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

ELECTRICAL ENGINEERING

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080 ELECTRICAL ENGINEERING

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LIST OF SYMBOLS AND ABBREVIATIONS

A	Ampere
C	Capacitor
D.C	Direct Current
e.m.f	Electromotive force
F	Farad
FTNA	Form Two National Assessment
μ	micro
NECTA	National Examinations Council of Tanzania
Ω	Ohm
R_L	Load Resistance
SIRA	Students' Item Response Analysis
V	Volt
Vdc	Direct Current Voltage
Wb	Weber

FOREWORD

This report presents Students' Items Response Analysis (SIRA) on Form Two National Assessment in Electrical Engineering subject which was conducted in November 2023. The report aims to provide feedback to all educational stakeholders on the factors that contributed to the student's performance in the Electrical Engineering subject.

The Form Two National Assessment (FTNA) is a formative evaluation which intends to monitor students' learning outcomes and provide feedback that teachers, students and other educational stakeholders can use to improve teaching and learning process. This analysis justifies the students' performance in the Electrical Engineering subject. The students who attained high scores demonstrated their ability to understand the demand of the questions, knowledge, skills and competence in the subject matter, as well as mastery of calculation skills. However, students who scored low marks faced difficulties in responding to the questions due to their insufficient knowledge of the tested concepts.

The National Examinations Council of Tanzania (NECTA) expects that the feedback provided in this report will highlight the challenging area for which education stakeholders should take proper measures to improve the teaching and learning of Electrical Engineering subjects. Consequently, students will acquire knowledge, skills and competence indicated in the syllabus for better performance in future assessments and examinations.

The Council appreciates the contribution of all those who participated to prepare this report.

Dr. Said A. Mohamed
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report presents a detailed analysis of the student's response to each question in the Electrical Engineering subject on the Form Two National Assessment (FTNA), 2023. The paper was comprised of three sections, namely A, B and C.

Section A consisted of questions 1 and 2. Question 1 had ten (10) multiple-choice items. These items were set from the topics of *Cells and Batteries, DC Circuits, Electrical Engineering Science and Technology, Electrical Draughting, Instruments and Measurements, Magnetism and Electromagnetism, Units, Electrical Workshop Orientation,* and *Workshop Practice.* Question 2 consisted of five (5) matching items, set from the topic of *Electrical Workshop Orientation.* The students were required to answer all items from this section. Each item carried 1 mark, making a total of 15 marks.

Section B consisted of seven short answer questions set from the topics of *Electrical Workshop Orientation, Cells and Batteries, DC Circuits, Instruments and Measurements, Electrical Draughting, Magnetism and Electromagnetism,* and *Workshop Practice.* The students were required to answer all questions in this section. Each question carried 10 marks, making a total of 70 marks.

Section C had one structured question set from the topic of *Electrical Draughting.* The question was compulsory and carried 15 marks. The analysis of the student's performance on each question is categorized into three grade ranges as shown in Table 1.

Table 1: Grade Ranges of the Students' Performance

Range in %	0 – 29	30 – 64	65 – 100
Remark on Performance	Weak	Average	Good

A total of 371 students sat for the Electrical Engineering paper in the year 2023. Among them, 230 (62.0%) passed, whereas 141 (38.0%) failed. Thus, the student's performance in Electrical Engineering subject was average. In the year 2022, a total of 387 students sat for the

assessment of which 253 (65.4%) passed, whereas 134 (34.6%) failed. Therefore, the performance in the year 2023 has decreased by 3.4 per cent compared to that of the year 2022. Table 2 compares students' performance in Electrical Engineering between the year 2022 and 2023.

Table 2: **Students' Performance in Electrical Engineering Assessment in 2022 and 2023**

Year	Students Who Sat	Students' Performance			
		Passed		Failed	
		Number	Percentage	Number	Percentage
2023	371	230	62	141	38
2022	387	253	65.4	134	34.6

Table 2 indicates that, both the number of students who sat for the Assessment and passed have decreased from the year 2022 to 2023.

2.0 ANALYSIS OF STUDENTS' RESPONSE TO EACH QUESTION

This part analyses the performance of the students in each sections A, B, and C. It presents strengths and weaknesses of the students as they responded to each question.

2.1 SECTION A: OBJECTIVE QUESTIONS

This section composed of questions 1 and 2, with a total of 15 marks. Question 1 consisted of 10 multiple choice items carrying a total of 10 marks and question 2 consisted of 5 matching items which carried a total of 05 marks. The analysis of the students' responses is as follows:

2.1.1 Question 1: Multiple Choice Items

Question 1 comprised of ten (10) items, (i) to (x), constructed from the following topics: *Cells and Batteries, DC Circuits, Electrical Engineering Science and Technology, Electrical Draughting, Instruments and Measurements, Magnetism and Electromagnetism, Units, Electrical Workshop Orientation* and *Workshop Practice.* The students were required to choose the correct answer from the given four alternatives (A to D) by writing its letter in the box provided. The total marks for this question were 10 as each item carried 1 mark.

A total of 371 students attempted this question. Among them, 14 (3.8%) scored from 0 to 2 marks; 156 (42.0%) scored from 3 to 6 marks and 201 (54.2%) scored from 7 to 10 marks. Figure 1 illustrates the students' performance in this question.

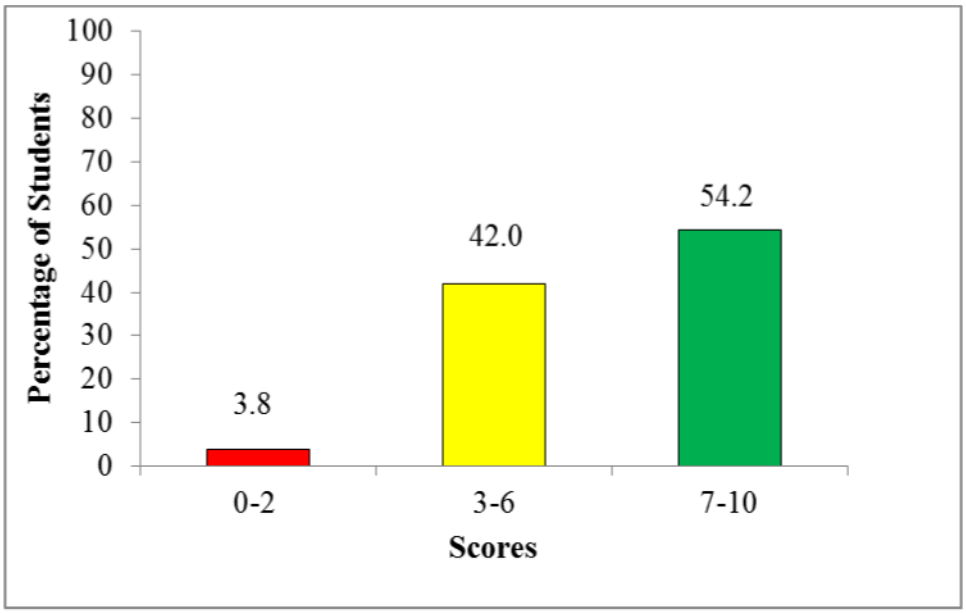


Figure 1: *Students' Performance in Question 1*

Figure 1 shows that the general performance on this question was good because 345 (96.20%) of the students had average performance or above. These students chose the correct responses to almost all the items. This implies that they had adequate knowledge of the content covered in these items. Despite the good performance on this question, 14 (3.80%) of the students had weak performance. These students failed to choose the correct answers in almost all items. This indicates that they had inadequate knowledge of the subject contents covered by these items. The following part analyses students' responses to each item from (i) to (x):

Item (i) was constructed from the topic of *Workshop Practice.* It required the student to identify the chemical properties in cells and batteries. The question was as follows:

A car battery has an accumulation of white paste in its terminals which is a sign that the battery undergoes sulphation. What does this phenomenon imply?

A Sulphur in the sulphuric acid combines with lead on the plates.
B Sulphur in the sulphuric acid combines with copper on the plates.
C Sulphur in the sulphuric acid combines with oxygen on the plates.
D Sulphur in the sulphuric acid combines with zinc on the plates.

Few students opted for the correct answer A, *Sulphur in the sulphuric acid combines with lead on the plates*. The students who opted for this alternative had acquired enough knowledge about batteries and cells, particularly the battery properties. Those who selected alternative B, *Sulphur in the sulphuric acid combines with copper on the plates*; C, *Sulphur in the sulphuric acid combines with oxygen on the plates* and D, *Sulphur in the sulphuric acid combines with zinc on the plates;* had misconceptions about various phenomenon, specifically chemical reactions that occur within a battery. They also failed to understand that lead is specifically used for battery plates and the white paste or powder that accumulates on a car battery's terminals is typically a result of a chemical reaction between sulfuric acid in the battery electrolyte and the lead terminals of the battery. Other metal such as copper and zinc are not used as car battery plates.

Item (ii) was set from the topic of *DC Circuits*. It assessed the students' understanding of basic electrical circuits, specifically the behavior of resistors in series connections. It also intended to measure the students' knowledge of the principles related to resistances, current flow, voltage distribution, and overall behavior in a series circuit. The question was as follows:

You are provided with an electric circuit which consists of two resistors with different values connected in series. What will be the behavior of the circuit?

A The voltage across each resistor will be the same.
B The same value of current will pass through each resistor.
C There will be same current division for each resistor.
D All resistors will have the same power loss.

The correct response was B, *The same value of current will pass through each resistor.* An average number of students opted for this alternative. These students had acquired enough knowledge about DC circuits, particularly the concept of connecting resistors in series circuit. For those who opted for alternative A, *the voltage across each resistor will be the same;* C, *there will be the same current division for each resistor;* and D, *all resistors will have the same power loss,* confused the characteristics of parallel to those of series circuit connection. They also failed to understand that resistors in parallel connections have the same numerical voltage drop but different currents through the junctions. This suggests that they lacked knowledge and ability to remember some concepts learnt in the topic of *DC Circuits* especially resistors in series connection.

Item (iii) was constructed from the topic of *Electrical Engineering Science and Technology.* It intended to assess the students' knowledge and understanding of the roles and duties associated with the position of an electrical engineering personnel. The item was as follows:

What are the responsibilities of an electrical technician in a manufacturing company?

A *To interpret the customers' requirements.*
B *To prevent random movement of employees.*
C *To study theories, design and application of electrical equipment.*
D *To buy manufactured electrical equipment and devices.*

Most students chose the correct answer C, *To study theories, design and application of electrical equipment.* The students who chose this alternative had sufficient knowledge of different types of electrical engineering occupations especially, the duties and responsibilities of electrical technician personnel. The students who opted for alternative A, *To interpret the customers' requirements* failed to understand that this role is played by the design engineer and not an electrical technician. Few students opted for alternative B, *To prevent random movement of employees,* and others opted for D, *To buy manufactured electrical equipment and devices*. These students opted randomly; they did not understand that these duties are more associated with management and safety personnel roles.

Item (iv) was intended to assess the student's understanding of different types of geometric figures and their properties, specifically triangles. The question was set from the topic of *Electrical Draughing*, and was as follows:

Which name is given to a triangle with two equal sides?
A Equilateral B Isosceles C Obtuse Scalene D Acute scalene

The correct response was B, *Isosceles,* and most of the students responded correctly. By answering this question correctly, the students demonstrated not only had factual knowledge about geometric figures but also the ability to apply that knowledge to classify a specific triangle based on its side lengths. On the other hand, those who opted for A, *Equilateral;* were confused with a triangle with three equal sides as most of them were attracted by the word equilateral which sounds similar to the word equal which appeared in the question. Similarly, those who opted for alternative C, *Obtuse scalene* and D, *Acute scalene*, did not know that obtuse scalene triangles must have one angle greater than 90° but less than 180°, and acute scalene has an equal sides and angles and none of the angles is greater than 90°.

Item (v) was set from the topic of *D.C Circuit*. It aimed to test the students' understanding of Ohm's Law and the relationship between voltage, current, and resistance in an electrical circuit by evaluating the value of the associated current. The question was;
The resistance of a conductor is 0.05 Ω. What will be the current passing through it to give a voltage drop of 6 V?
A 0.3 A B 120 A C 12 A D 3 A

The correct answer was B*, 120A.* The students who answered correctly demonstrated a solid understanding of basic electrical principles and their application specifically Ohms law. A few students who selected alternative A*, 0.3 A,* managed to use the correct formula $\left(I=\frac{V}{R}\right)$ but failed to compute decimal numbers which lead to errors in the final answer. On the other hand, those who selected alternatives C*, 12 A,* and D*, 3 A* might have misapplied Ohm's Law by either using an incorrect formula or incorrectly manipulated the given values. These students lacked fundamental

understanding of electrical concepts, especially Ohm's Law. Lack of understanding based on the relationship between voltage, current and resistance resulted in errors when problems in this domain.

Item (vi) was constructed from the topic of *Instrument and Measurements* and was set as follows:

Which electrical instrument would you use to measure voltage, current and resistance?

A Ohmmeter B Voltmeter C Ammeter D Multimeter

This question intended to assess the student's knowledge of electrical instruments and their functions. The item was well done by most of the students as they selected the correct alternative which was D*, Multimeter*. This implies that they had enough knowledge on the common electrical instruments used in electrical quantity measurements, particularly a multimeter which is used to measure more than one quantity. However, those who opted for alternative A, *Ohmmeter*; B, *Voltmeter* and C, *Ammeter,* have limited knowledge on electrical instruments. They could not realize that a multimeter is capable of measuring voltage, current, and resistance. They chose a specific instrument (an ammeter, voltmeter or an ohmmeter) because they thought it matches with the quantity being measured more precisely, without realizing that a multimeter encompasses all the options.

Item (vii) was constructed from the topic of *Magnetism and Electromagnetism*. It intended to measure the student's understanding of the behavior of current-carrying conductors when placed parallel to each other. It also assessed their knowledge of electromagnetic forces and how they apply in this scenario. The question was as follows:

If two conductors are placed parallel to one another and the current is applied on one side of those conductors; what will happen to the conductors?

A Force of repulsion will occur between conductors.
B Force of attraction will occur between conductors.
C No force will occur between conductors.
D Force of gain and lose to the conductors will occur.

The correct response was B, *Force of attraction will occur between conductors*. The students who selected this option had adequate knowledge on the concepts of magnetism and electromagnetism. These students realized that a magnetic field is associated with a current-carrying conductor which leads to a force of attraction on the other conductor. Those who selected alternative A, *Force of repulsion will occur between conductors* failed to understand that repulsion occurs when two conductors are placed in parallel to one another and current is flowing on both conductors in the same direction that will create the same polarities hence, repel. However, for those who opted for option C, *No force will occur between conductors;* and *D, Force of gain and loose to the conductor will occur* had insufficient knowledge of electromagnetism particularly the effect of current flowing in a conductor.

Item (viii) aimed to assess the student's knowledge of basic electrical quantities and their units, as well as their ability to identify and differentiate between the quantities. Also it intended to evaluate whether the students could recall and apply fundamental concepts in electrical quantities. The question was as follows:

What are the three different ways of expressing electrical quantities?

A Ampere, Ohm and Volt. *B Ampere, Watt and Volt.*
D Ohm, Volt and Second. *E Metre, Ampere and Volt.*

This item was correctly responded by most of the students by selecting alternative A, *Ampere, Ohm and Volt.* It was simple for students to select these units as they frequently used in expressing electrical quantities. Students who managed to remember Ohm's Law (V = IR) related voltage (V), current (I), and resistance (R); hence, reinforcing the significance of these three quantities in electrical circuits. Those who selected alternatives B, *Ampere, Watt and Volt* probably recognized that the unit "volt" is associated with electricity. They also seemed to be familiar with the concept power (watt) in electrical circuits. However, they overlooked the fact that "watt" is a unit of power but not a fundamental electrical quantity like current (ampere), resistance (ohm), and voltage (volt). However, those who opted for option C, *Ohm, Volt and Second* and D, *Meter, Ampere and Volt* lacked knowledge of fundamental electrical quantities and their associated units. They choose options which have units that are unrelated

to electricity such as "meter" which is a unit of length, and "second" which is a unit of time.

Item (ix) was designed to test student's ability to identify the primary cause of electrical accidents in the workshop. The question was;

What could be the main causes of electrical accidents in workshops?
A Lack of protective equipment *B Carelessness and inexperience*
C Students' lack of technical skills *D Bad rules of working area*

The item was set from the topic of *Electrical Workshop Orientation*. The correct answer was B, *Carelessness and inexperience* but most students opted for other alternatives since they also related to the causes of electrical accidents in the workshop. Those who opted for alternative A, *Lack of preventive equipment* seemed to focus on the importance of protective equipment in preventing accidents and overlooked the role of human factors such as carelessness and inexperience. They thought that accidents primarily occur due to lack of protective gear rather than human behavior. For those who selected alternative *C, Students' lack of technical skills;* probably they assumed that accidents are primarily caused by lack of technical skills or knowledge rather than carelessness and inexperience. They failed to recognize that despite technical skills being important for safety, accidents can still occur due to human error, even with adequate technical knowledge. Likewise, those who opted for *D, Bad rules of working area,* might incorrectly associated accidents to ineffective workplace rules or regulations rather than individual behavior. They failed to understand that, although workplace rules are important for safety, accidents can still occur due to human factors such as carelessness and inexperience. Generally, students who selected wrong options overlooked the significance of human factors such as carelessness and inexperience in contributing to accidents. They seemed to focus on other aspects of safety, such as protective equipment, technical skills, or workplace rules, and underestimate the role of human behavior in accident prevention.

Item (x) was constructed from the topic of *Workshop Practice* and was as follows:

You are required to remove sharp edges on a metal conduit. Which tool would you use?

A Chisel B Gas Plier C Reamer D Punch

This question intended to measure the student's knowledge of tools and their appropriate usage in a specific task. A few students chose the correct response *C*, *Reamer*. These students demonstrated to have knowledge, understanding of task requirements, and ability to identify the appropriate tool for the given scenario. For those who opted for A, *Chisel;* B, *Gas pliers* and D, *Punch* could be attributed to a lack of knowledge about tools and their appropriate use. That's why they randomly selected the options without fully understanding the requirement of the question.

2.1.2 Question 2: Matching Items

The question was set from the topic of *Electrical Workshop Orientation*. The question required the students to match the functions of the protective equipment in List A with their respective protective equipment in List B by writing a letter of the correct response in the table provided. The question was as follows;

Match the functions of the protective equipment in List A with their respective protective equipment in List B by writing a letter of the correct response.

List A	***List B***
(i) It safeguards the head from falling objects and from bangs against obstruction.	*A Gloves*
(ii) It is used to protect the eyes from injury when drilling and grinding any materials.	*B Headphone*
(iii) It is applied when working close to noisy machinery or work operations.	*C Goggles*
(iv) It protects hands from injury, cuts, abrasions and burns.	*D Full-face respirator*
(v) It is used when working on poisonous gases and in dusty environment.	*E Helmet*
	F Hat
	G Overall
	H Boot

A total of 371 (100%) students attempted this question. Among them, 7 (1.90%) scored from 0 to 1 mark; 50 (13.50%) scored from 2 to 3 marks;

and 314 (84.60%) scored from 4 to 5 marks. Table 3 illustrates the distribution of students' scores in this question.

Table 3: Students' Performance in Question 2

Scores	Number of Students	Percentage (%)	Remark
0-1	7	1.90	Weak
2-3	50	13.50	Average
4-5	314	84.60	Good
Total	**371**	**100**	

Table 3 indicates that, the overall performance on this question was good since 364 (98.10%) of them scored from 2 to 5 marks. These students matched correctly most or all the items. This implies that the students had sufficient knowledge about the concepts tested from the topic of *Electrical Workshop Orientation*, especially in the area which covers safety management in electrical engineering workshops to prevent accidents or injuries. On the other hand, 1.90 per cent had weak performance as they scored marks from 0 to 1. These students demonstrated insufficient knowledge of the tested concepts regarding *Electrical Workshop Orientation.* The analysis of students' response to each item is as follows:

Item (i) was: *It safeguards the head from falling objects and from bangs against obstruction.* The correct response was E, *Helmet.* The students who matched the item correctly understood the protective equipment particularly headgear. Other students incorrectly matched with option B, *Headphone* because they associate it with head protection due to the appearance of the word "head" in the option. They could not recognize that headphone is an audio device worn on the ears and it is unrelated to head protection equipment.

Item (ii) stated that: *It is used to protect the eyes from injury when drilling and grinding any materials.* The correct answer was C, *Goggles.* The

students who matched the item correctly demonstrated knowledge and understanding in the area of workplace safety and protective equipment. However, some students incorrectly mismatched this item with option D, *Full-face respirator.* These students incorrectly associated the term 'face' with eye protection. They might interpret "protect the eyes" more broadly as protecting the entire face. In fact, a full-face respirator provides protection for the entire face, including the eyes. It is primarily designed for respiratory protection against airborne contaminants and not specifically for eye protection. Students who incorrectly matched with the rest alternatives, they either lacked knowledge or understanding of the functions of different types of protective equipment.

Item (iii) stated that: *It is applied when working close to noisy machinery or work operations.* The correct response was B, *Headphone.* The students who correctly matched this item were aware that headphones or ear defenders are specifically designed to protect the ears from loud noises by reducing the intensity of sound reaching the ears. They are commonly used in industrial settings, construction sites, and other environments where noise levels exceed safe limits. Very few students mismatched this item. For example, one student wrongly matched the item with response D, *Full-face respirator*, instead of B, *Headphone.* This student might have overgeneralized the function of a full-face respirator, assuming that it provides protection against a wide range of hazards, including noise. This misconception led him/her to select a full-face respirator to match with the given item while it is specific for respiratory protection.

Item (iv) stated that: *It protects hands from injury, cuts, abrasions and burns.* The students who opted for A, *Gloves* got it correctly. These students recognized that gloves are used to protect hands from various hazards, including injury, cuts, abrasions, and burns, as described in the item. On the other hand, students who incorrectly matched the item with the remaining options lacked knowledge of functions of different types of protective equipment, particularly in relation to hand protection.

Item (v) stated that: *It is used when working on poisonous gases and in dusty environment.* The correct response was D, *Full-face respirator.* Most of the students matched this item correctly. This implies that these students had sufficient knowledge about the concepts tested from the topic of

Electrical workshop orientation, particularly, Safety Management in Electrical Engineering Workshops. In contrast, there were some students who incorrectly matched with C, *Goggles* and G, *Overall* instead of D, *Full-face respirator*. These students lacked knowledge of the functions of different types of protective equipment, particularly in relation to hazards such as poisonous gases or dust. They did not understand that goggles (option C) are designed to protect the eyes from airborne particles or chemical splashes, while overalls (option G) provide protection for the body and clothing from contamination. The students were required to understand that full-face respirator serves an important function in providing respiratory protection.

Extracts 2.1 and 2.2 are samples of students' correct and incorrect responses respectively

Answer

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

Extract 2.1: A sample of the correct response to Question 2

In Extract 2.1, the student managed to match correctly all five functions of the protective equipment in List A with their respective protective equipment in List B.

Answer

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

Extract 2.2: A sample of an incorrect response to Question 2

In Extract 2.2, the student failed to provide the correct answers to any of the items because he/she had inadequate knowledge about Safety Management in Electrical Engineering Workshops.

2.2 SECTION B: SHORT ANSWER QUESTIONS

The analysis of students' answers to each question in this section is as follows:

2.2.1 Question 3: Cells and Batteries

The question intended to evaluate the students' understanding of lead-acid battery charging principles and their competence in identifying indicators of a fully charged battery. It also assessed the students' ability to apply Ohm's law to calculate resistance in a charging circuit. The question had two parts, (a) and (b), and was as follows;

(a) A good indication of a fully charged lead acid cell is a colour change in both positive and negative plates.

(i) Which colour will be produced in each plate that will indicate if the battery is fully charged?

(ii) Suggest four things which should be done before charging the lead acid cell to increase its life span.

(b) Calculate the value of resistance required to give the charging current of 10 A if a battery of 12 cells is charged from a 30 Vdc supply. The terminal voltage (E) per cell is 1.9 V and the internal resistance being neglected.

A total of 371 (100%) students attempted this question, among them 269 (72.50%) scored from 0 to 2.5 marks, 88 (23.70%) scored from 3 to 6 marks, and 14 (3.80%) scored from 6.5 to 10 marks. Generally, the performance of the students was weak since only 102 (27.50%) students passed. Figure 2 summarizes the students' performance in this question.

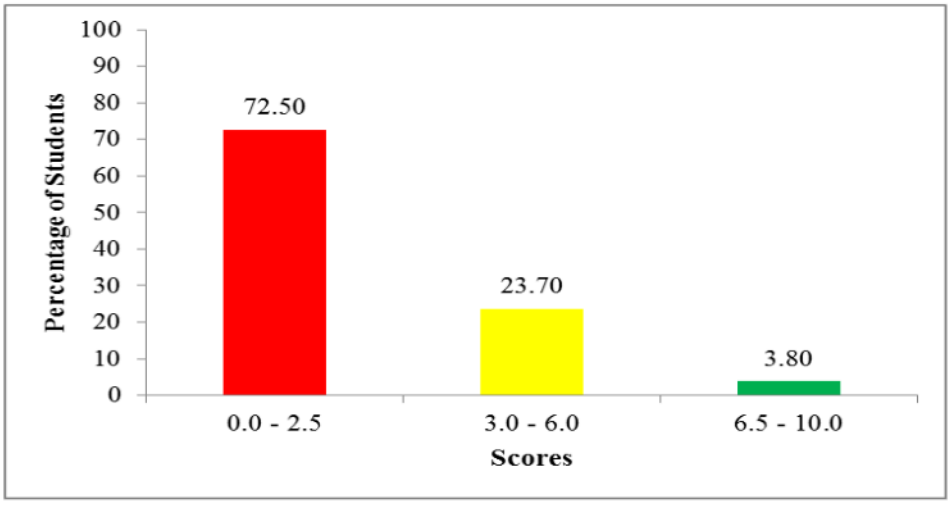
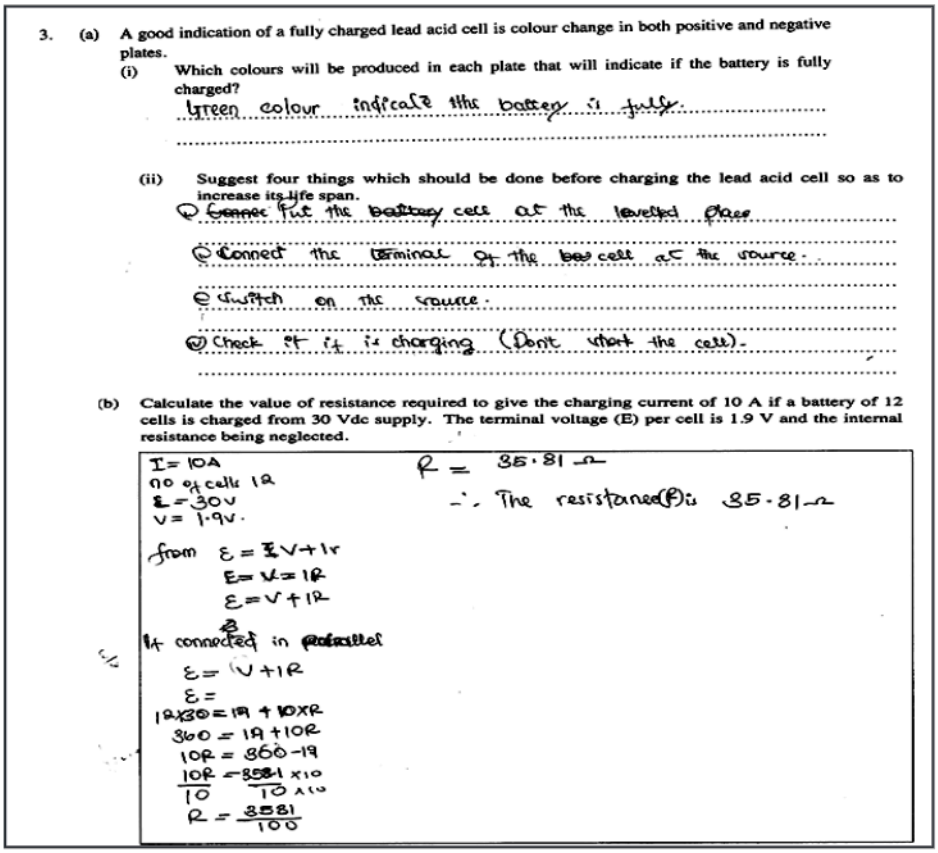


Figure 2: *Students' Performance in Question 3*

The analysis of students' responses shows that 269 (72.50%) students had weak performance. Most of them failed to identify colours produced in the palates as an indicator for a fully charged battery. They also could not suggest things to be done to increase life span of the lead acid cell. Moreover, these students applied an incorrect formula to calculate the value of the required resistance. For example, one of the students incorrectly responded to part 3(b) by simply applying Ohms Law $\left(I=\frac{V}{R}\right)$ to calculate resistance while skipping the step of calculating the total e.m.f that could be used to calculate the required resistance. The wrong responses indicate that the students had inadequate knowledge of the concepts tested on the topic of *Batteries and Cells*. Extract 3.1 illustrates a sample of incorrect responses from one of the students.



3. (a) A good indication of a fully charged lead acid cell is colour change in both positive and negative plates.

(i) Which colours will be produced in each plate that will indicate if the battery is fully charged?

Green colour indicate the battery is fully.

(ii) Suggest four things which should be done before charging the lead acid cell so as to increase its life span.

① Connect the battery cell at the levelled place

② Connect the terminal of the battery cell at the source.

③ Switch on the source.

④ Check if it is charging (Don't short the cell).

(b) Calculate the value of resistance required to give the charging current of 10 A if a battery of 12 cells is charged from 30 Vdc supply. The terminal voltage (E) per cell is 1.9 V and the internal resistance being neglected.

I = 10A
no of cells 12
ε = 30V
V = 1.9V.

from ε = ΣV + Ir
E = V = IR
ε = V + IR

If connected in parallel
ε = V + IR
ε =
12x30 = 19 + 10xR
360 = 19 + 10R
10R = 360 - 19
10R = 3581 x10
10 10 x10
R = 3581/100

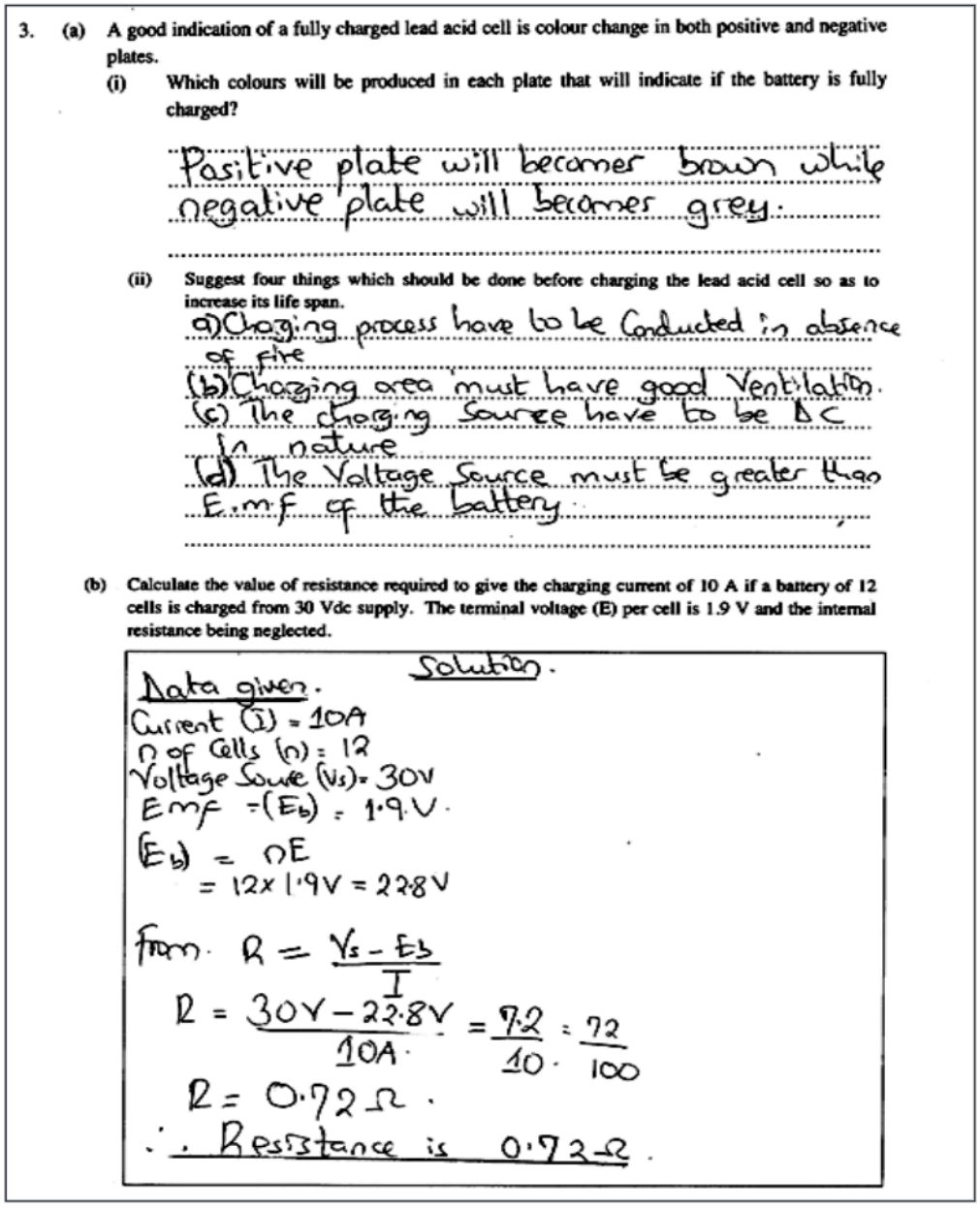
R = 35.81 Ω

∴ The resistance(R) is 35.81 Ω

Extract 3.1: A sample of incorrect responses to Question 3

Extract 3.1 shows that, in part 3(a) the student identified green colour instead of chocolate brown and bright gray for positive and negative plates respectively as an indication of the fully charged battery. He/she have overgeneralized the color changes observed in batteries. For instance, he/she might have seen green indicator lamps on electronic devices which indicate either power status, battery charging, or device operation. Therefore the student assumed that green color also applied to a fully charged lead acid cell batteries. In part 3 (b) the student misarranged the parameter in equation by writing E=V+IR instead of the correct formula V (applied) = E+IR. This led to a wrong substitution, hence, incorrect answer.

However, 102 (27.50%) students performed well and scored average marks and above. This indicates that they had sufficient knowledge of the concepts related to Batteries and Cells. Extract 3.2 shows a sample of good responses provided by one of the students.



3. (a) A good indication of a fully charged lead acid cell is colour change in both positive and negative plates.

(i) Which colours will be produced in each plate that will indicate if the battery is fully charged?

Positive plate will becomes brown while negative plate will becomes grey.

(ii) Suggest four things which should be done before charging the lead acid cell so as to increase its life span.

a) Charging process have to be Conducted in absence of fire

(b) Charging area must have good Ventilation.

(c) The charging source have to be DC in nature

(d) The Voltage source must be greater than E.m.f of the battery.

(b) Calculate the value of resistance required to give the charging current of 10 A if a battery of 12 cells is charged from 30 Vdc supply. The terminal voltage (E) per cell is 1.9 V and the internal resistance being neglected.

Solution.

Data given.

Current (I) = 10A

No of Cells (n) = 12

Voltage Sourse (V_s) = 30V

Emf = (E_b) = 1.9V.

$E_b = nE$

$= 12 \times 1.9V = 22.8V$

From. $R = \frac{V_s - E_b}{I}$

$R = \frac{30V - 22.8V}{10A} = \frac{7.2}{10} = \frac{72}{100}$

$R = 0.72\Omega$.

∴ Resistance is 0.72Ω.

Extract 3.2: A sample of the correct response to Question 3

In Extract 3.2, the student demonstrated to have understanding on the features of the *Cell and Battery* as requested in Question 3(a) (i) and (ii). The student also applied the correct formula to calculate the value of resistance in part (b).

2.2.2 Question 4: DC Circuit

This question had two parts namely (a) and (b). Part (a) intended to measure the students' understanding of how capacitors behave when connected in parallel. Part (b) assessed the students' problem-solving skills and their ability to apply knowledge of series and parallel connections to achieve a desired capacitance. The question was as follows;

(a) Two capacitors C_1 and C_2 are connected in parallel, across a supply of 'V' volts and a charge of 'Q' coulombs is produced. With the aid of a circuit diagram, show the equivalent capacitance given by $C = C_1 + C_2$.

(b) Suppose you need 10 μF capacitance for a certain application and the available capacitance in store is of value 0.05 μF only, how would you make sure that you get the total capacitance?

A total of 371 (100%) students attempted this question, and their scores were as follows; 290 (78.20%) students scored from 0 to 2.5 marks; 59 (15.90%) scored from 3 to 6 marks and 22 (5.90%) scored from 6.5 to 10 marks. The students' performance on this question is summarizes in Figure 3.

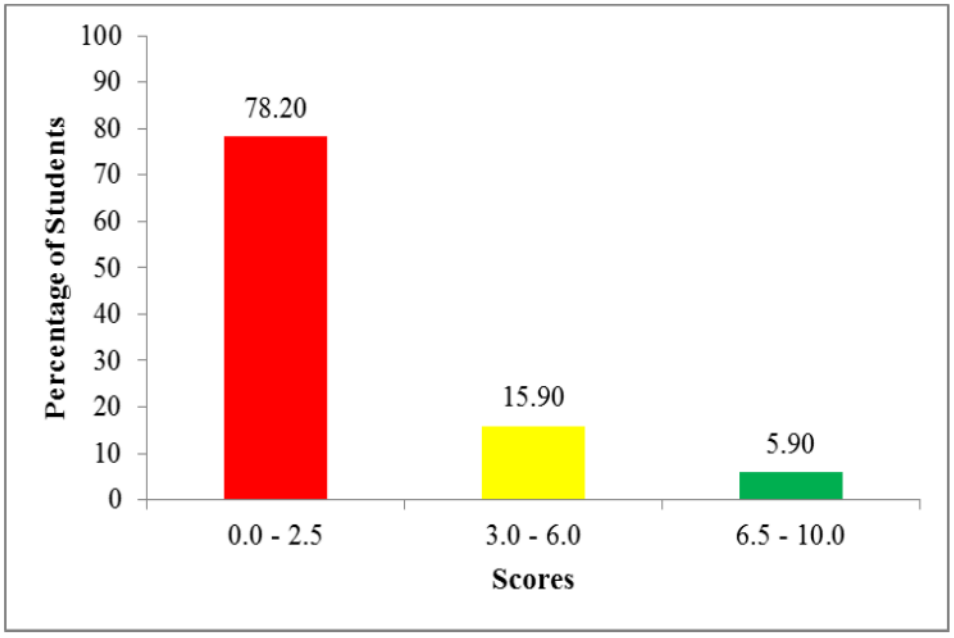
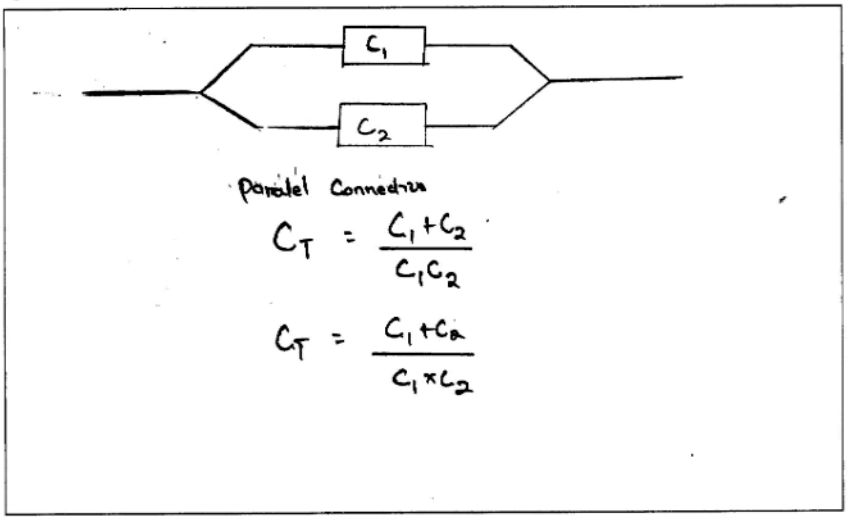


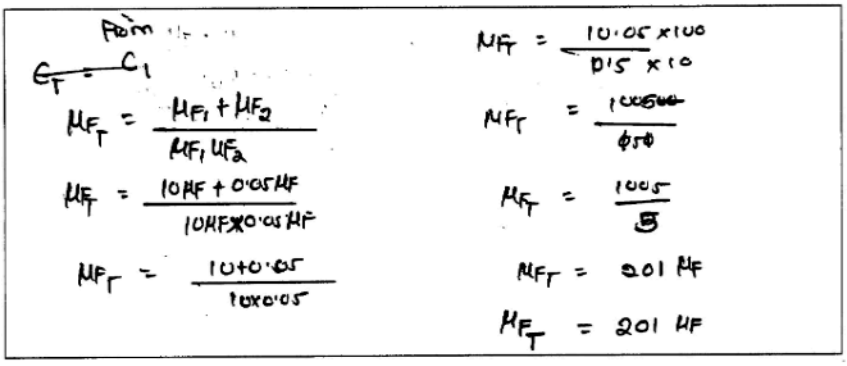
Figure 3: *Students' Performance in Question 4*

The students' general performance on this question was weak as statistical analysis reveals that 290 (78.20%) of the students failed while 81 (21.80%) passed. Moreover, most of the students failed to draw a circuit showing the equivalent capacitance when two capacitors are connected in parallel. Some of the students also failed to derive the correct formula to calculate the total capacitance. For example, in part (a), one student wrongly drew an equivalent circuit by connecting capacitors in series instead of parallel. Also in part (b), one student wrongly calculated the total capacitance by simply subtracting the available capacitance (0.005 μF) from needed capacitance (10 μF). These students had limited understanding of fundamental principles of basic electric circuits, such as the behavior of capacitors and resistors in circuits, principles of series and parallel connections, and how component values are combined in different configurations. Without a strong foundation in circuit theory, the student may struggle to construct circuits correctly. Extract 4.1 is the sample of incorrect responses.

4. (a) Two capacitors C_1 and C_2 are connected in parallel, across a supply of 'V' volts and a charge of 'Q' coulombs is produced. With the aid of circuit diagram, show the equivalent capacitance given by $C = C_1 + C_2$.



(b) Suppose you need 10 μF capacitance for a certain application and the available capacitance in store is of value 0.05 μF only, how would you make sure that you get the total capacitance?



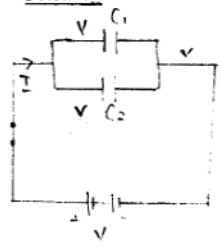
Extract 4.1: A sample of incorrect responses to Question 4

In Extract 4.1, the student drew a parallel circuit with an incorrect symbol. In part (a), he/ she used a symbol of resistor to represent a capacitor and failed to derive the equation of the equivalent capacitance since he/she used the formula of finding equivalent resistance of two resistors in parallel connection but reciprocated it. Also in part (b), still the student applied the wrong formula derived in part (a) which led to an incorrect solution.

However, 81 (21.80%) of the students who had satisfactory performance provided the correct responses to some items of the question and there was no student who scored 10 marks allotted to this question. This indicates that they had sufficient knowledge of the concepts related to D.C Circuits. Extract 4.2 shows a sample of good responses from one of the students.

4. (a) Two capacitors C_1 and C_2 are connected in parallel, across a supply of 'V' volts and a charge of 'Q' coulombs is produced. With the aid of circuit diagram, show the equivalent capacitance given by $C = C_1 + C_2$.

Solution



Note;- that, Components in parallel receives the same voltage.

- The total quantity of charge is equal to the sum of individual charges

So,

$V = V_1 = V_2$ and $Q = Q_1 + Q_2$

but $Q = CV$

So, $Q = C_1V + C_2V$

$= CV = C_1V + C_2V$

$= CV = V(C_1 + C_2)$

$\therefore C = C_1 + C_2$

$\therefore$ The equivalent capacitance is given by $C = C_1 + C_2$

(b) Suppose you need 10 μF capacitance for a certain application and the available capacitance in store is of value 0.05 μF only, how would you make sure that you get the total capacitance?

I will get the total capacitance by finding another capacitor in parallel of 9.05μF and connect with it or I will increase the quantity of charge in that appliance and keep the voltage constant.

It means $= \frac{10\mu F}{0.05\mu F} = 200$ times $C = \frac{Q}{V} = 10 = \frac{10Q}{V} = 200\mu F = \frac{10Q}{V} = 200$ times

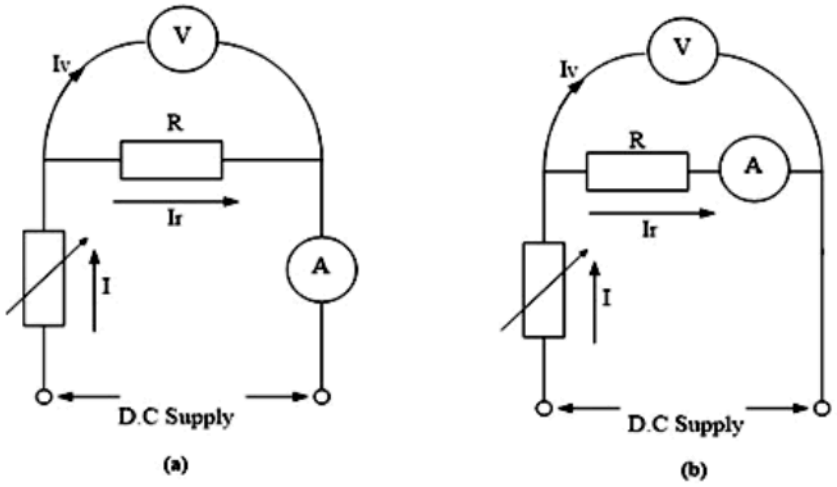
$\therefore$ I will increase the quantity of charge 200 times and keep the voltage constant.

Extract 4.2: A sample of the correct responses to Question 4

Extract 4.2 shows that the student demonstrated to have good skills in using proper symbols to draw the required circuits and derive the formulae to calculate the equivalent capacitances in both parts (a) and (b).

2.2.3 Question 5: Instruments and Measurements

The question intended to assess the students' understanding of electrical circuits, specifically the principles of measuring current and voltage using ammeters and voltmeters, as well as the impact of these measuring instruments on the overall circuit resistance. The question was as follows: *The resistance of the ammeters and voltmeters in diagrams (a) and (b) are 0.05 Ω and 350 Ω respectively. If the ammeter and voltmeter readings are 5A and 35 V respectively, calculate the value of resistance R in diagrams (a) and (b).*



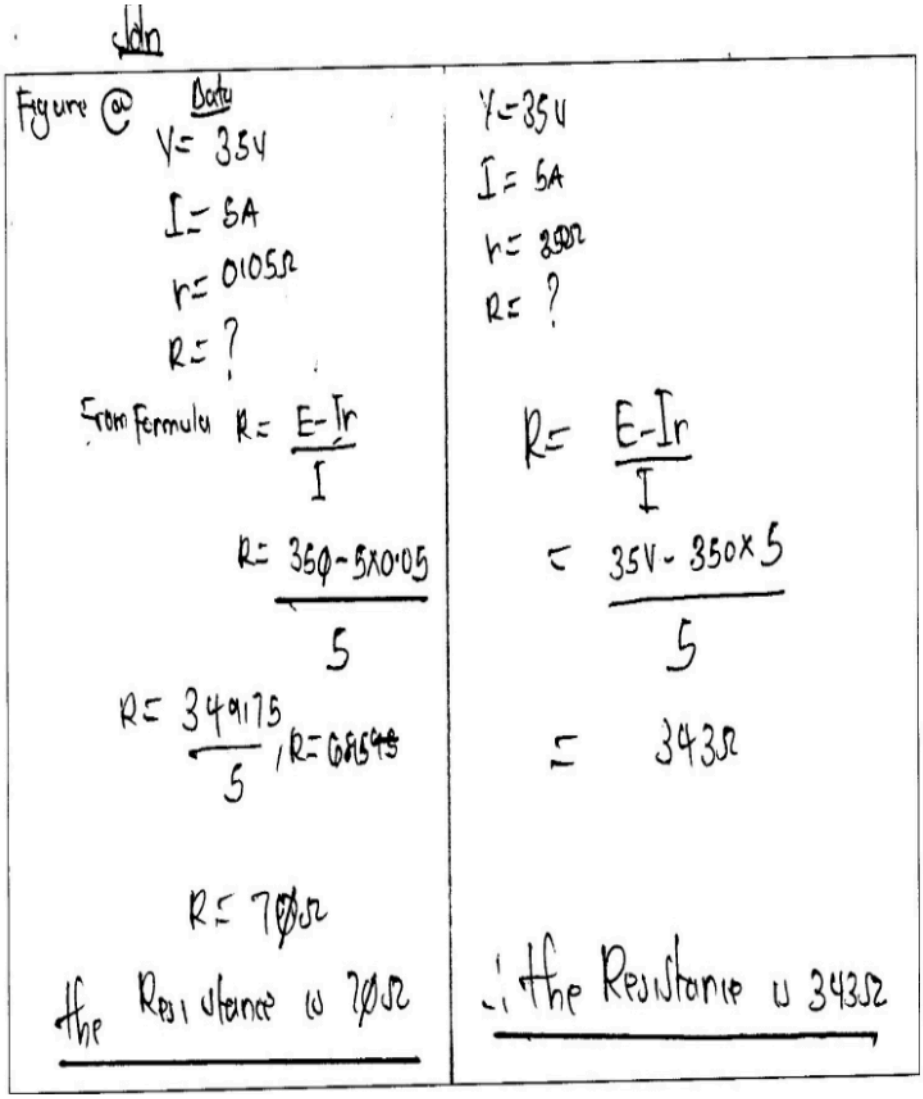
The question was attempted by 371 (100%) students. A total of 336 (90.60%) students scored from 0 to 2.5 marks; among them 168 (45.30%) scored zero. Moreover, 34 (9.10%) scored from 3 to 6 marks, and 1 (0.30%) scored 7 marks which was the highest. Table 5 illustrates this performance.

Table 4: Students' Performance in Question 5

Scores	Number of Students	Percentage (%)	Remark
0-2	336	90.60	Weak
3-6	34	9.10	Average
6.5-10	1	0.30	Good
Total	**371**	**100**	

The analysis of the student's performance on this question was generally weak because 336 (90.60%) of them scored below average marks. These students demonstrated inadequate knowledge about instruments and measurements particularly on reading ammeter and voltmeter as well as calculations. Despite the weak performance observed in this question, 35 (9.40%) students attained average and good scores. These students had sufficient knowledge about the tested concepts covering *instrumentation and measurements* though they provided insufficient responses to some cases.

Analysis reveals that 336 (90.60%) of the students with weak performance, failed to apply the correct formula and calculate the required value (R) in figures (a) and (b). Most of them failed to incorporate the given parameters in the given circuit diagrams. For example, one student wrongly calculated the resistance of both circuits by simply dividing the values of voltmeter reading (35 V) by the ammeter reading (5 A). In figure (b), majority could not realize that, since resistor and ammeter are connected in series, then their voltages are not the same. Therefore, they required to find the voltage across each component, which will help to calculate the resistance R in figure (b). Extract 5.1 is illustrative.

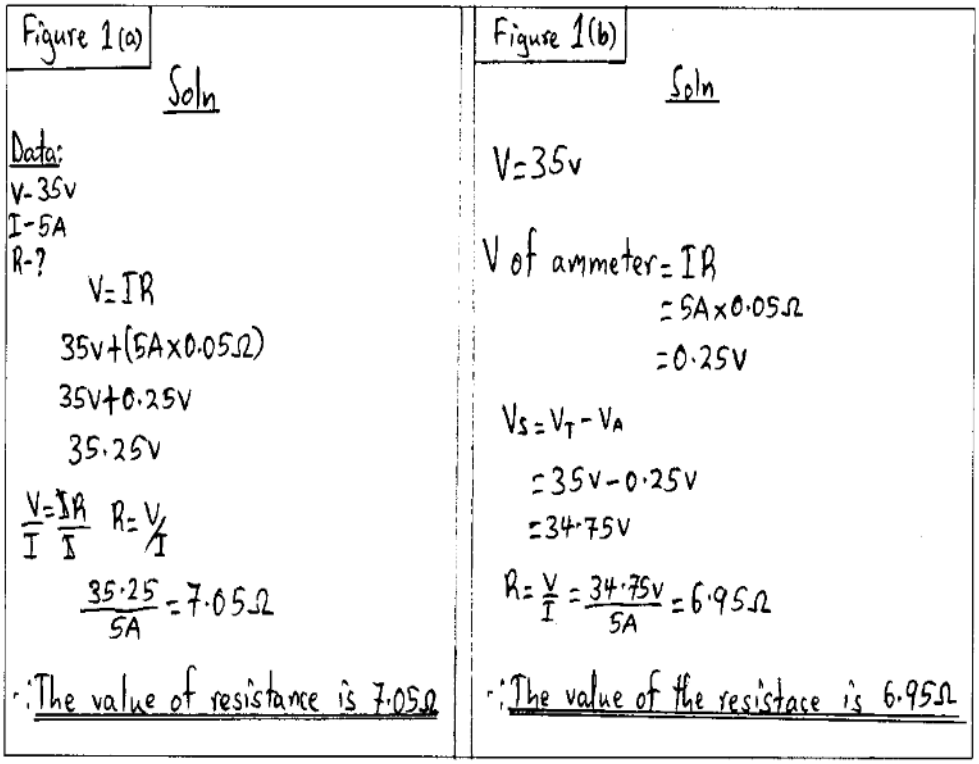


Extract 5.1: A sample of incorrect responses to Question 5

In Extract 5.1, the student applied an incorrect formula to calculate resistance in figure (a) and (b). The used formula $R=\frac{E-Ir}{I}$ appeared to be as the rearrangement of Ohm's Law which was not applicable in this context. The student struggled to apply Ohm's Law in complex circuits which associated with multiple components and measurements. In order to solve this problem, the student was required to analyze the circuit arrangement and apply the principles of electrical circuit analysis,

including Ohm's Law and the rules of combining resistors in series and parallel.

Further, the analysis indicates that 35(9.50%) of the students with good performance demonstrated knowledge on the topic of *Instrument* and *Measurements*. They demonstrated computational skills on finding the values of resistance R in the given figures (a) and (b). Extract 5.2 shows a sample of the correct responses from one of the students who scored high marks in this question.



Extract 5.2: A sample of the correct response to Question 5

In Extract 5.1, the student managed to recall Ohms Law (V=IR) in calculating the resistance R in figure (a) but incorrectly substituted the given values. This led to an incorrect answer. However, the student correctly applied the formula to calculate the value of resistance R as requested in figure (b). Despite this mistake, the student demonstrated a good understanding on the concepts of the topic *Instruments and Measurements.*

2.2.4 Question 6: Electrical Draughting

This question was designed to measures the students' knowledge on the importance of dimensions in engineering drawings and their proficiency in using various types of lines. The question had two parts, (a) and (b), and was as follows;

(a) Why dimensions are very important in engineering drawings?

(b) With the aid of a diagram, describe how the following types of lines are used in a drawing:

(i) An extension line

(ii) A dimension line

(iii)A leader

A total of 371 (100%) students attempted the question. Their scores are categorized as follows: 228 (61.50%) of the students scored from 0 to 2.5 marks and 143 (38.50%) scored from 3 to 6 marks. there was no student who scored above 6 marks. Figure 4 summarizes this performance.

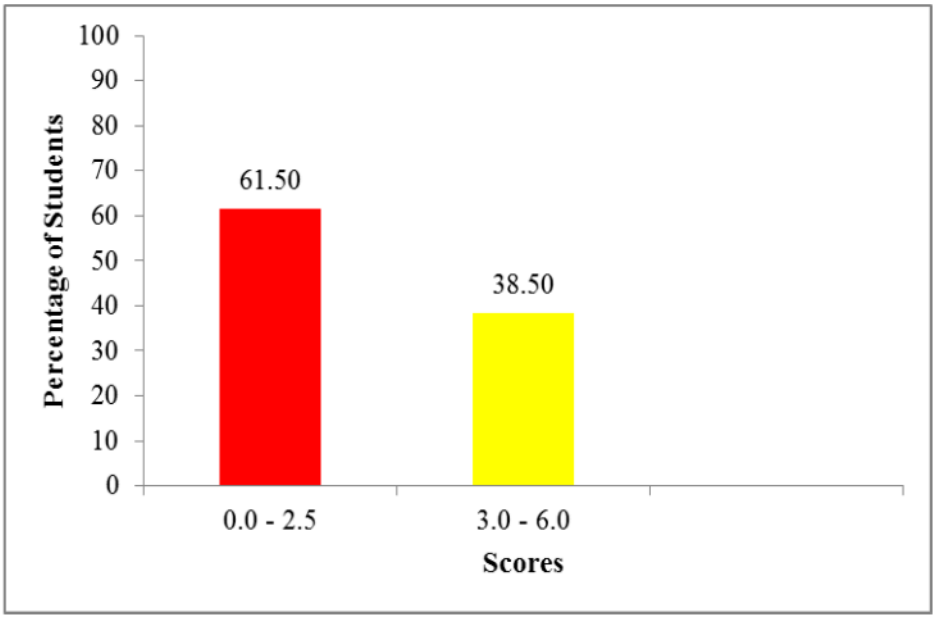


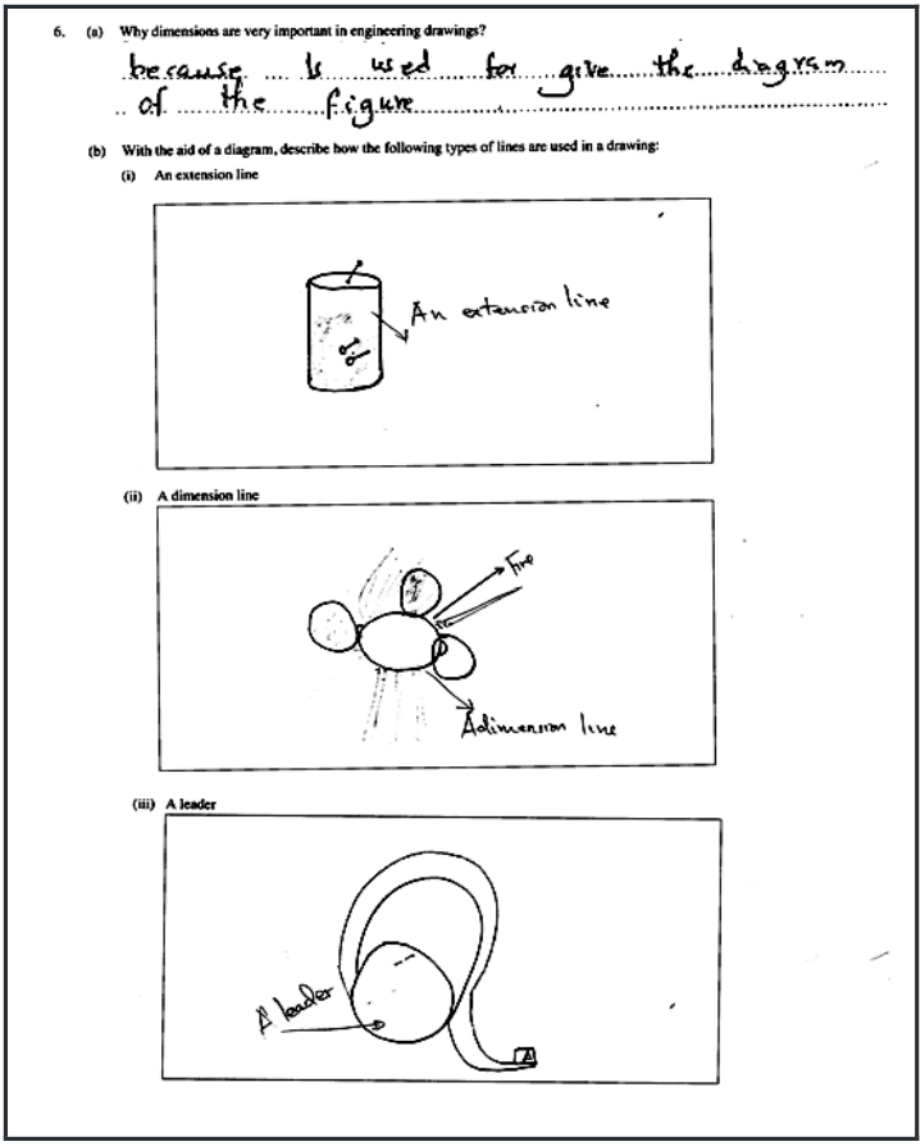
Figure 4*: Students' Performance in Question 6*

Figure 4 depicts that the performance in this question was average because 143 (38.50%) of the students who attempted this question

scored above the marginal level of fail. The highest score in this question was 5 marks out of 10 allotted.

The analysis indicates that, 228 (61.50%) students had weak performance due to inadequate knowledge about the topic of *electrical Draughting.* Generally, the weakness was observed on identifying the importance of dimensions and the use of various types of lines in electrical draughting. In part (a), most of the students provided the importance of constructional lines instead of dimensions. They failed to understand that, construction lines are typically used to sketch out the initial layout or framework of a drawing before final lines are added, while dimensions are added to provide precise information about the size and location of features within the drawing. In fact, the process of creating an engineering drawing starts with rough sketches and construction lines to establish the basic layout and proportions. As the drawing progress, dimensions are added to provide precise measurements and specifications. For example, one student incorrectly provided the importance of dimension lines by writing, "because it is used in constructional lines when making drawings".

Likewise in part (b), they failed to provide a diagram and indicate the lines used in drawing. Also they failed to describe applications of the lines provided. Responding to this part, most of the students drew lines without incorporated them in the diagram. Despite having failing to show various lines in the drawing, the students drew lines that did not match to the requirements of the question. For example, one student wrongly drew a projection line instead of an extension line, and hidden line instead of a dimension line. Extract 6.1 is a sample of the incorrect responses to the question.

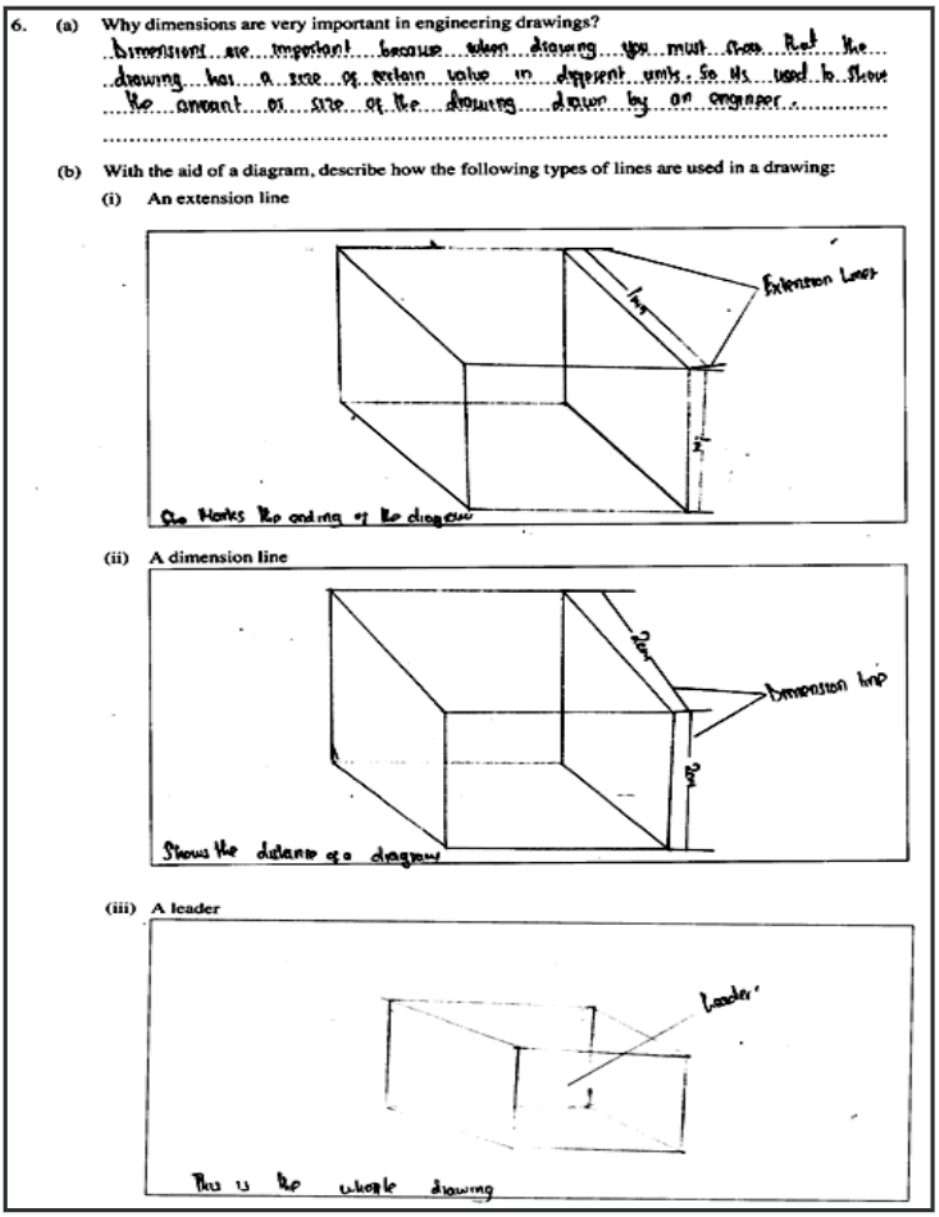


Extract 6.1: A sample of incorrect responses to Question 6

In Extract 6.1, the student provided irrelevant responses to all parts of the question. This suggests that the student lacked knowledge about basic drawing techniques and practices especially the importance of dimensions and the appropriate application of different types of lines.

Despite the weak performance shown by most of the students, 143 (38.50%) of the students revealed to have satisfactory knowledge on the concept of dimensioning and application of different types of lines used

in engineering drawing. Extract 6.2 represents a sample of good responses to this question.



Extract 6.2: A sample of the good responses to Question 6

In Extract 6.2, the student demonstrated to have good understanding of *Electrical Draughting*. He/she highlighted the importance of dimensions in part (a) and managed to indicate the lines in the diagram,

but he/she failed to describe in words the function of the lines as required in part (b).

2.2.5 Question 7: Instruments and Measurements

This question had two parts, (a) and (b). The question assessed the students' knowledge on different types of measuring instruments commonly used in electrical circuits. Also the question required the students to demonstrate their ability to identify the appropriate measuring instruments for a particular task. The question was as follows;

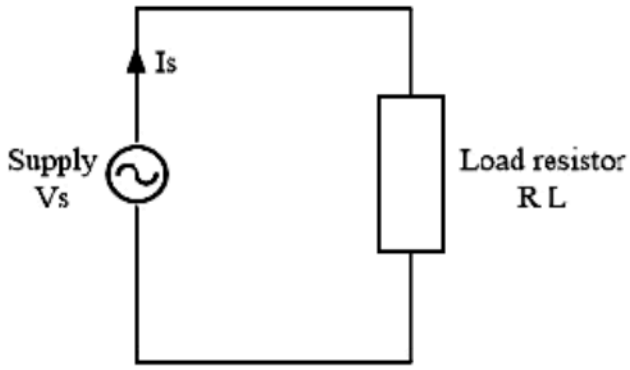
(a) You are in a workshop and you have been given several measuring instruments.

(i) How will you categorise the instruments as either analog or digital instruments?

(ii) Assume some of the instruments given are the KVA meter and Clamp meter. In which circumstance would you need to use these instruments?

- *KVA meter*
- *Clamp meter*

(b) Suppose you are provided with an electric circuit as shown in the figure and you are tasked to measure the electric current (Is) and load resistance (R_L) of the circuit.



(i) What measuring instruments will you use to accomplish the assigned task?

(ii) *Redraw the circuit and show how you will position the meters to measure the current (Is) and load resistance (R_L) of the given circuit.*

A total of 371 (100%) students who sat for this paper attempted this question. Statistical data show that 106 (28.60%) students scored from 0 to 2.5 marks; of whom, 34 (9.20%) scored zero. In addition, 185 (49.80%) scored from 3 to 6 marks, and 80 (21.60%) scored from 6.5 to 10 marks. Figure 5 summarizes their performance.

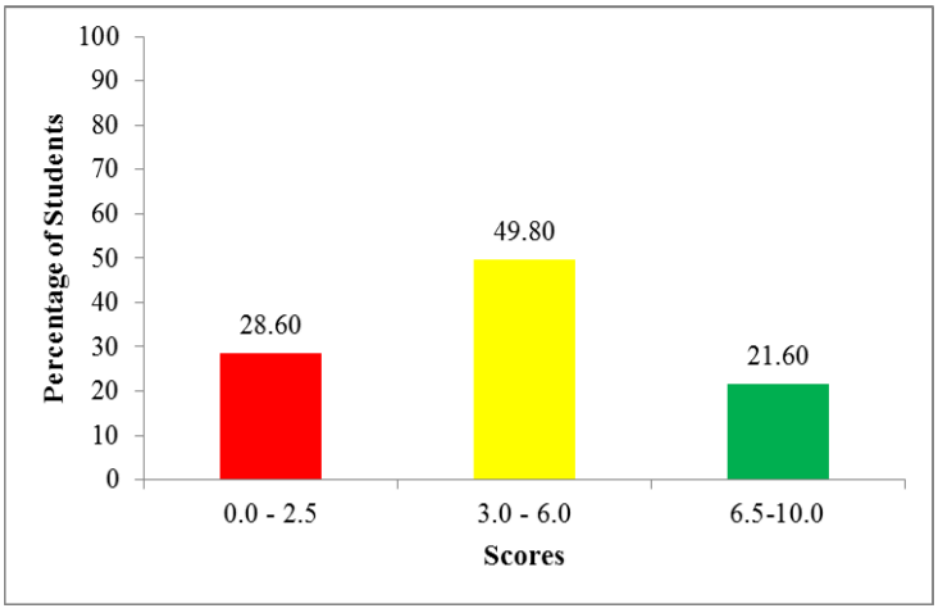
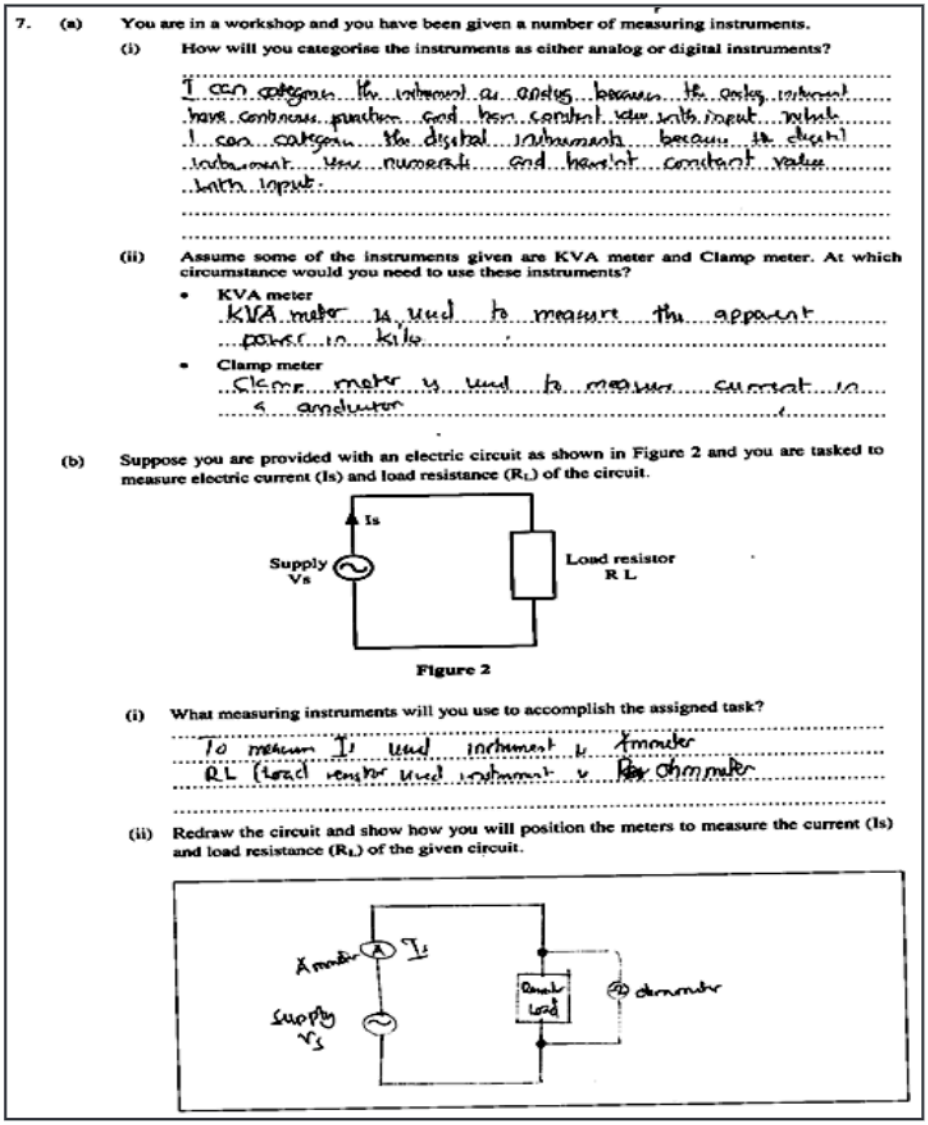


Figure 5*: Students' Performance in Question 7*

The students' general performance in this question was good as statistical analysis reveals that 265 (71.40%) of the students scored average marks and above. Most of the student in this category demonstrated their ability to identify the appropriate measuring instruments, redraw the circuit diagram, and position the meters correctly to obtain the required measurements. Extract 7.1 shows a sample of good responses from one of the students.

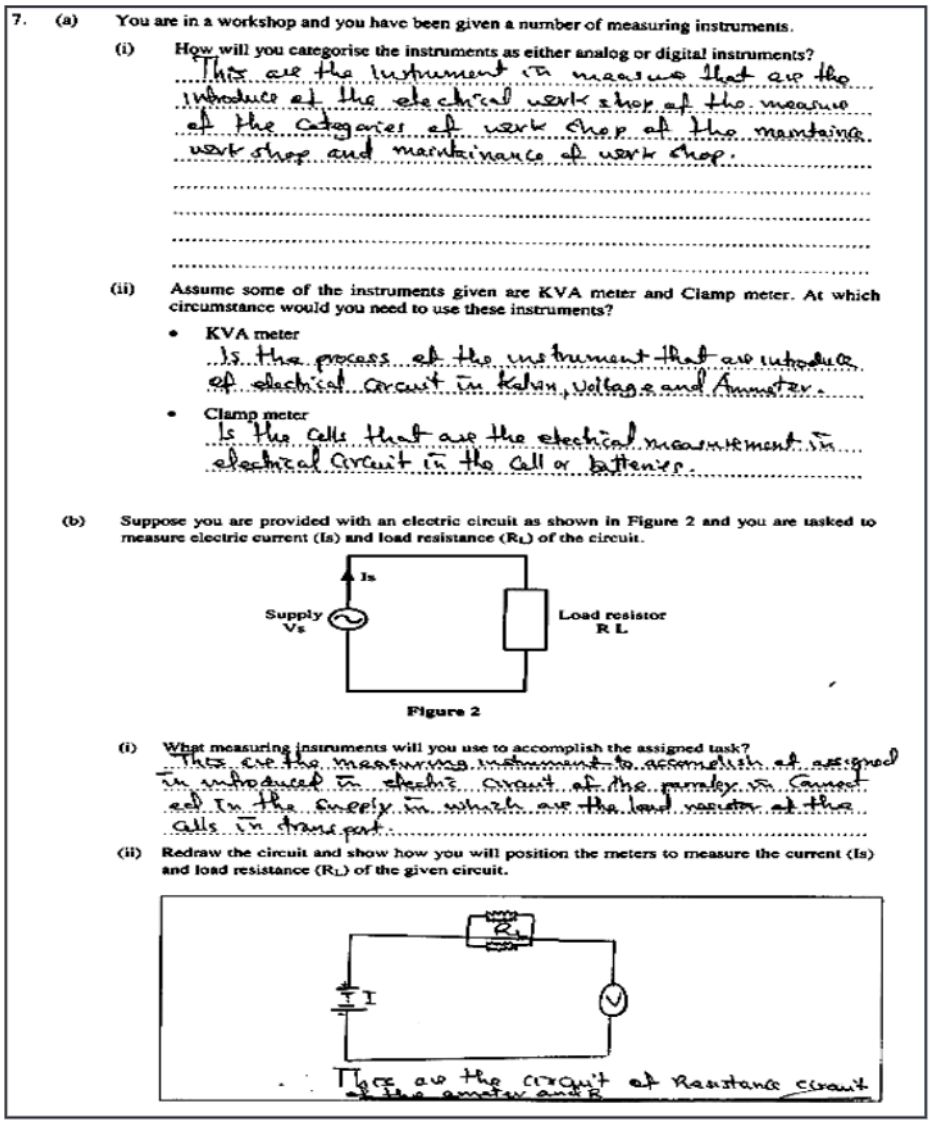


Extract 7.1: A sample of correct responses to Question 7

Extract 7.1 shows that, the student provided the correct answer in both parts (a) and (b) of the question. The student indicated to be competent enough in *Instrument and Measurements.*

In spite of good performance, 106 (28.60%) students scored low marks, and among them, 34 (9.20%) scored zero. These students had inadequate knowledge on the topic of *Instruments and Measurements*. The major challenge for many students in this category was lack of competence in placing the ammeter and ohmmeter in the correct

positions to measure current and load resistance in the circuit as requested in part (b)(ii). For those who scored zero, could not provide correct response to any part of the question. Extract 7.2 is a sample of the incorrect responses by one of the students.


7. (a) You are in a workshop and you have been given a number of measuring instruments.

(i) How will you categorise the instruments as either analog or digital instruments?

This are the instrument in measure that are the introduce of the electrical work shop of the measure of the categaries of work shop of the maintaing work shop and maintainance of work shop.

(ii) Assume some of the instruments given are KVA meter and Clamp meter. At which circumstance would you need to use these instruments?

- KVA meter

Is the process of the instrument that are introduce of electrical circuit in kelvin, voltage and Ammeter.

- Clamp meter

Is the cells that are the electrical measurement in electrical circuit in the cell or batteries.

(b) Suppose you are provided with an electric circuit as shown in Figure 2 and you are tasked to measure electric current (Is) and load resistance (R_L) of the circuit.

Figure 2

(i) What measuring instruments will you use to accomplish the assigned task?

This are the measuring instrument to accomplish of assigned in introduced in electric circuit of the parralex in connected in the supply in which are the load resistor of the cells in transport.

(ii) Redraw the circuit and show how you will position the meters to measure the current (Is) and load resistance (R_L) of the given circuit.

This are the circuit of Resistance circuit of the ameter and R

Extract 7.2: A sample of incorrect responses to Question 7

Bases on Extract 7.2, it is evident that the student confused about the KVA meter asked in (a)(ii). He/she assumed that KVA stands for Kelvin-Voltage-Ammeter, which is incorrect. He/she failed to

understand that, KVA meter is used to measure apparent power in an electric circuit, and its unit is Kilo Volt-Ampere. The student represented letter K for Kelvin (the SI unit of Temperature) instead of Kilo. In part (b)(i), the student provided a response which was irrelevant to the question. The answers provided include transport issues, cells, and batteries. Furthermore, in part 7(b)-(ii), the student did not know how to use an ammeter to measure current in the circuit, as a result he/she did not know where to position an ammeter for the assigned task. Likewise, the student incorrectly redrew the circuit by using a D.C source and connected the voltmeter in series instead of an ammeter. Hence, ended up with wrong representation of the given circuit.

2.2.6 Question 8: Magnetism and Electromagnetism

The question assessed the students' comprehension of fundamental concepts related to magnetic and electric circuits. It also intended to evaluate students' ability to apply principles of electromagnetic induction and inductance to solve real-world problems. This question had two parts, (a) and (b), and was composed as follows;

(a) Give two differences between magnetic and electric circuits.

(b) A coil of 150 turns is linked with a flux of 0.01 Wb when carrying a current of 10 A. If the current is uniformly reversed in 0.01 seconds, calculate:

(i) Inductance of the coil.

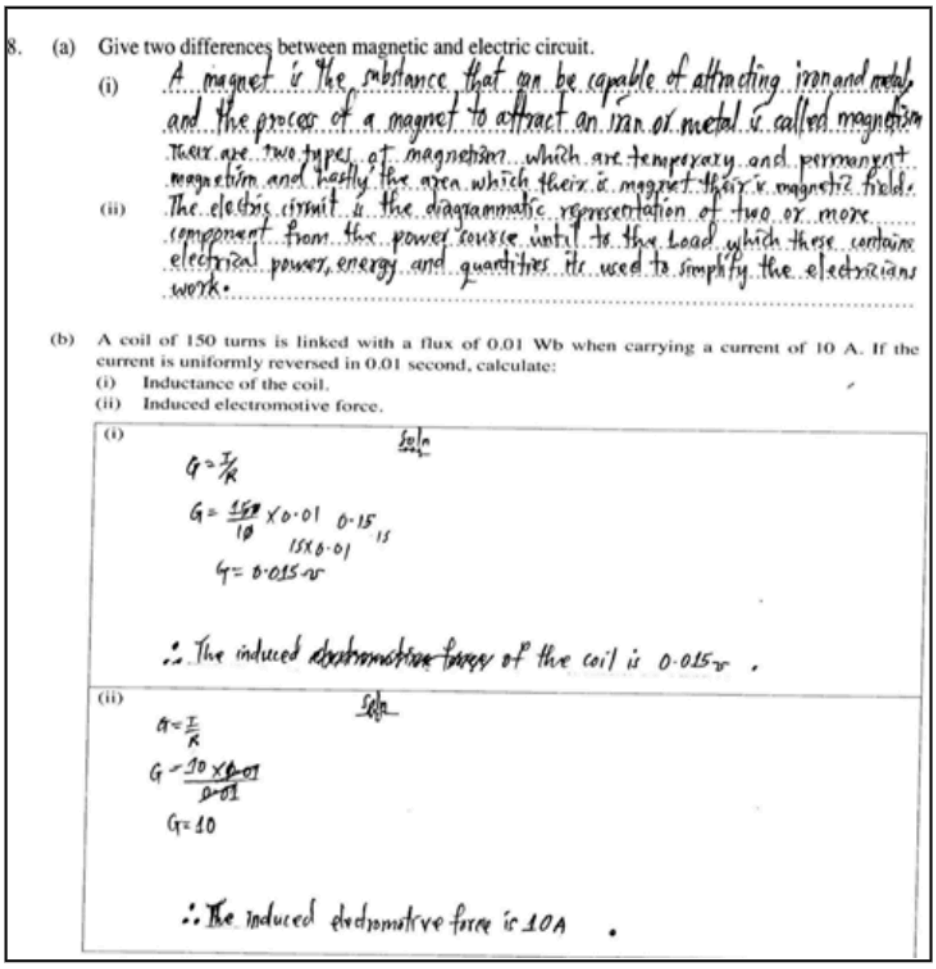
(ii) Induced electromotive force

The analysis shows that, a total of 371 (100%) students attempted this question. Among them, 331 (89.20%) of the students scored from 0 to 2.5 marks; 39 (10.50%) scored from 3 to 6 marks; and 1 (0.30%) scored 8 marks. there was no student who scored above 10 marks to this question. Table 5 summarizes the students' performance on this question.

Table 6: Students' Performance in Question 8

Scores	Number of Students	Percentage (%)	Remark
0-2	331	89.20	Weak
3-6	39	10.50	Average
6.5-10	1	0.30	Good
Total	**371**	**100**	

The analysis shows that the overall students' performance on this question was poor because 331 (89.20%) scored from 0 to 2 marks. Most of the students failed to differentiate between magnetic and electric circuit in part (a) and apply the incorrect formula to calculate the values of the required parameters in part (b). For example, in responding to part (a), one of the students applied an incorrect formula to find the inductance by writing $\left(\text{Inductance} = \frac{\text{Coil Turns}}{\text{Current}}\right)$ instead of $\left(\text{Inductance} = \frac{\text{Number of Turns} \times \text{Flux}}{\text{Current}}\right)$. The incorrect answers provided confirm that the students lacked sufficient understanding of the concepts tested in the topic of Magnetism and Electromagnetism, particularly in the application of formulas. Extract 8.1 is a sample of such responses.


8. (a) Give two differences between magnetic and electric circuit.

(i) A magnet is the substance that can be capable of attracting iron and metal, and the process of a magnet to attract an iron or metal is called magnetism There are two types of magnetism which are temporary and permanent magnetism and lastly the area which their is magnet their is magnetic field.

(ii) The electric circuit is the diagrammatic representation of two or more component from the power source until to the Load which these contains electrical power, energy and quantities are used to simplify the electricians work.

(b) A coil of 150 turns is linked with a flux of 0.01 Wb when carrying a current of 10 A. If the current is uniformly reversed in 0.01 second, calculate:
(i) Inductance of the coil.
(ii) Induced electromotive force.

(i) Solution

$G = \frac{I}{R}$

$G = \frac{150}{10} \times 0.01 \quad \frac{0.15}{15}$

15×0.01

$G = 0.015$

∴ The induced electromotive force of the coil is 0.015.

(ii) Solution

$G = \frac{I}{R}$

$G = \frac{10 \times 0.01}{0.01}$

$G = 10$

∴ The induced electromotive force is 10A.

Extract 8.1: A sample of incorrect responses to Question 8

In Extract 8.1, the student provided a definition of a magnetic piece instead of explaining a magnetic circuit. Furthermore, the student described an electric circuit as a diagram representing more than two components from electrical power to simplify electrical tasks. Ultimately, he/she failed to distinguish between a magnetic circuit and an electric circuit as required in part (a). In part (b), the student applied a wrong formula $\left(G=\frac{I}{R}\right)$ to calculate the value of inductance of the coil as well as the electromotive force. The students confused the formula to that of Conductance which is given by $\left(G=\frac{1}{R}\right)$. To calculate the

inductance L for the coil and the induced electromotive force E, the student was required to apply the following formula:

(i) Inductance of the coil (L): $\left(L=\frac{N\phi}{I} \right)$

(ii) Induced electromotive force (E): $\left(E=\frac{\Delta IL}{\Delta T} \right)$

However, 40 (10.80%) of the students who had satisfactory performance provided the correct responses to some items of the question; hence, they scored 3 to 8 marks out of the 10 marks allotted. Since there was no student who scored above 8 marks, it is an indication that most of them had partial knowledge about the concepts of *Magnetism and Electromagnetism.* Extract 8.2 represents a sample of good responses from one of the students.

8.(a) Give two differences between magnetic and electric circuit.

(i) In Magnetic circuit there is presence of reluctance (Rm) which is the opposition of Magnetic flux while in Electric current there is presence of resistance(R) which is the opposition of electric current flow in a circuit.

(ii) In Magnetic circuit there is presence of Permeance (Pm) which is the reciprocal of reluctance and is the measure of the ease of a material to allow Magnetic flux to flow while in electric circuit there is presence of Conductance(G) which is the reciprocal of resistance and measure of ease of a material to allow current to flow.

(b) A coil of 150 turns is linked with a flux of 0.01 Wb when carrying a current of 10 A. If the current is uniformly reversed in 0.01 second, calculate:

(i) Inductance of the coil.

(ii) Induced electromotive force.

(i) Solution

Data given

N (Number of turns) = 150 turns

Φ (flux) = 0.01 Wb

I (current) = 10 A

t (time) = 0.01 s

From, Inductance = $\frac{\text{Number of turns} \times \text{flux}}{\text{time Current}}$

$L = \frac{N\Phi}{I}$

$L = \frac{150t \times 0.01Wb}{0.01s \times 10A}$

$L = \frac{1.5 \text{ Wbt}}{10 \text{ A}}$

L = 0.15 Henry

∴ The inductance of coil is 0.15H

(ii) Solution

From

$e = \frac{LI}{t}$ OR $e = \frac{N\Phi}{t}$

Electromotive force = $\frac{\text{Inductance} \times \text{Current}}{\text{Time}}$

$E = \frac{0.15H \times 10A}{0.01 s}$

$E = \frac{1.5}{0.01}$

E = 150 V

∴ The value of induced electromotive force is 150 V

Extract 8.2: A sample of the good responses to Question 8

In Extract 8.2, the student did well in part (a) and part (b)(i). However, in part (b)(ii), the student used an incorrect equation to find induced electromotive force. This mistake led to an incorrect answer that

doubled the value of the correct answer. Specifically, the student obtained a value of 300 V instead of the correct value of 150 V.

2.2.7 Question 9: Workshop Practice

This question had two parts, (a) and (b). It assessed the students' ability to identify different tools, explain their importance, and ensure safe handling and usage in practical scenarios. The question was as follows;

(a) You have been provided with tools such as pliers, pocket knife, chisel, hand drill and center punch for doing electrical lighting and wiring. Why are these tools important for such work?

(i) Pliers
(ii) Pocket knife
(iii) Chisel
(iv) Hand drill
(v) Centre punch

(b) What safety precautions you should observe in handling each tool mentioned in (a) (i) – (v)?

This question was attempted by 371 (100%) students. Among them 158 (42.60%) scored from 0 to 2.5 marks; 184 (49.60%) scored from 3 to 6 marks and 29 (7.8%) scored from 6.5 to 10 marks. This trend of performance verifies that the students had an average performance. Figure 6 summarizes the students' performance in this question.

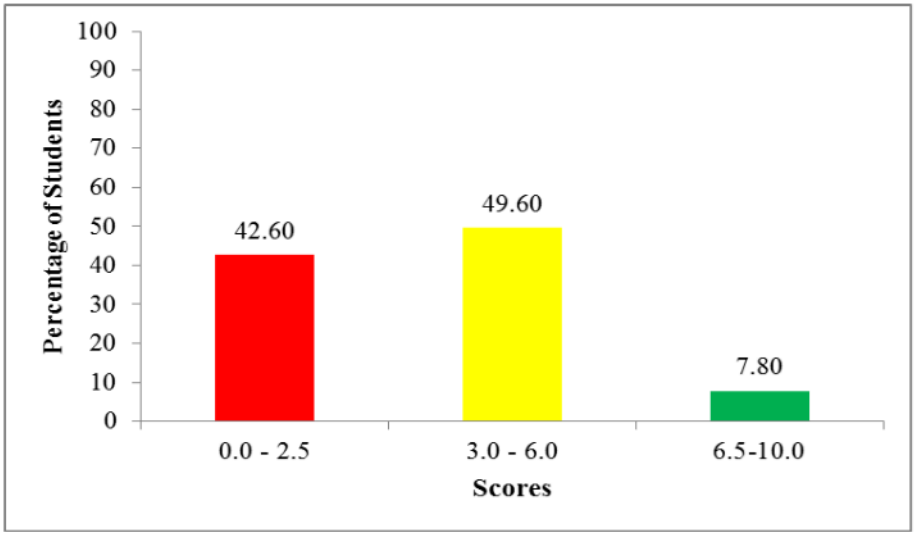
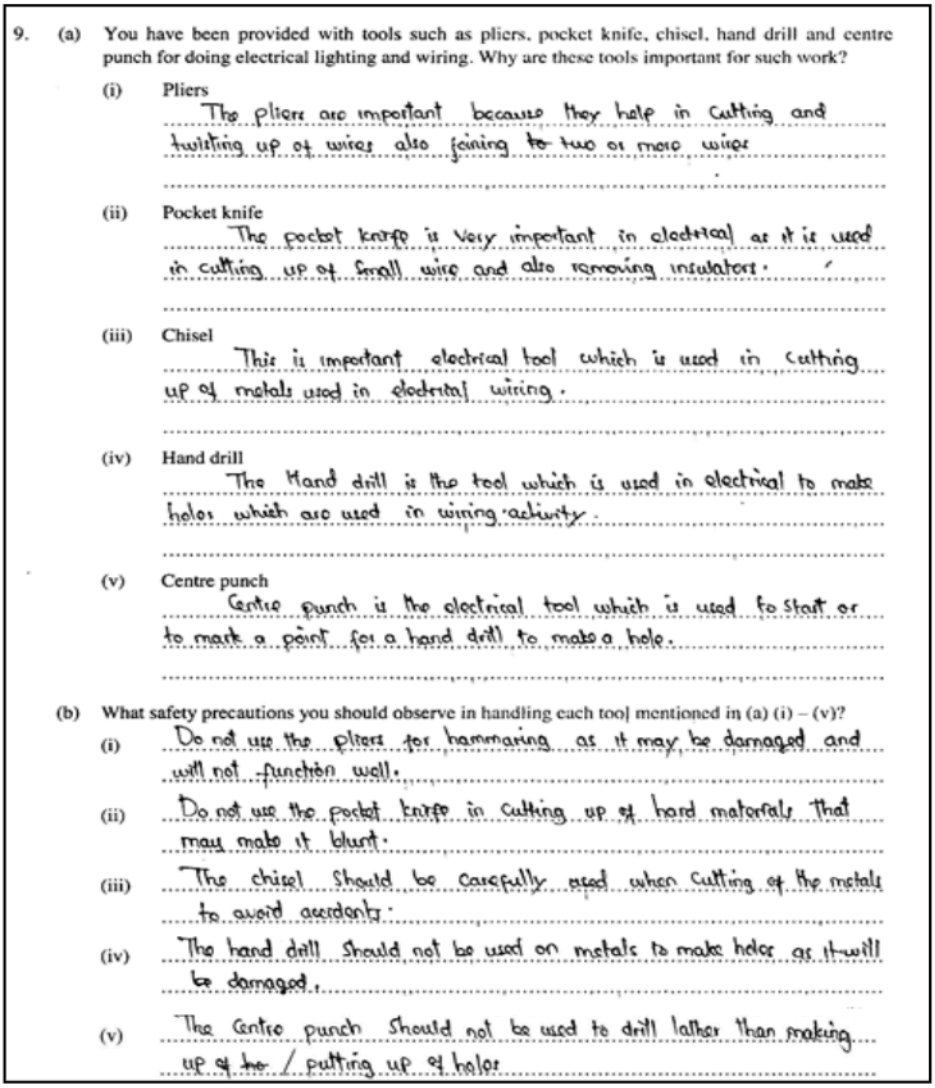


Figure 6: *Students' Performance in Question 9*

The students average performance on this question was average because 213 (57.40%) of them scored from 3 to 10 marks. These students responded to some of the items correctly and partially responded to a few items. Extract 9.1 is the sample of correct responses from one of the students.



9. (a) You have been provided with tools such as pliers, pocket knife, chisel, hand drill and centre punch for doing electrical lighting and wiring. Why are these tools important for such work?

(i) Pliers
The pliers are important because they help in cutting and twisting up of wires also joining ~~to~~ two or more wires

(ii) Pocket knife
The pocket knife is very important in electrical as it is used in cutting up of small wire and also removing insulators.

(iii) Chisel
This is important electrical tool which is used in cutting up of metals used in electrical wiring.

(iv) Hand drill
The Hand drill is the tool which is used in electrical to make holes which are used in wiring activity.

(v) Centre punch
Centre punch is the electrical tool which is used to start or to mark a point for a hand drill to make a hole.

(b) What safety precautions you should observe in handling each tool mentioned in (a) (i) – (v)?

(i) Do not use the pliers for hammaring as it may be damaged and will not function well.

(ii) Do not use the pocket knife in cutting up of hard materials that may make it blunt.

(iii) The chisel should be carefully used when cutting of the metals to avoid accidents.

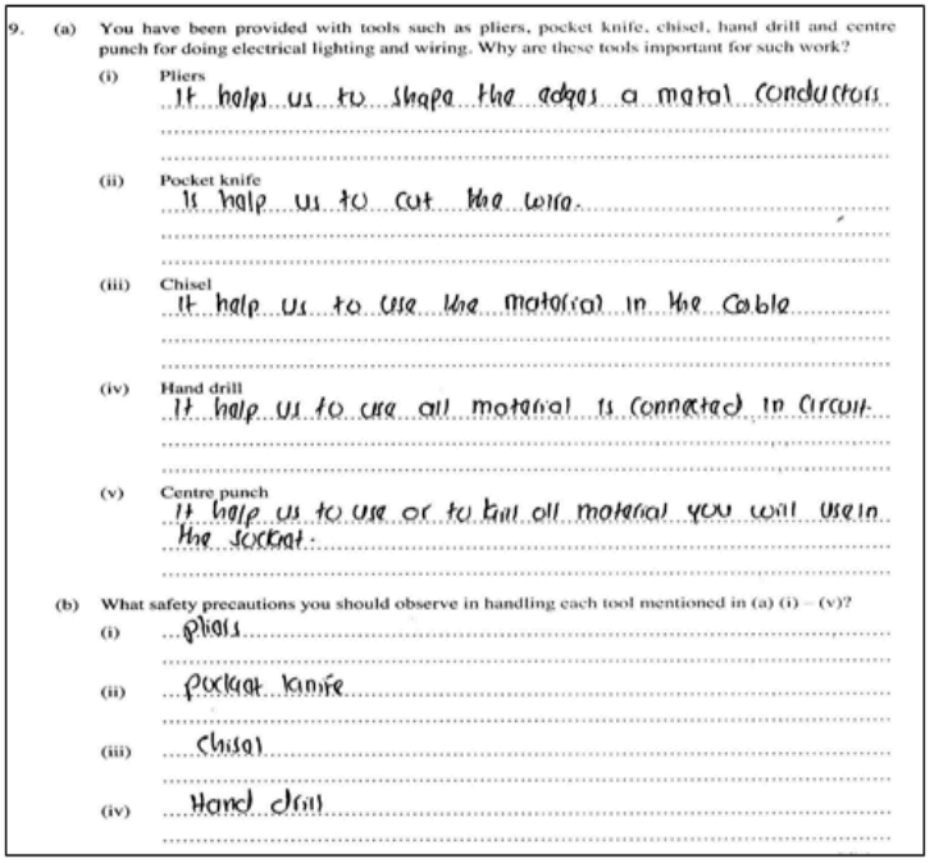
(iv) The hand drill should not be used on metals to make holes as it will be damaged.

(v) The Centre punch should not be used to drill rather than making up of the / putting up of holes

Extract 9.1: A sample of the good responses to Question 9

In Extract 9.1, the student demonstrated a good understanding of safety measures and knowledge on application of different electrical tools.

Moreover, analysis indicates that 258 (42.60%) students performed poorly. Among them, 48 (12.90%) scored zero since they could not provide the correct use of the tool and safety precautions in handling the given tools. Some of these students provided the general safety precautions in any electrical workshop instead of stating the safety precautions to be observed in handling the given tools as requested in part (b). This result indicates that the students had little knowledge about workshop practice especially safety procedures and regulation of using tools and accessories in electrical engineering workshop. Extract 9.2 is a sample of the incorrect responses provided by one of the students.


9. (a) You have been provided with tools such as pliers, pocket knife, chisel, hand drill and centre punch for doing electrical lighting and wiring. Why are these tools important for such work?

(i) Pliers
It helps us to shape the edges a metal conductors

(ii) Pocket knife
It help us to cut the wire.

(iii) Chisel
It help us to use the material in the Cable

(iv) Hand drill
It help us to use all material is connected in circuit.

(v) Centre punch
It help us to use or to hit all material you will use in the socket.

(b) What safety precautions you should observe in handling each tool mentioned in (a) (i) – (v)?

(i) pliers

(ii) pocket knife

(iii) chisel

(iv) Hand drill

Extract 9.2: A sample of incorrect responses to Question 9.

In Extract 9.2, the student gave incorrect importance of all the tools given in part (a). He/she also copied the tools given in part (a) as responses to 9 (b).

2.3 SECTION C: STRUCTURED QUESTION

This section consisted of one (1) structured type question, carrying 15 marks. The analysis of students' responses to the question is as follows:

2.3.1 Question 10: Electrical Draughting

The question assessed the student's ability to represent a three-dimensional object in a series of two-dimensional views (*front, end and plan*) using orthographic projection principles. Also it tested the students' ability to accurately project the features of the object onto the drawing plane according to third angle projection rules. This includes correctly positioning and aligning the features in each view relative to the viewing planes. The question was as follows;

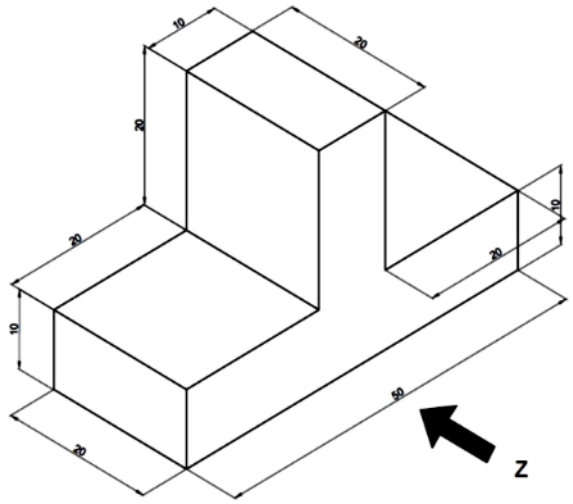
The following object is presented to you for the development. Produce the following views in full scale size by using third angle projection.

(a) Front view in direction of Z.

(b) End view.

(c) Plan view.

All dimensions are in mm. Construction lines must not be erased and all drawings should be neatly shown.



This question was attempted by 371 (100%) students. Analysis indicates that 75 (20.20%) of the students scored from 0 to 4 marks; 89 (24.00%) scored from 4.5 to 9.5 marks; and 207 (55.80%) scored from 10 to 15 marks. Figure 7 summarizes their overall performance on the question.

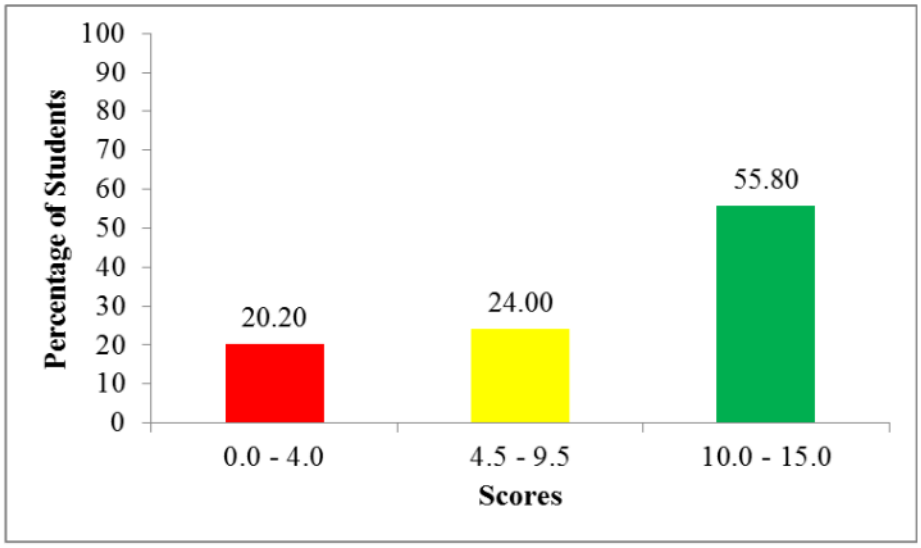
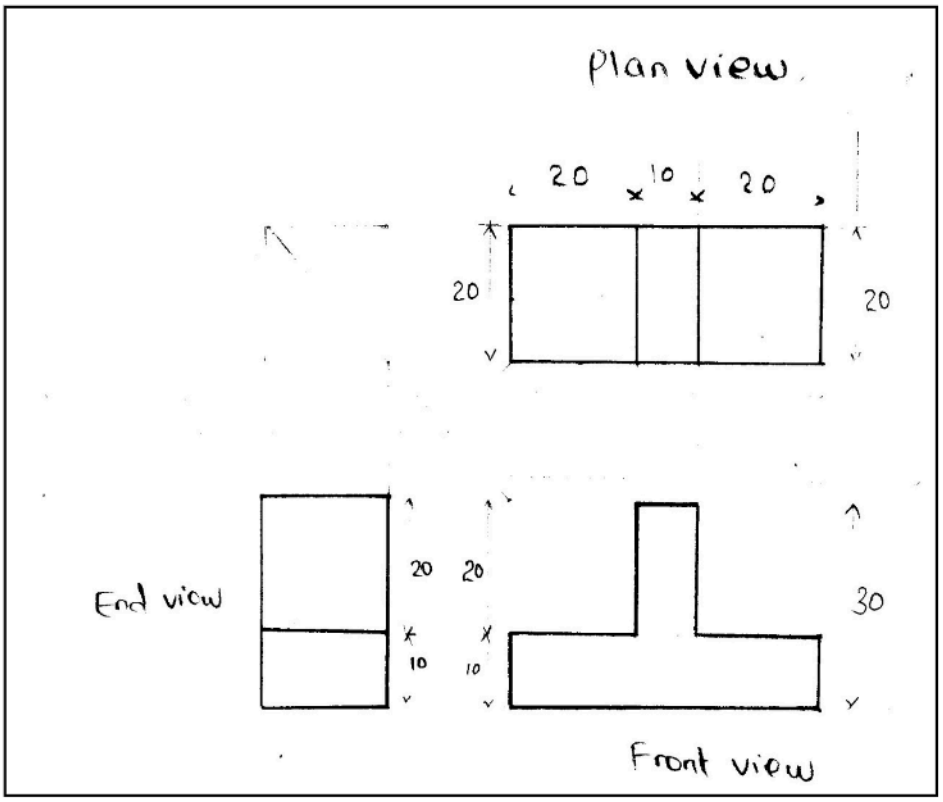


Figure 7: *Students' Performance in Question 10*

As it is seen from Figure 7, most of the students performed well on this question. They were able to construct the orthographic three views, namely front, end, and plan views of the object in full scale size as well as correct dimensions as required. Extract 10.1 provides an example of a correct response by one of the students.

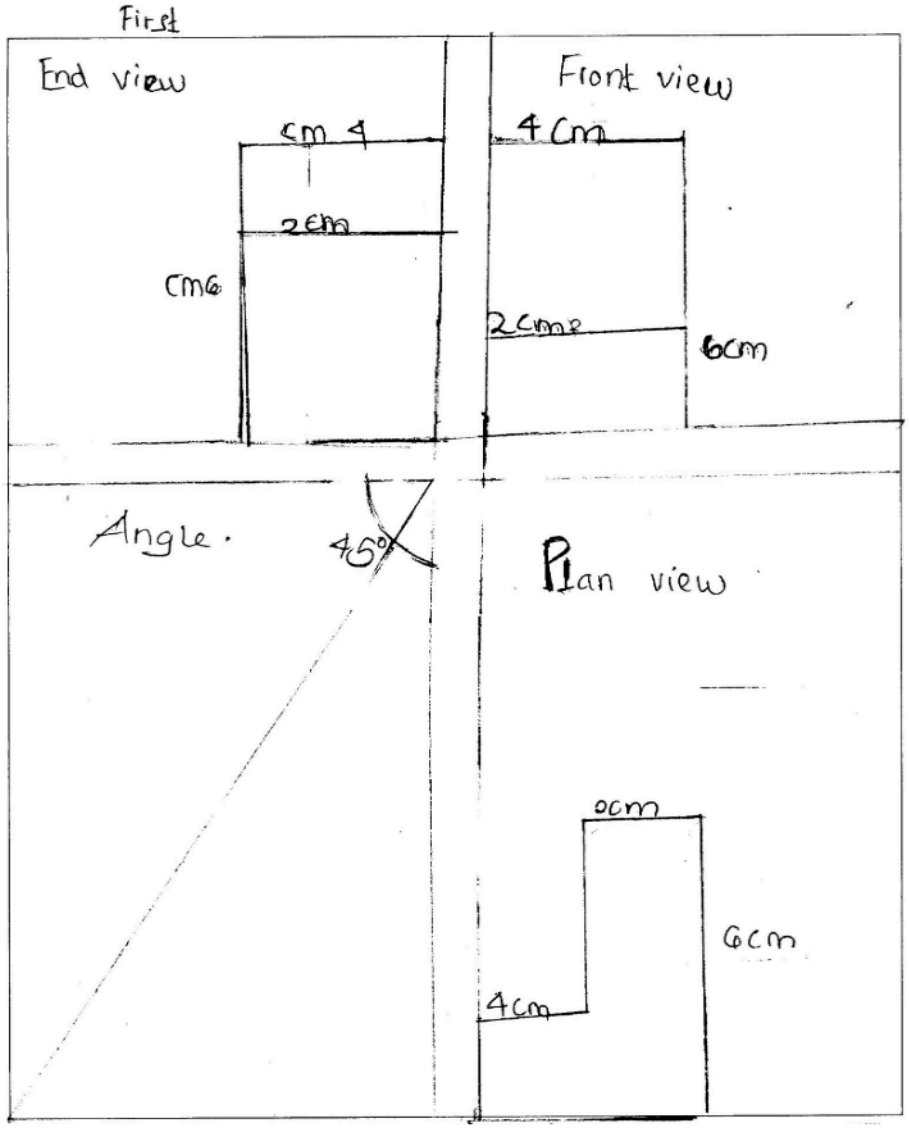


Extract 10.1: A sample of the correct response to Question 10

In Extract 10.1, the student was successfully produced front, end, and plan views of an object in full scale size. This indicates that the student possessed sufficient knowledge and skills about *Electrical Draughting.*

Nevertheless, 75 (20.20%) of the students had weak performance on this question as they failed to produce the views in full size scale using third angle projection. Some of these students incorrectly presented the object using first angle projection. These students were supposed to understand that, in first angle projection, the object is positioned between the object and the viewing planes where, in third angle projection, the object is positioned behind the viewing planes.
Besides, there were other students who redrew the given figure as response to the question. This indicates that the students had partial knowledge and lacked enough exercises on pictorial drawing and orthographic projection. Hence, they failed to interpret and convert the

given views as required. Extract 10.2 illustrate the poor response from one of the students.



Extract 10.2: A sample of incorrect response to Question 10

In Extract 10.2, the student tried to provide an end view but it was the inverted one. Also he/she presented a cube in oblique (45°) form which was irrelevant to the question. This indicates that the students had partial knowledge and lacked enough exercises in interpreting and converting objects into views.

3.0 STUDENT'S PERFORMANCE ON EACH TOPIC

The analysis of the student's performance on the topics which were assessed in the Electrical Engineering subject for the year 2023 indicates that the students performed well on *Electrical Workshop Orientation* (98.10%), tested in Question 2 and *Cells and Batteries, DC Circuits, Electrical Engineering Science and Technology, Electrical Draughting, Instruments and Measurements, Magnetism and Electromagnetism, Units, Electrical Workshop Orientation, Workshop Practice* (96.20%) tested in Question 1 which comprised 10 multiple choice items. The good performance on these topics signifies that the students had enough knowledge, skills and competence in the concepts included in the assessment. It also shows that they had ability to follow the required assessment instructions and identify the demands of the questions.

The topics on which the students had average performance were *Electrical Draughting* (59.19%) tested in questions 6 and 10, *Workshop Practice* (57.40%) tested in question 9 and *Instruments and Measurements* (40.50%) tested in questions 5 and 7. The students had average performance on these topics because they provided fewer points than those demanded by each question. Moreover, some of them mentioned correct points without providing satisfactory explanations or used inappropriate formulae in calculations.

The students had a weak performance on the topics of *Cells and Batteries* (27.50%) tested in question 3, *D.C Circuit* (21.80%) tested in question 4 and *Magnetism and Electromagnetism* (10.80%) tested in question 8.

The appendix summarizes the students' performance on each topic. The *green, yellow* and *red* colours are used to represent good, average and weak performances respectively.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The general performance of the students in Electrical Engineering for Form Two National Assessment (FTNA) in the year 2023 was average. Out of the 371 students who sat for the paper, 230 (62.00%) passed, while 141 (38.00%) failed. Their good performance resulted from their ability to understand the demands of the questions, their knowledge, skills and competence in the subject matter, as well as their ability to use appropriate formula to perform calculations.

Further analysis shows that the topic of *Magnetism and Electromagnetism* has continued to have poor performance for two consecutive years, namely in 2022 and 2023, with percentages of 13.40% and 10.80% respectively. On the other hand, the topic of *Instrument and Measurement,* which had poor performance (4.10%) in 2022, has risen to an average level (40.50%) in 2023. The increase in performance in this topic is attributed to students having sufficient knowledge about the concepts covered in the respective topic

However, few shortcomings have been revealed. These include the students' insufficient knowledge in responding to some of the questions, failure to understand the questions, and inability to apply appropriate mathematical formulae in computations as it was highly observed in the topics of *Cells and Batteries, DC Circuit* and *Magnetism and Electromagnetism* which was poorly done.

4.2 Recommendations

Based on the observations made in the Students' Item Response Analysis (SIRA), the following recommendations are put forward to improve the performance of Form Two students on this subject.

(a) Students should be diligent in their studies to increase their knowledge, skills, and proficiency in the concepts taught in various topics as outlined in the syllabus.

(b) Competence-based teaching and learning should be emphasized in each topic. This will enable students to acquire competence and sufficient proficiency in the subject.

(c) As identified in the topic of *Magnetism and Electromagnetism*, which had a poor performance, teachers should guide students in practicing various exercises that require the application of formulas in calculation to build their capability in answering questions that demand this skill. Additionally, teachers can start with simple examples and gradually progress to more complex ones related to the relevant concepts. This will provides students with the opportunity to practice and build confidence, and finally, achieving the intended goals.

Appendix

A Summary of Students' Performance Per Topic in the Electrical Engineering Subject in the Year 2023

S/N	Topic	Question Number	Percentage of Students who Scored 30 Per cent or Above	Remarks
1	Electrical Workshop Orientation	2	98.10	Good
2	Cells and Batteries, DC Circuits, Electrical Engineering Science and Technology, Electrical Draughting, Instruments and Measurements, Magnetism and Electromagnetism, Units, Electrical Workshop Orientation, and Workshop Practice.	1	96.20	Good
3	Electrical Draughting	6 & 10	59.19	Average
4	Workshop Practice	9	57.40	Average
5	Instruments and Measurements	5 & 7	40.25	Average
6	Cells and Batteries	3	27.50	Weak
7	DC Circuits	4	21.80	Weak
8	Magnetism and Electromagnetism	8	10.80	Weak