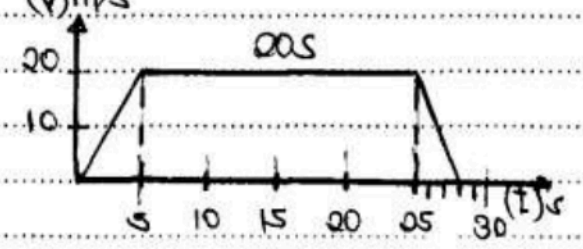
6. John started moving the car from rest and the car accelerated uniformly at the rate of 4 m/s^2 for 5 s and maintained a constant velocity for 20 s. Afterwards he applied the brakes and the car retarded uniformly to rest in 3 s. Calculate the total distance covered by the car. **(10 marks)**

Solution

From, $a = \frac{\Delta v}{t}$

$4 m/s^2 = \frac{\Delta v}{5s}$

Velocity = 20m/s



Total distance = $\frac{(a+b)h}{2}$

$= \frac{(20s + 28s)\, 20m/s}{2}$

$= \frac{(48s)\, 10\, 20m/s}{2} = 480m$

∴ The total distance is 480m.

Extract 5.2: A sample of the student's correct response in Question 6, graphically.

The analysis of the students' scripts revealed that few of them obtained correct responses numerically. They applied all three equations of motion to compute the total distance covered by the car. These students demonstrated a high competence level in handling the equations of motion. Extract 5.3 shows the student's correct response to Question 6 by numerical computation approach using equations of motion.

6. John started moving the car from rest and the car accelerated uniformly at the rate of 4 m/s^2 for 5 s and maintained a constant velocity for 20 s. Afterwards he applied the brakes and the car retarded uniformly to rest in 3 s. Calculate the total distance covered by the car. **(10 marks)**

Solution

1st
Initia velocity (u) = 0m/s
acceleration (a) = 4m/s^2
time (t) = 5s
$s_1 = ut + \frac{1}{2}at^2$
$s_1 = \frac{1}{2} \times 4 \times (5)^2$
$s_1 = 50m$

2nd
$s_2 = vt$
but $a = \frac{v-u}{t}$
$4m/s^2 = \frac{v-0}{5}$
$v = 20m/s$
V become constant

$s_2 = vt_2$
$= 20m/s \times 20s$
$s_2 = 400m$

3rd
$u = 20m/s$
$v = 0m/s$
$t = 3s$
$a = \frac{v-u}{t} = \frac{0-20m/s}{3s} = -6.67m/s^2$
$v^2 = u^2 + 2as$
$0 = 400 + 2 \times -20 \times s$
$-400 \times 3 = -40s \quad s = 30m$
$-40 \quad -40$

$s_T = s_1 + s_2 + s_3 = (400 + 50 + 30)m$
$s_T = 480m.$

∴ Total distance covered by car is 480m.

Extract 5.3: A sample of the correct responses in Question 6, numerically.

2.2.5 Question 7: Simple Machines

The question consisted of parts (a) and (b). Part (a) had two items, namely (i) and (ii). The question was constructed from the topic of *Simple Machines*. Part (a) of this question was a conceptual question which assessed the ability of the students to describe why an inclined plane is regarded as a simple machine. Part (b) of the question was a numerical question. The students were required to apply a proper formula to deduce the velocity ratio and the mechanical advantage of the wheel and axle.

The question was attempted by 691,924 (100%) students out of which 527,239 (76.20%) scores from 0.0 to 2.5 marks, 124,511 (17.99%) scored

from 3.0 to 6.0 marks and 40,174 (5.81%) scored from 6.5 to 10 marks. This data shows that the performance of students in this question was weak since majority of the students, 527,239 (76.20%) who attempted this question scored from 0.0 to 2.5 marks. Figure 7 summarizes the performance of students in this question.

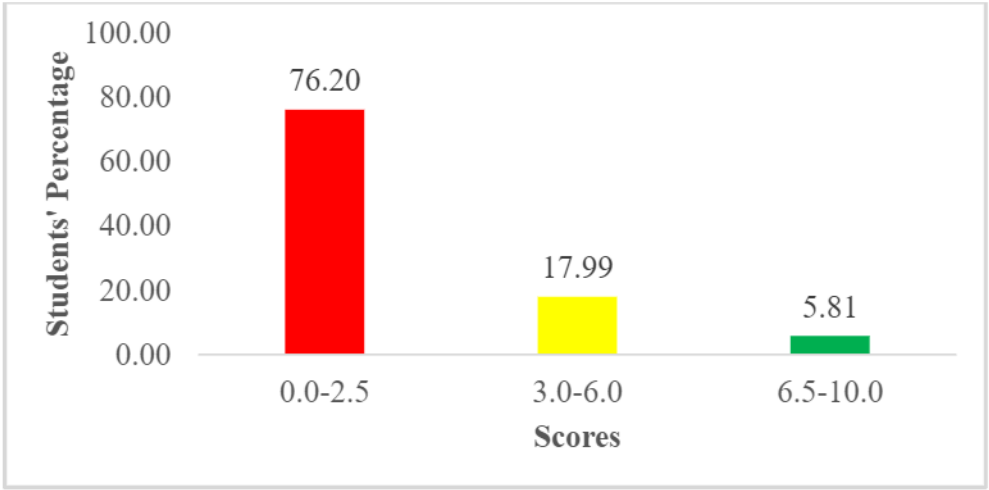


Figure 7: The performance of the students in Question 7.

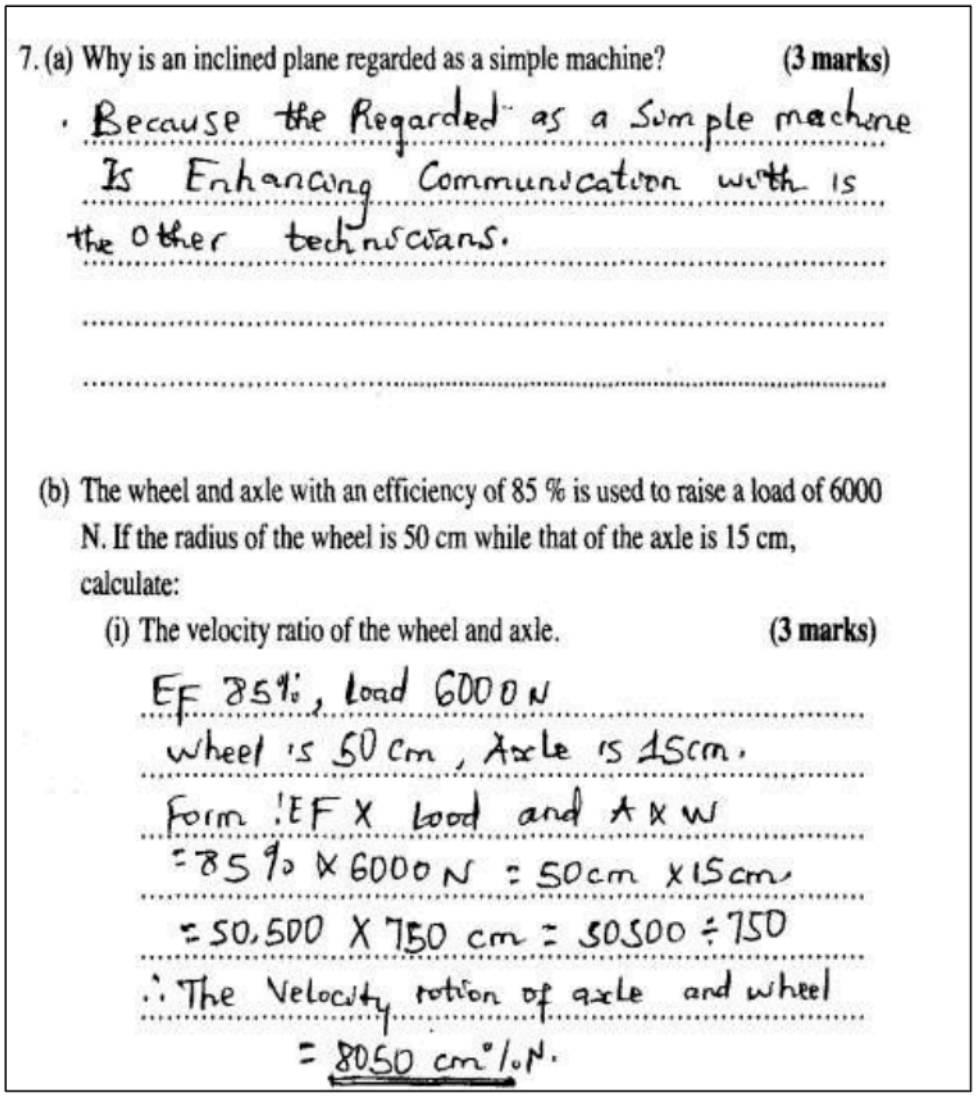
Statistical analysis of the students' performance revealed that the majority of students scored higher in part (b) than in part (a). This is an indication that students were weak in the conceptual questions. Those who failed part (a) of the question had insufficient knowledge and skills on the concepts of *inclined plans and simple machines*. Some of the students wrote incorrect reasons. For instance, one of the students wrote that "*it helps to reduced efficiency"*. Some of the students stated that "*it is used to know the velocity ratio*". Those were incorrect responses. Those students failed to realize that the inclined plane reduces the amount of force needed to move an object to a higher height. Other students wrote that "*because its surface is smooth*" which is not the criteria for a device to be regarded as a Simple Machine. They were supposed to realize that for a device to be regarded as a simple machine it must amplify the amount of force applied on an object to be lifted. The smoothness of the surface is not a necessary ingredient for the inclined plane to be regarded as a simple machine.

In part (b) (i), students who scored low marks had insufficient knowledge and skills in the concept of *Simple machines* and mathematical skills. Most of the students who scored low marks failed to apply the appropriate

formula. They failed to differentiate the expression of the velocity ratio that describes the wheel and axle from other simple machines. They were supposed to realize that despite the fact that the velocity ratio measures how easy it is to move a load the computation depends on the type of the simple machine. For instance, the velocity ratio of the wheel and axle is described by the complete turn of the wheel and axle: Velecity ratio, $VR = \frac{\text{Radius of the wheel}}{\text{Radius of the axle}} = \frac{R}{r}$ while that of the inclined plane is defined as $VR = \frac{\text{Effort distance}}{\text{Load height}} = \frac{L}{h}$. Some of the students used the wrong formula to determine the value of the velocity ratio. For example, one of the students used the formula, $VR = \frac{R-r}{\text{pitch}}$. Another student used the formula $VR = \frac{2\pi}{p}$. Extract 6.2, shows an example of a student who used the wrong formula $\text{efficiency}\,(e) \times Load\,(L) = R \times r$. These relations are incorrect and make no sense in the Physics context. This is an indication that those students had enough knowledge and skills in the topic of *Simple machines*.

In part (b) (ii) some students failed to understand the question. They defined mechanical advantage as $M.A = \frac{Load}{Effort}$, then computed the mechanical advantage as $M.A = \frac{6000\,\text{N}}{65\,\text{cm}} = 92.3\ \text{N/cm}$. As per examination item context, the mathematical expression was incorrect. In addition, the final value of the calculated physical quantity and SI unit make no sense. The item demanded the use of the efficiency of the wheel and axle to determine the mechanical advantage. The students were required to use the following expression $M.A = \frac{\text{velocity ratio} \times \text{efficiency}}{100\%}$. Some of the students expressed the mechanical advantage of the wheel and axle $M.A = \frac{\text{Efficiency}}{\text{Axle}}$. This was an incorrect formula to be used and it has no meaning in per physics context. Some of the students provided unclear responses. For example, one of the students wrote that the "*mechanical*

advantage of wheel and axle is due to the frictional force." Another student responded by writing "*used in agriculture*". Some of the students wrote that "*source of tools in the agriculture"*. These responses were incorrect and irrelevant. Extract 6.1 a student mixed the concept of mechanical advantage with the concepts related to work, energy and power.



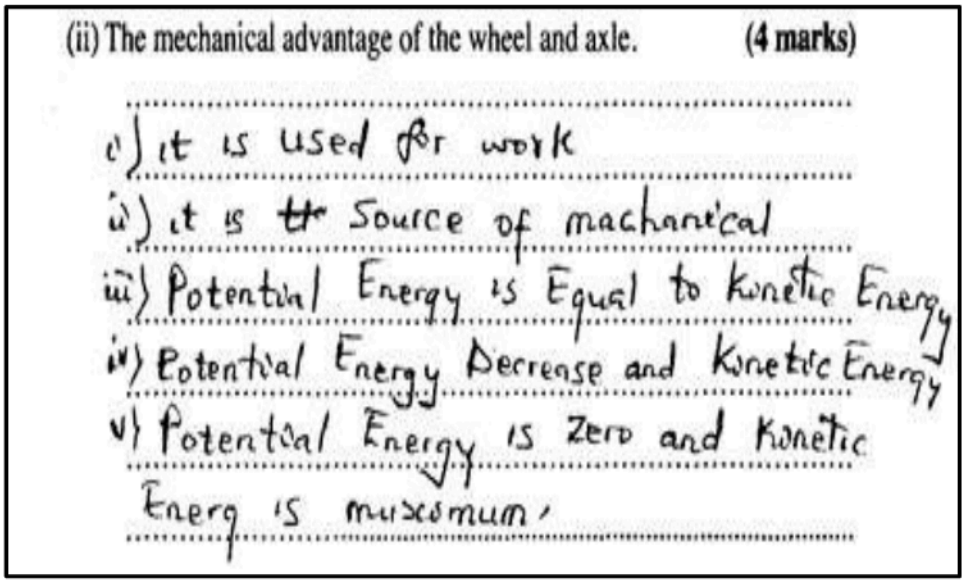
7. (a) Why is an inclined plane regarded as a simple machine? **(3 marks)**

Because the Regarded as a Sumple machine Is Enhancing Communscation with is the other technscians.

(b) The wheel and axle with an efficiency of 85 % is used to raise a load of 6000 N. If the radius of the wheel is 50 cm while that of the axle is 15 cm, calculate:

(i) The velocity ratio of the wheel and axle. **(3 marks)**

EF 85%, load 6000 N
wheel is 50 cm, Axle is 15cm.
Form EF X Load and A X W
= 85% X 6000 N = 50cm X 15cm
= 50,500 X 750 cm = 50500 ÷ 750
∴ The Velocity ration of axle and wheel
= 8050 cm°/.N.


(ii) The mechanical advantage of the wheel and axle. **(4 marks)**

i) it is used for work

ii) it is ~~the~~ source of machanical

iii) Potential Energy is Equal to Konetic Energy

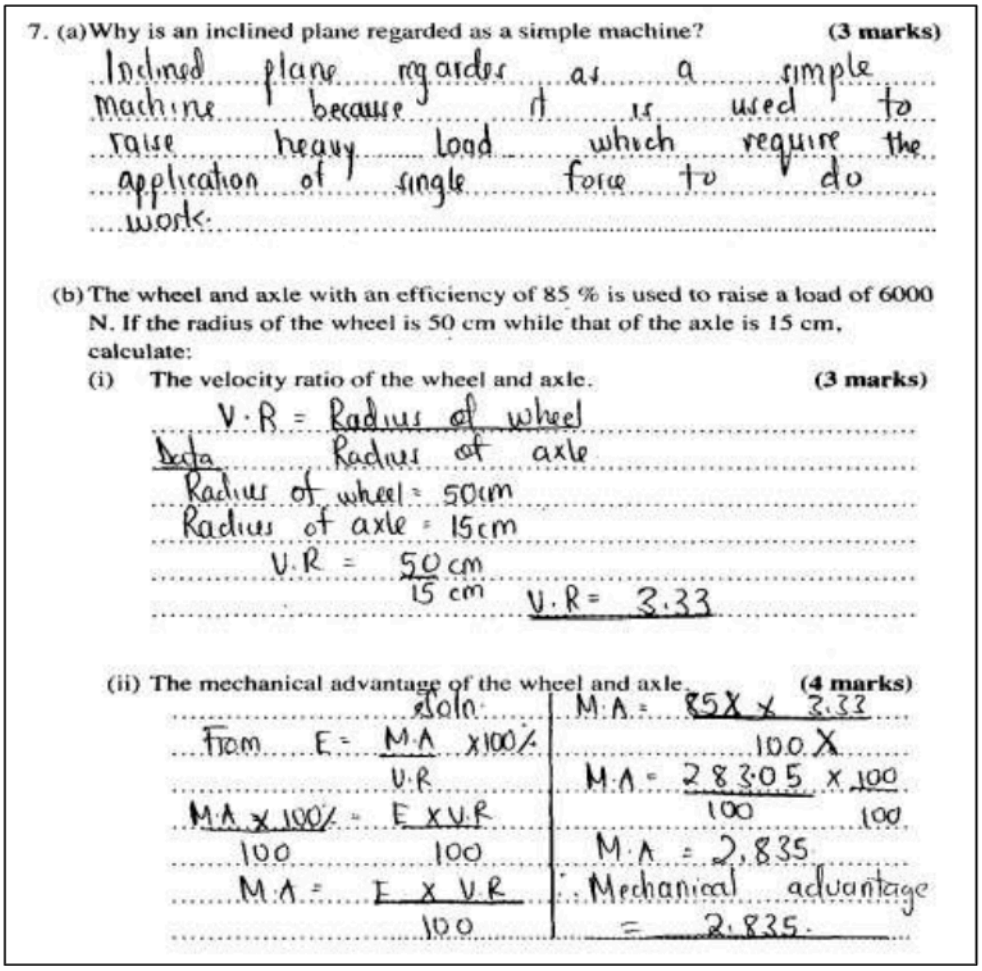
iv) Potential Energy Decrease and Konetic Energy

v) Potential Energy is zero and Konetic Energ is maximum.

Extract 6.1: A sample of incorrect responses in Question 7.

In extract 6.1, a student did not understand that for an inclined plane to be regarded as a simple machine must use lesser efforts to raise the heavy loads by dragging them along its surface but the student stated about enhancing communication with other technicians. In part (b), he/she lacked the knowledge and skills of mathematics to calculate the velocity ratio and mechanical advantage of the wheel and axle in simple machines instead he/she mentioned the issues of mechanical energy.

The students who scored high marks in this question demonstrated good knowledge and skills in the concepts of *Simple Machines*. They also had good mathematical skills as they applied the appropriate formula to calculate the velocity ratio and mechanical advantage of the wheel and axle. Extract 6.2 is a sample of students' correct responses to this question.


7. (a) Why is an inclined plane regarded as a simple machine? (3 marks)

Inclined plane regarded as a simple machine because it is used to raise heavy load which require the application of single force to do work.

(b) The wheel and axle with an efficiency of 85 % is used to raise a load of 6000 N. If the radius of the wheel is 50 cm while that of the axle is 15 cm, calculate:

(i) The velocity ratio of the wheel and axle. (3 marks)

V.R = Radius of wheel / Radius of axle

Data

Radius of wheel = 50cm

Radius of axle = 15cm

V.R = 50 cm / 15 cm

V.R = 3.33

(ii) The mechanical advantage of the wheel and axle. (4 marks)

Soln:

From E = M.A x 100% / V.R

M.A x 100% / 100 = E x V.R / 100

M.A = E x V.R / 100

M.A = 85 x 3.33 / 100

M.A = 283.05 / 100 x 100 / 100

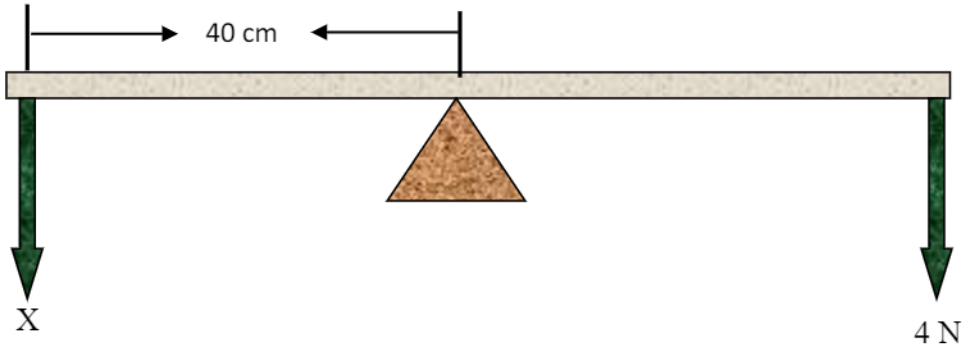
M.A = 2.835

∴ Mechanical advantage = 2.835.

Extract 6.2: A sample of the correct responses in Question 7.

2.2.6 Question 8: Forces in Equilibrium

This question consisted of two parts, namely parts (a) and (b). Part (a) was a conceptual question which demanded the students to give reason (s) to a rotating body when acted by an applied force. Part (b) was a numerical question, designed to assess the ability of the students to apply the principle of moment to determine the value of unknown force that is needed to keep the system in the state of rotational balance. The students were provided with the following diagram that shows the forces acting on the metre rule.



The question was attempted by 691,924 (100%) students out of which 676,807 (97.82%) scored from 0.0 to 2.5 marks, 11,293 (1.63%) scored from 3.0 to 6.0 marks and 3,824 (0.55%) scored from 6.5 to 10 marks. This data shows that the performance of students in this question was weak since only 15,117 (2.18%) of students who attempted this question scored from 3.0 to 10 marks. In other words, majority (97.82%) of the students scored the lowest range of marks from 0.0 to 2.5 out of 10.0 marks. Figure 8 summarizes the percentage of performance of students in this question.

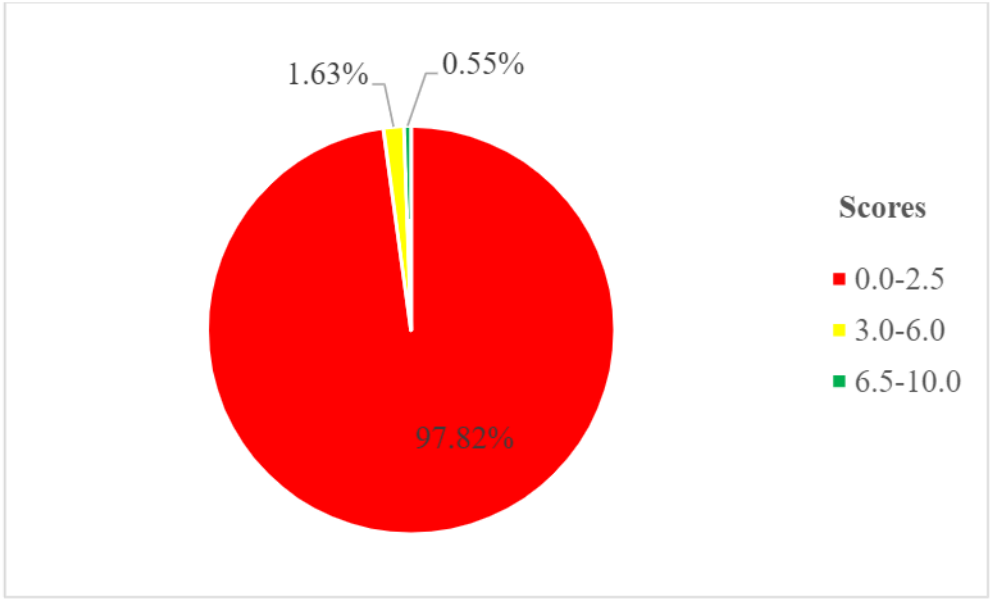


Figure 8: *The performance of students in Question 8.*

The analysis showed that at least a big number of students who scored high marks was from part (b) compared to part (a). This is to say that most of the students were very weak in the conceptual question. It can be said that those students failed to integrate the concepts and principles related to the force in

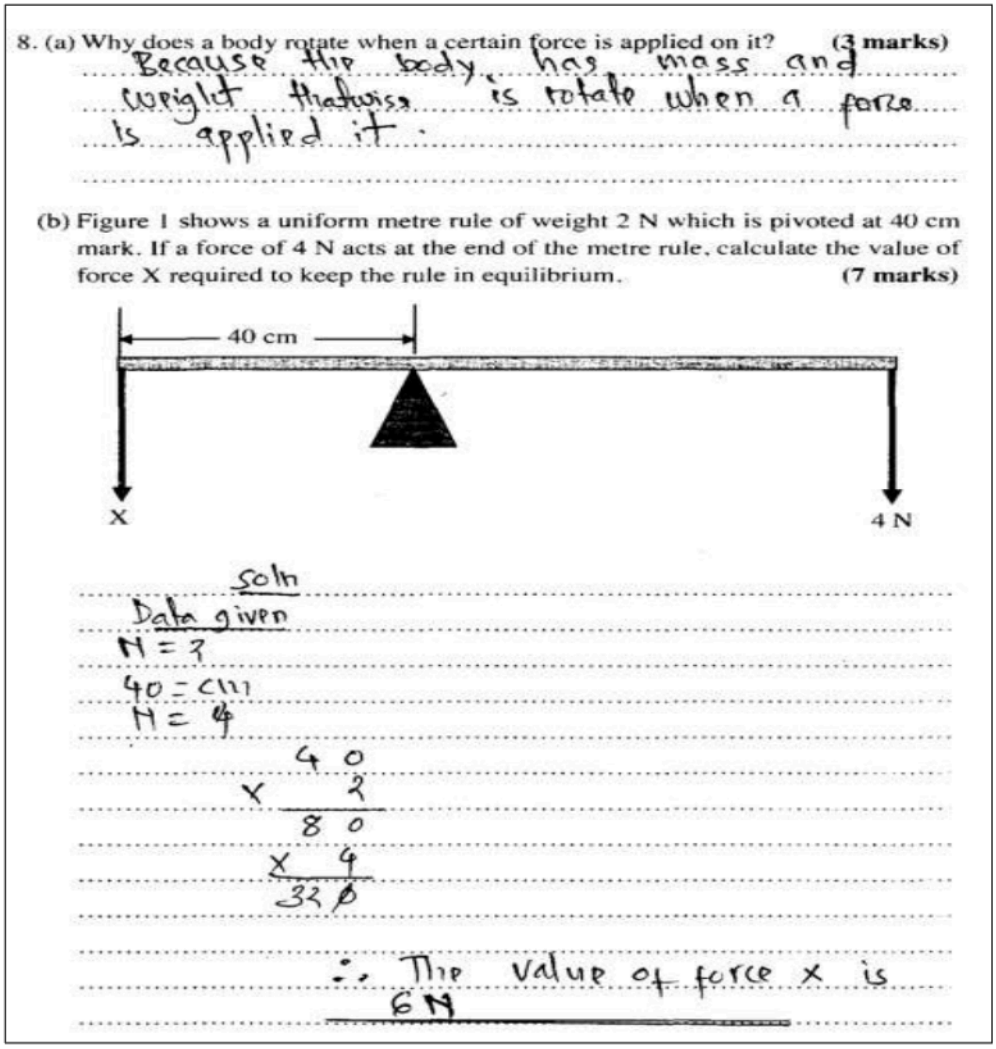
equilibrium to evaluate physical situations. In part (a), most of the students who failed to provide correct responses had insufficient competency in the turning effect (a moment of force). Some of the students applied Newton's first law of motion and the principle of moment to describe the state of rotational of the body. Those students were unaware that if there is no net force acting on the body, it will remain unchanged. Therefore, it is wrong to apply Newton's first law of motion for a rotating body. They also failed to realize that an important quantity that describes the turning of the body is a moment of force. A moment of force is related to the applied force and distance between the applied force and pivot moment of force $= r \times F$ where r distance between the applied force and pivot. For a body to turn, a moment of force must be non-zero. For a moment of force to be non-zero, the distance between applied force and pivot should also be non-zero.

In diagram (a), the moment of force is non-zero. On the other hand, diagram (b) shows that a moment of force $= 0 \times F = 0$, no rotational motion. This is to say that a moment of force is non-zero when the applied force does not act at the centre of the mass of the body.

Those who used the principle of moment were not correct. They were supposed to realize that the principle of moment describes the system at the rotational balance. Some of the students applied the concepts of the topic of *Simple machines*. For instance, one of the students wrote that "*Mechanical advantage*" as the cause of the rotation of the body which is absolutely wrong assertion.

In part (b), the students who performed poorly were not able to apply the principle of moment to compute the applied force. Most of the students failed to locate the centre of mass of the ruler. In order for the students to apply the principle of moment, they should first establish the centre of mass.

Some of the students ignored the weight of the ruler in calculating the value of force X that was needed to balance the metre rule. Some of the them failed to find the distance from the pivot to the centre of mass. Those students failed to establish the correct relation between correct clockwise and anticlockwise moments. Generally, it can be said that those who scored low marks had poor knowledge of the topic of force in equilibrium as well as poor mathematics skills. Extract 7.1 is a sample of a student's incorrect responses to this question..



Extract 7.1: A sample of incorrect responses in Question 8.

In extract 7.1, the student responded by claiming that a body rotates because it has mass and weight which is evident that he/she lacked enough

knowledge and reasoning skills. In addition, in part (b), the computations makes no sense indicating that the student had insufficient concepts related to force in equilibrium and mathematical skills. The student failed to provide an appropriate formula that could be helpful for solving the given physical problem.

Few students who scored well in part (a) of this question had the ability to apply the concept of a moment of force to evaluate the condition of the system. In part (b) of the question, most of the students who scored good marks demonstrated the ability to locate the centre of mass and the distance from the centre of mass to the pivot correctly. They further demonstrated the ability to apply the principle of moment to evaluate the force X needed to keep the system in equilibrium. Extract 7.2 is a sample of student's correct responses to this question.

pai

8. (a) Why does a body rotate when a certain force is applied on it? **(3 marks)**

A body rotates because the line of action does not passes through the centre of gravity of a body. And therefore the rotational motion occurs

(b) Figure 1 shows a uniform metre rule of weight 2 N which is pivoted at 40 cm mark. If a force of 4 N acts at the end of the metre rule, calculate the value of force X required to keep the rule in equilibrium. **(7 marks)**

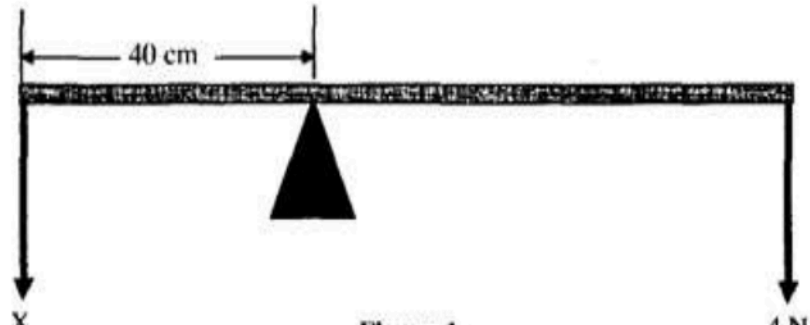
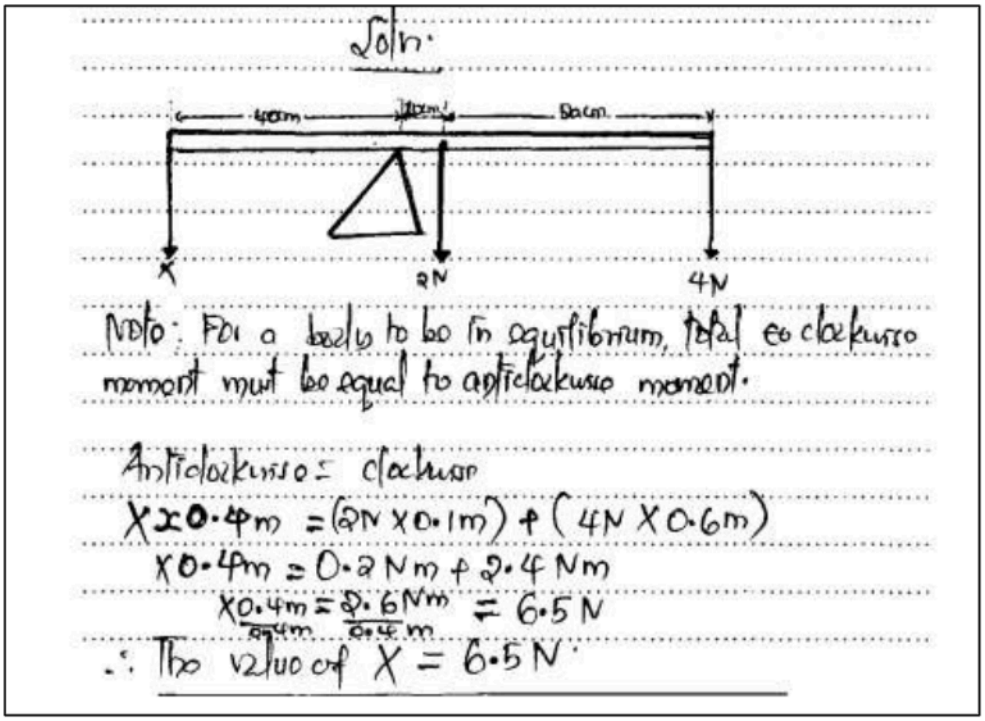


Figure 1



Extract 7.2: A sample of the correct responses in Question 8.

2.2.7 Question 9: Sustainable Energy Sources

This question comprised of three parts, namely part (a), (b) and (c). Part (a) of this question consisted of items (i) and (ii). In this part, the students were supposed to compare the natural gas and geothermal energy sources with respect to their environmental safety and sustainability. Part (b) of this question was constructed with the aim of assessing the ability of the students to identify the advantages of solar-powered cars over petrol-powered cars. In part (c), the students were required to state the advantages of the hydroelectric power plant.

The question was attempted by 691,924 (100%) students out of which 571,064 (82.53%) scored from 0.0 to 2.5 marks, 94,432 (13.65%) scored from 3.0 to 6.0 marks and 26,428 (3.82%) scored from 6.5 to 10.0 marks. This data shows that the performance of students in this question was weak since only 120,860 (17.47%) students who attempted this question scored from 3.0 to 10 marks. Figure 9 summarizes the performance of students in this question.

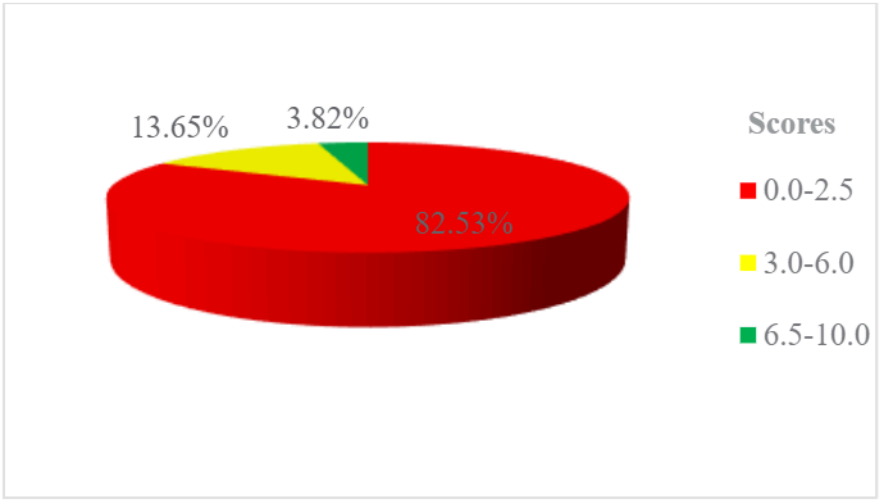


Figure 9: *The performance of students in Question 9.*

From the analysis, most of the students scored low marks suggesting that they had insufficient knowledge about the topic of sustainable energy sources especially, the comparison of geothermal energy and natural gas; the importance and advantages of solar cars over petrol cars; and the disadvantages of hydroelectric power. Some of the students had adequate knowledge of the topic but failed to present their ideas. This suggested that they lacked communication skills.

In part (a), those who scored low marks failed to compare geothermal energy sources and natural gas in terms of their environmental safety and sustainability. Some of the students provided incorrect responses. For instance, one of the students wrote that *"Natural gas causes land degradation but also Geothermal energy causes environmental pollution"*. These students failed to realize that geothermal energy sources are renewable and clean energy sources. Another student responded by writing that "*Both natural gas and Geothermal energy have no effect on the environment because they do not emit harmful gases to the atmosphere."* This suggested that the student failed to distinguish between renewable energy (geothermal energy sources) and Natural gas (non-renewable energy sources). Some of the students failed to grasp the meaning of environmental safety. One of the students wrote, "*Natural gas is the rocks that is decomposed for a long period of time and make a natural gas but this environment is safe while geothermal energy this is the source that is very hot but can erupt any time but this environment is not safe because*

even plant will not grow on the earth's surface". This was the incorrect response and suggested that the student had inadequate knowledge of the topic of *Sustainable energy sources*. In part (a) (ii), some of the students stated that both energy sources are sustainable. For example, one of the students wrote "*They are both not sustainable energy sources because when they are finished up in one area, we have found another place in order to continue mining the energy source."* It is evidence that this student failed to comprehend the meaning of sustainability as per energy context. Some of the students' responses indicate that students lacked understanding of the topic of *sustainable energy sources,* particularly environmental safety and sustainability. Some seemed to have a good understanding of the concept but did not understand the question demand and ended up delivering incorrect information. Students were required to realize that natural gas is a fossil fuel and non-renewable energy. It emits CO_2 which is well acknowledged as the main contributor to global warming. On the other hand, geothermal energy sources are heated within the earth. The heat inside the earth is continuously produced, thus, geothermal is renewable energy and sustainable. However, geothermal can cause volcanic eruption.

Students who scored low marks in part (b) failed to demonstrate mastery of the concepts of sustainable energy sources. They were supposed to comprehend that solar energy is a renewable energy source originating from the sun. This type of energy source emits no CO_2 to the atmosphere. On the contrary, petrol is a fossil fuel, it produces CO_2 which is the main contributor to global warming. Therefore, the two can be compared by considering environmental pollution and running costs. The students were supposed to know that the running cost of petrol is higher since the price of petrol fluctuates compared to solar energy. In addition, they were required to realize that the initial cost of solar energy is higher than that of petrol.

In part (c), many students Some students who provided incorrect responses suggested that they failed to identify and describe the disadvantages of hydroelectric power. One of the students responded "*It needs intensive management for the machine and dams"* which was an incorrect response. The response was not very clear, it can be ssumed that the student lacked communication skills. Some of the students wrote unclear responses. For instance, one of the students responded as "*poor infrastructure"*. This response is not clear and somewhat irrelevant as per item context. Other

students mentioned the advantages of hydroelectric power instead of the disadvantages of hydroelectric power. One of the students wrote "*It is cheap"* which was an incorrect response. Others misinterpreted the question by stating the reason for the shortage of power supply in Tanzania. The student responded, "*The hydroelectric power in our country now days have got a very poor kind of infrastructure to lead to poor production."* Extract 8.1 is a sample of students' incorrect responses to this question.

9. (a) Compare natural gas and geothermal energy sources by considering the following:

(i) Environmental safety **(2 marks)**

Enviromental safety is the source of natur
environment which can be use by the geot
thermal energy which is used to provide
the enviromental safety this is a natural
nature environment and not are envirome
nt problem are not caused by a geother
mal energy.

(ii) Sustainability **(2 marks)**

This is a enviromental which can cause
by geothermal energy gas the susta
inability it can be increase by energy
increases of sustainability the sustaina
bility of energy which can be caused by
geothermal energy in enviromental this enviro
mental are natural gas and at the
Source of geothermal energy.

(b) Using two points, state why solar cars are better than petrol cars.

(3 marks)

i) Because solar cars are better than petrol cars because solar cars a used to charge a positive charges by the sun light energy this is better than petrol are liquid and it is vapour.

(ii) Solar car are used to charge by sunlight equred to positive charge and it can loss for a long time better than petrol cars.

(c) Give three disadvantages of hydroelectric power. **(3 marks)**

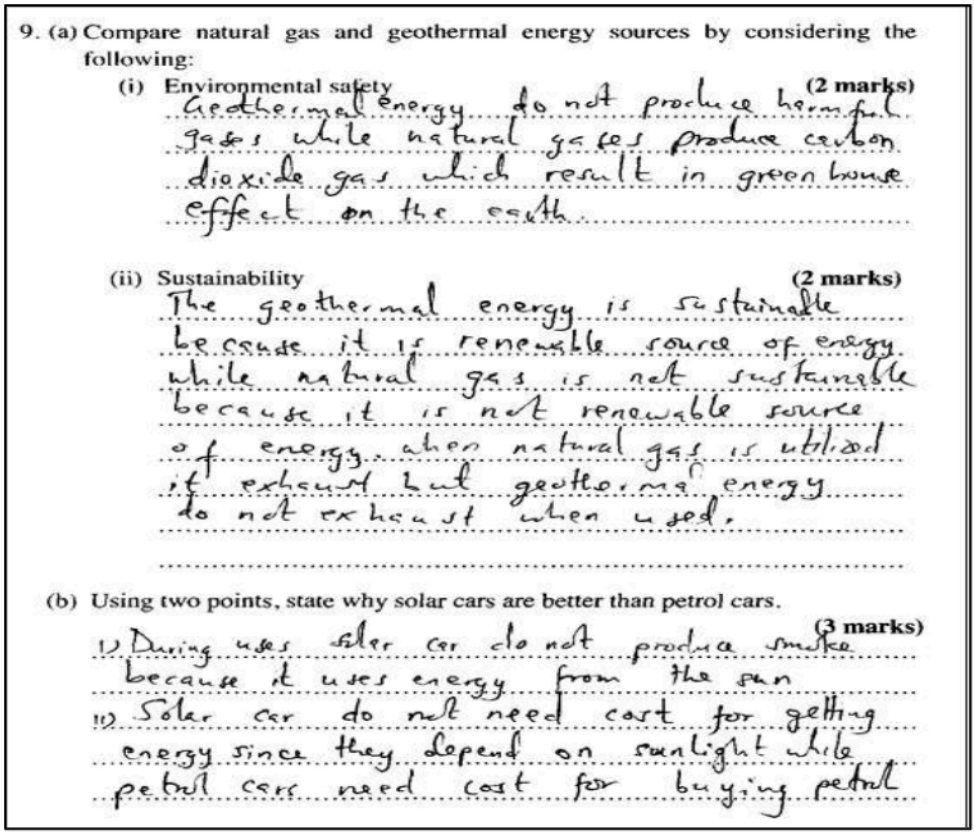
(i) It can cause environmental problem. Through are hydroelectric power it can cause enviro ment problem like air pollution and water pollution.

(ii) It can cause loss of Nature power because hydroelectric it can take large space to provid a electric power.

Extract 8.1: A sample of incorrect response in Question 9.

Extract 8.1 shows the responses of the student who lacked proper knowledge about renewable and non-renewable energy sources.

Most of the students who attempted this question and scored average performance managed to provide correct responses in parts (b) and (c) but failed to perform part (a). Some scored high marks because they demonstrated an understanding of sustainable energy sources and hence scored each part of the question correctly. Extract 8.2 is a sample of a student's correct responses to this question.



9. (a) Compare natural gas and geothermal energy sources by considering the following:

(i) Environmental safety **(2 marks)**

Geothermal energy do not produce harmful gases while natural gases produce carbon dioxide gas which result in green house effect on the earth.

(ii) Sustainability **(2 marks)**

The geothermal energy is sustainable because it is renewable source of energy while natural gas is not sustainable because it is not renewable source of energy. when natural gas is utilized it exhaust but geothermal energy do not exhaust when used.

(b) Using two points, state why solar cars are better than petrol cars. **(3 marks)**

i) During uses solar car do not produce smoke because it uses energy from the sun

ii) Solar car do not need cost for getting energy since they depend on sunlight while petrol cars need cost for buying petrol

(c) Give three disadvantages of hydroelectric power. **(3 marks)**

i) They can affect ecosystem of marines

ii) During dry seasons, the hydroelectric power plants decrease their efficiency

iii) During operation, more cost is needed for developing hydroelectric plants.

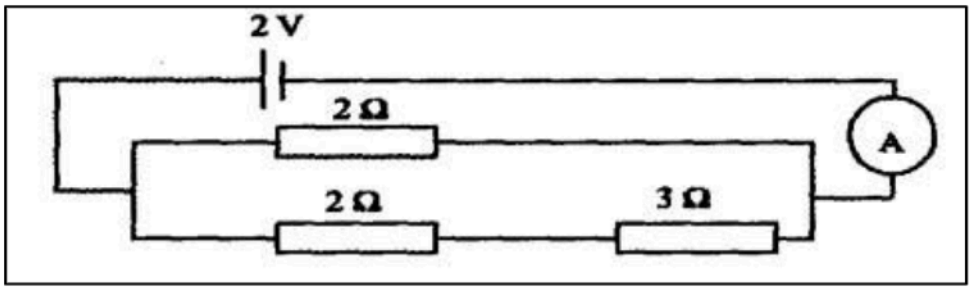
Extract 8.2: A sample of the correct responses in Question 9.

2.3 Section C: Short Answer Question

This section had one question which carried a total of 15 marks and the students were required to attempt it. The question was constructed from the topic of *Current electricity*.

2.3.1 Question 10: Current Electricity

This question consisted of two parts, namely parts (a) and (b). Part (a) was a conceptual question testing the ability of the students to describe the connection of the ammeter and voltmeter in the electrical circuit. Part (b) was a numerical question, designed to assess the ability of the students to apply concepts and Ohm's law to evaluate the amount of current flowing through the circuit. The students were given the following electric circuit.



The question was attempted by 691,924 (100%) students out of which 625,719 (90.43%) scored from 0.0 to 4.0 marks, 49,414 (7.14%) scored from 4.5 to 9.5 marks and 16,719 (2.43%) scored from 10.0 to 15.0 marks. This data shows that the performance of students in this question was weak since only 66,133 (9.57%) of students who attempted this question scored from 10.0 to 15.0 marks. Conversely, majority (90.43%) of students scored low marks ranging from 0.0 to 4.0 marks out of 15.0 marks. Figure 10 depicts the performance of students in this question.

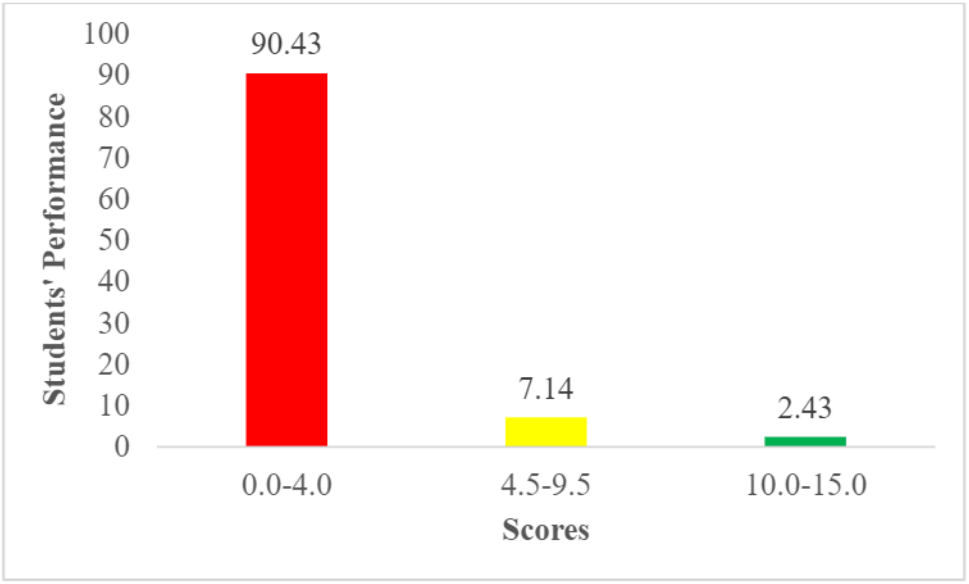


Figure 10: *The performance of students in Question 10.*

The students who scored low marks (from 0.0 – 4.0 marks) failed to provide the correct responses to almost all parts of the question. Those students failed to demonstrate mastery skills in the concepts and theories related to designing and constructing a simple electric circuit which involves an ammeter and voltmeter. However, most of the students were able to realize that a voltmeter is a device used to measure voltage, whereas, an ammeter is applied for the quantification of electric current in the circuit. They failed to explicitly identify where they will be connected in the electric circuit. Some of the students failed to identify the function of an ammeter and voltmeter in the circuit. In this regard, one of the students wrote that "*Voltmeter is connected to the circuit near to the battery that supply charge so as to measure current but ammeter is connected near to bulb in order to minimize amount of current that entering the circuit"*. This was an incorrect response and the student was supposed to know that a voltmeter measures the voltage across the component in the circuit and an ammeter is designed with very low resistance such that it does not affect the current flowing through the circuit.

An ammeter does not limit the flow of current. The electric component that limits the flow of current is called a resistor. Some of the students wrote that "*Ammeter can be connected anywhere in the circuit."* This was an incorrect response because the students failed to clearly state how the ammeter is connected to the circuit. A few students stated, "*The ammeter is connected to the voltmeter using wire, "*This was also an incorrect response. Indeed, every electric component in an electric circuit is connected using connecting wires. The students were supposed to explain how those components are connected in the circuit using those connecting wires. Some of the students responded, "*Ammeter and voltmeter are connected in parallel"*. The students in this category had an idea but they were supposed to realize that a voltmeter is designed with very high resistance, and thus draws very little current, whereas an ammeter is designed with very low resistance such that it does not affect the current flowing through the circuit. Therefore, a voltmeter is connected in parallel to measure the voltage across the components in the circuit, while an ammeter is connected in series to measure the current flowing through the circuit.

In part (b), the students who failed this part had inadequate knowledge and skills in analyzing simple electric circuits and application of Ohm's law.

Some of the students failed to determine the effective resistance for resistors connected in parallel and series. They used a formula, $R_T = R_1 + R_2$ to determine the effective resistance for parallel connection and the formula $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ to find the effective resistance for resistors connected in series. One student used the formula, "$R_T = \frac{R_1 \times R_2 \times R_3}{R_1 + R_2 + R_3}$." Another student used the formula, "$R_T = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$." Some students used a formula, "$R_T = \frac{R_1 \times R_2}{R_1 + R_2} + R_3$." These formulas were incorrect and make no sense in current electricity. Those students in this category failed to demonstrate their mathematical skills to analyse simple electric circuits. In addition, the student failed to provide an SI unit of the current. Extract 9.1 is a sample of a student who employed the concept of the topic of *static electricity*. This suggests that the student failed to distinguish the symbol of the resistance and capacitance.

10. (a) Explain how an ammeter and a voltmeter are connected in a circuit. (6 marks)

voltmeter are connected in circuit near to the battery that supply charge in the whole circuit to connect near to cell to measure amount of current but Ammeter is connected in circuit near to the bulb in order to minimize the amount of current that interring in the circuit

(b) In the circuit shown in Figure 2, the battery and an ammeter have negligible internal resistance. Determine the ammeter reading. (9 marks)

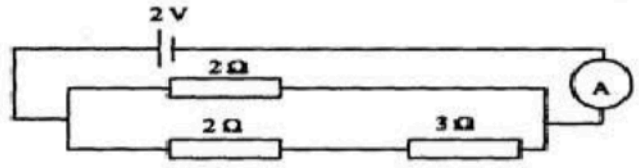


Figure 2

from $C_T = C_1 + C_2 + C_3$

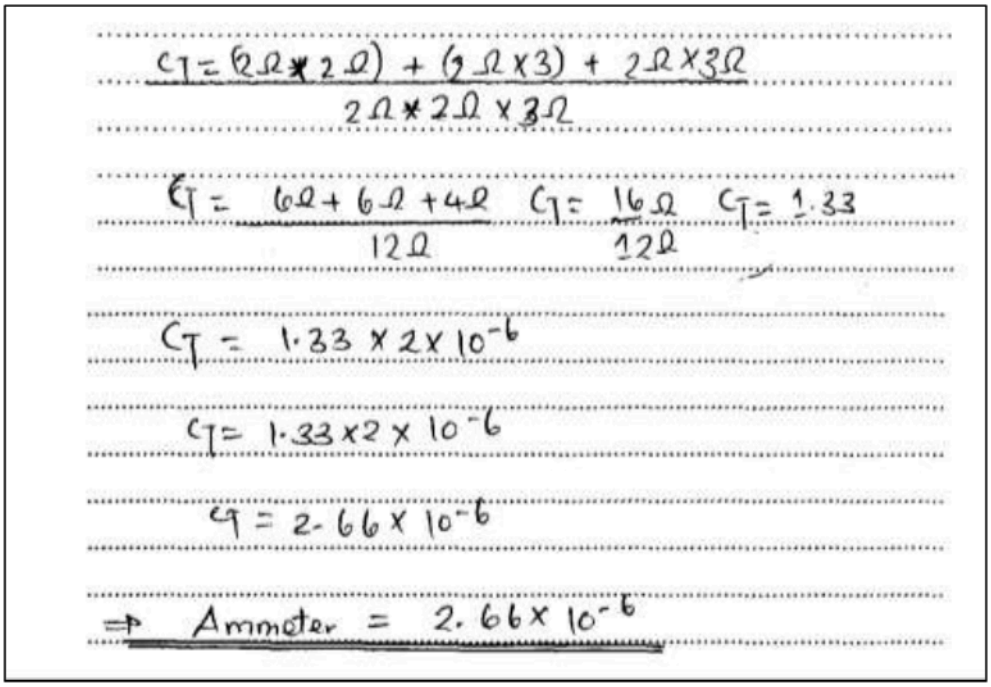
$C_T = 2\Omega + 2\Omega + 3\Omega$

$C_T = 1.33 \times 2 \times 10^{-6}$

2.66×10^{-6}

$C_T = 2.66 \times 10^{-6}$

Ammeter $= 2.66 \times 10^{-6}$



Extract 9.1: A sample of incorrect responses in Question 10.

In extract 9.1, the student applied the concept of capacitance in part (b) to find the effective resistance of the connected resistors in the circuit instead of that of resistances and hence ended up with incorrect answers.

Students who scored high marks on this question demonstrated an understanding of constructing simple electric circuits and computing effective resistance for parallel and series connections. They were able to apply Ohm's law to find the current flowing through the circuit. Students had a proper interpretation of the given circuit and treated 2Ω and 3Ω resistors to be connected in series and then their combination parallel to a second 2Ω resistor. Extract 9.2 is a sample of students' correct responses to this question.

10. (a) Explain how an ammeter and a voltmeter are connected in a circuit. **(6 marks)**

Ammeter in the circuit is always connected in series connection with other device since it is used to measure current of the entire circuit.

Voltmeter in the circuit is always connected in parallel connection with other devices like all resistors or bulb since it is used to measure potential difference.

(b) In the circuit shown in Figure 2, the battery and an ammeter have negligible internal resistance. Determine the ammeter reading. **(9 marks)**

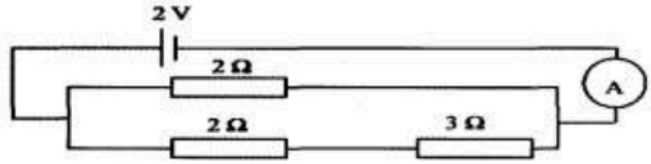


Figure 2

Solution

V = 2V

R = 2Ω, 2Ω and 3Ω

Req; I = ?

from; $I = \frac{V}{R}$

R = which are in series connection

$R_T = R_1 + R_2$

$R_T = 2\Omega + 3\Omega$

$R_T = 5\Omega$

In parallel connection

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_T} = \frac{1}{2} + \frac{1}{5}$

$\frac{1}{R_T} = \frac{5+2}{10}$

$\frac{1}{R_T} = \frac{7}{10}$

$\frac{7R_T}{7} = \frac{10}{7}$

$R_T = 1.43\Omega$

since; $I = \frac{V}{R}$

$I = \frac{2V}{1.43\Omega}$

$I = 1.399A$

CURRENT = 1.399 A

Extract 9.2: A sample of correct responses in Question 10.

3.0 ANALYSIS OF THE STUDENTS' PERFORMANCE PER TOPIC

3.1 The Analysis of the Students' Performance in Each Topic

The Physics assessment for the year 2023 tested a total of eighteen (18) topics which are disputed in the Physics syllabus of 2010. These topics were: *Introduction to Physics; Introduction to Laboratory Practices; Measurement; Archimedes' Principle and Law of Flotation; Force; Structure and Properties of Matter; Pressure; Light; Work, Energy and Power; Static Electricity; Magnetism; Temperature; Newton's Laws of Motion; Motion in a Straight Line; Simple Machines, Forces in Equilibrium, Sustainable Energy Sources; and Current Electricity.*

As per statistical data, there was no topic or question which had good performance. The analysis of students' performance indicates that question 1, 2 and 3 were averagely performed as they scored 30% marks and above out of the total marks allotted for the paper.

The first ranked average students' performance was from question 1 (62.92%) which was a multiple choice question constructed from the topics of *Introduction to Physics; Introduction to Laboratory Practices; Measurement; Archimedes' Principle and Law of Flotation; Force; Structure and Properties of Matter; Pressure; Light; Work, Energy and Power; and Static Electricity*. The second ranked average students' performance was from question 2 (55.52%) which was a matching items question composed from the topic of *measurement*. It portrays therefore that, a significant average performance was observed in objective questions which require students' competences in recognition and recall of subject matter. The third ranked average students' performance was from question 3 (34.06%), a short answers question set from the topic of *Magnetism* which assessed the students' competences in applying the knowledge of magnetism in daily life.

However, the weak performance was observed in question 7 set from the topic of *Simple Machines*, question 9 from *Sustainable Energy Sources*, question 10 from the topic of *Current Electricty*, question 6 from the topic of *Motion in a Straight Line*, question 5 from the topic of *Newton's Laws of Motion*, question 8 from the topic of *Forces in Equilibrium* and question 4 constructed from the topic of *Temperature*. Their respective performance in percentages are: *Simple Machines* (23.80%), *Sustainable Energy Sources* (17.47%), *Current Electricty* (9.57%), *Motion in a Straight Line*

(8.94%), *Newton's Laws of Motion* (5.49%), *Forces in Equilibrium* (2.18%) and *Temperature* (1.23%). Nevertheless, the major reasons noted for the weak performance include: inability to interpret and identify the task of the question, inadequate skills in solving numerical questions, poor English language skills and inadequate knowledge pertaining to the subject matter concerned . In addition, some students' weak performance was due to naming or stating points without exhaustive elaborations for questions involving deep explanation, for instance, conceptual questions. With regard to the weak performed topics, all Physics stakeholders are advised to take measures towards overcoming the observed challenges.The detailed information which shows the performance of students in all topics is shown in Appendix I.

3.2 Comparison of the Students' Performance between the year 2022 and 2023 Topic-wise

The comparison of the statistical analysis for the assessed topics in the year 2022 and the year 2023 revealed fluctuations in students' performance, with some topics experiencing improvement and others dropping in performance. Looking at Question 1 which is a multiple choice items indicates that students' performance drops from 73.5 per cent in 2022 to 62.92 per cent in 2023. It is worth noting that this type of question was constructed from various topics. The items (i) – (ix) were constructed from form I topics and item (x) was developed from form II topics (*static electricity*) as stipulated in the Physics syllabus of 2010. This might be because some of the items set in 2022 are different in setting styles although they have the same level of difficulty as those set in 2023.

For the case of Question 2, the analysis shows that the performance for the year 2023 was better than the year 2022. It is somewhat difficult to hypothesize the main cause because, in the year 2022, the items were constructed from the topic of *Simple Machines* while in the year 2023, the items were derived from the form I topic, *Measurement*. However, for the year 2023, we observed a rise in the students' performance for question 2 (matching items). The students' performance was 32.74.% in the year 2022 compared to 55.52% in the year 2023.

The analysis further revealed that there was an improvement in performance in the topic of *Magnetism*. It was observed that the students' performance increased from 10.84% in the year 2022 to 34.06% in the year

2023. This is an indication that teachers and students have put deliberate efforts to improve its performance. Unlike the year 2022, where the students' performance in the topic of Temperature was 10.18 per cent, surprisingly the performance dropped to 1.23 per cent in the year 2023. This implies that both teachers and students need to take more actions in order to raise the students' performance in this topic.

Another significant improvement in performance was in the topic of Newton's Laws of Motion which had students' performance of 3.1 in the year 2022 but increased to 5.49 per cent in 2023. However, this improvement was still very weak. Consequently, there was a slight increase of students' performance from 8.73 percent in the year 2022 to 8.94 percent in 2023 in the topic of *Motion in a Straight Line*. Likewise, more efforts should be put in order to eradicate the problem of poor performance in this topic. For the case of the topic of *Simple Machines*, students' performance dropped from 32.74 percent in the year 2022 to 23.80 percent in the 2023 indicating a decrease from average to weak performance. Similarly, the analysis shows that there has been continous weak students' performance in the topics of *Forces in Equilibrium* and *Current Electricity* for the two consecutive years. Another remarkable increase in students' performance was observed in the topic of Sustainable Energy Sources from 2.69 percent in 2022 to 17.49 percent in 2023. Despite this improvement, still various content delivery to students and other modes of teaching and learning need to be modified for future good performance in this topic. See Appendix II for more illustrations.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The general performance of the Physics assessment was weak (19.16%). The analysis of students' performance revealed that the students faced challenges when attempting the questions. Based on the students' scripts analysis, it was observed that insufficient knowledge and skills in the concepts, theories and physical principles pertaining to the subject matter was the major reason for the weak performance by most of the students. As a result, students either failed to provide correct responses or provided irrelevant responses that did not align to the context of the subject matter. Moreover, most of the students applied inappropriate formulae to evaluate various physical phenomena.

Poor reasoning skills was another challenge as most students failed to integrate physics concepts, theories and principles with daily life. Additionally, students had poor mathematical skills on the numerical questions, thus, failed to manipulate the mathematical formula to solve problems.

It was also noted that, poor communication skills influenced some of the students respond with grammatical errors. In some cases, students with problems in English language communication skills failed to give detailed responses required in the questions.

4.2 Recommendations

For future improvement of students' performance, it is recommended that teachers should:

(a) guide students in groups to use various resources such as books, journals and the internet to identify ways in which magnets can be destroyed and how they can be used in our daily lives;

(b) lead students to demonstrate various features of clinical thermometers and the principle on which the liquid-in-a-glass thermometer works. In addition, students should be guided on the best way to use the conversion equations to determine the temperature in degrees centigrade (^{0}C), Fahrenheit (^{0}F) and Kelvin (K);

(c) assists students in experimenting to verify Newton's laws of motion for a stationary body to be in motion under the action of an applied force by using materials such as a large sheet of paper, stone, masses, pulleys, strings and trolleys. Moreover, they should guide students on the concept of linear momentum and conversion of units including Km/h to m/s;

(d) use simulation and think-write-pair-share and other techniques to provide more help to the students on sketching and interpreting the velocity–time graphs and application of equation of uniformly accelerated motion in solving problems;

(e) use a practical approach to demonstrate different Physics devices like simple machines to capture students' attention and emphasize retention among them; and

(f) facilitate students to apply deductive thinking to perform mathematical computations, especially those concerned with Forces in equilibrium, Simple machines, Newton's laws of motion, Motion in a straight line and Current electricity.

Appendix I

The Performance of Students in Each Question in FTNA 2023

S/N	Topic	Question Number	Percentage of Students who Scored 30% or Above	Remarks
1.	Introduction to Physics, Introduction to laboratory practice, Measurement, Force, Archimedes principle and the law of flotation, Structure and Properties of Matter, Pressure, Sustainable Energy Sources, Work, energy and power, and Static Electricity,	1	62.92	Average
2.	Measurements	2	55.52	Average
3.	Magnetism	3	34.06	Average
4.	Simple Machines	7	23.80	Weak
5.	Sustainable Energy Sources	9	17.47	Weak
6.	Current Electricity	10	9.57	Weak
7.	Motion in a Straight Line	6	8.94	Weak
8.	Newton's Laws of Motion	5	5.49	Weak
9.	Forces in Equilibrium	8	2.18	Weak
10.	Temperature	4	1.23	Weak

Appendix II:

Comparison of Students' Performance between 2022 and 2023 in Terms of Topics