



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) 2024**

ELECTRICAL ENGINEERING



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080 ELECTRICAL ENGINEERING

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LIST OF SYMBOLS AND ABBREVIATIONS

A	Ampere
cm	Centimeters
DC	Direct Current
FTNA	Form Two National Assessment
mm	millimeters
μ	micro
NECTA	National Examinations Council of Tanzania
Ω	Ohm
SIRA	Students' Item Response Analysis
V	Volt

FOREWORD

This report presents Students' Items Response Analysis (SIRA) on the Form Two National Assessment (FTNA) in the Electrical Engineering subject, which was conducted in 2024. 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 that 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 demands 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 challenges of 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 in preparing 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), 2024. The paper was comprised of three sections, namely A, B, and C.

Section A consisted of questions 1 and 2. Question 1 had ten multiple-choice items, (i) to (x), set from the topics of *DC Circuits, Electricity, Electrical Engineering Science and Technology, Electrical Draughting, Electrical Workshop Orientation, Instruments and Measurements, Magnetism and Electromagnetism, Units, and Workshop Practice*. Question 2 consisted of five matching items, (i) to (v), set from the topic of *Instruments and Measurements*. 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 (7) short answer questions set from the topics of *Cells and Batteries, DC Circuits, Electricity, Electrical Draughting, Electrical Workshop Orientation, Instruments and Measurements, and Magnetism and Electromagnetism*. 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 essay 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 412 students sat for the Electrical Engineering paper in 2024. Among them, 345 (83.70%) passed, whereas 67 (16.30%) failed. Thus, the student's performance in the Electrical Engineering subject in 2024 was good. In the year 2023, a total of 371 students sat for the assessment, of

which 230 (62.00%) of the students passed and 141 (38.00%) failed. Therefore, the performance in the year 2024 has increased by 21.70 percent. The students' grade scores are presented in Table 2, showing the performance trend from the year 2021 to date.

Table 2: Performance Scores from 2021 to 2024

Year	Number of Students	Passed		Failed	
		No	%	No.	%
2024	412	345	83.70	67	16.30
2023	371	230	62.00	141	38.00
2022	387	253	65.40	134	34.60
2021	437	271	62.00	166	38.00

Table 2 indicates that the performance of students' remained to be good for four consecutive years (2021 - 2024), with the pass percentages above average.

2.0 ANALYSIS OF STUDENTS' RESPONSE TO EACH QUESTION

This part analyses the performance of the students in each section, A, B, and C. It presents strengths and weaknesses of the students' responses to each question.

2.1 SECTION A: OBJECTIVE QUESTIONS

This section is 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 that 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) which were constructed from the following topics: *DC Circuits, Electricity, Electrical Engineering Science and Technology, Electrical Draughting, Electrical Workshop Orientation, Instruments and Measurements, Magnetism and Electromagnetism, Units, 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 412 (100%) students attempted this question. Among them, 52 (12.60%) scored from 0 to 3 marks, 270 (65.60%) scored from 4 to 6 marks, and 90 (21.80%) scored from 7 to 10 marks. Figure 1 illustrates the students' performance on this question.

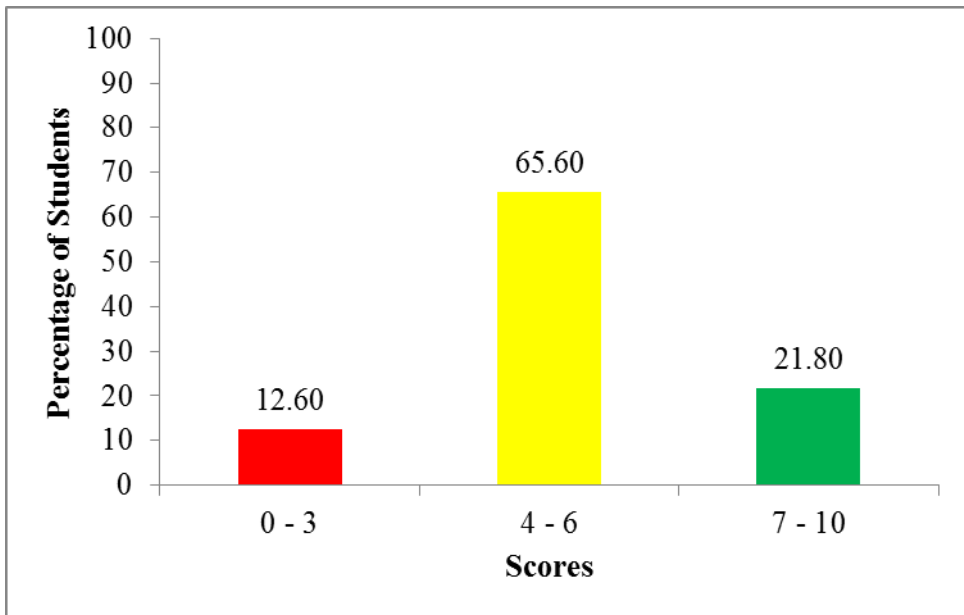


Figure 1: *The Students' Performance in Question 1*

Figure 1 shows that the overall performance on this question was good because 260 (87.40%) 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, 52 (12.60%) of the students had poor performance. These students failed to choose the correct answers in many items. This indicates that they had insufficient knowledge of the subject contents covered by these items. The following part analyses students' responses to each item from (i) to (x) of question 1.

Item (i) was constructed from the topic of *Electrical Workshop Orientation*. It required the student to identify the safety measures to be taken in case of accidents in the workshops, specifically the effect of battery acid when spilled on the skin. The question was as follows:

During workshop a battery acid is accidentally spilled on the skin of one of the students. What should be done on the affected part as an immediate action?

- A To wash it with methylated spirit.*
- B To pour cold water on the affected part.*
- C To cover it with antiseptic cream.*
- D To consult a doctor.*

The correct answer was B, *To pour cold water on the affected part*. The students who opted for this alternative had acquired sufficient understanding about safety measures to be taken in case of accidents in the workshops. Those who selected alternative A, *To wash it with methylated spirit*, and C, *To cover it with antiseptic cream*, lacked knowledge about the effect of acid reactions on the body skin, as the affected part will get burnt. Similarly, when antiseptic cream is applied on the affected part, the skin of that part will be damaged. Those who opted for option D, *To consult a doctor*, thought that the immediate action to help the victim is to focus on medical treatment without considering first aid before seeking the medical assistance from the doctor.

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

You have been given an electric circuit which consists of two resistors with different values connected in series. What will be the behaviour of the circuit?

- A All resistors will have the same voltage.*
- B All resistors will have the same power loss.*
- C The same current will pass through each resistor.*
- D All resistors will have the same energy.*

The correct response was C, *The same current will pass through each resistor*. The students who opted for this had acquired enough knowledge about DC circuits, particularly in the concept of current flowing when connecting different value resistors in a series circuit. For those who opted

for alternative A, *all resistors will have the same voltage*; B, *All resistors will have the same power*; and D, *All resistors will have the same energy*, confused the features of parallel to those of series circuit connection. They also failed to understand that resistors in parallel connections have the same numerical voltage. This suggests that they lacked knowledge and ability to remember some concept learnt in the topic of DC circuits, especially resistors in series circuit connections.

Item (iii) was constructed from the topic of *Electrical Engineering Science and Technology*. It intended to assess the students' knowledge and understanding of the role of electrical engineering technology in society. The question was as follows:

What is the main role of electrical engineering technology in the society?

A To study and design electrical equipments.

B To design and apply electrical equipment, devices and systems.

C To study and sell electrical equipment and devices.

D To buy manufactured electrical equipment and devices.

The correct answer was B, *To design and apply electrical equipment, devices and systems*. The students who chose this alternative had sufficient knowledge on the topic of electrical engineering science and technology, specifically on the role of electrical engineering technology in society. The student who opted for alternative A, *To study and design electrical equipments*, might focus on the word "study" and associate it with theoretical knowledge, which is often emphasized in academic environments. They might think that an engineer must have gone to school (to study) first and then perform designing of electrical equipment.

Those who opted for alternative C, *To study and sell electrical equipment and devices*, lacked knowledge about the roles of electrical engineering personnel. The inclusion of the term "sell" in this option could mislead students who associate electrical engineers with sales roles in industries or shops of electrical equipment and devices. This misunderstanding could stem from a lack of clarity about the engineering field's scope versus roles in marketing or sales.

On the other hand, those who opted for alternative D, *To buy manufactured electrical equipment and devices*, failed to differentiate

between core engineering roles and auxiliary roles like procurement or sales. These students may have interpreted this option as part of the engineering profession's role in procurement or supply chain management. This choice could be a result of confusion about the practical tasks engineers undertake, such as sourcing/locating equipment, versus their primary responsibility, which is designing and applying electrical systems.

Item (iv) intended to assess the student's understanding of different types of lines used in electrical engineering drawing. The question was set from the topic of *Electrical Draughting*, and was as follows:

When are the thin – short dashes line used in drawing?

- A *When hatching a sectional view.*
- B *When outlining the hidden part.*
- C *When making centre line for cylindrical object.*
- D *When cutting a plane of a sectional view.*

The correct answer was B, *When outlining the hidden part*, and most of the students responded correctly. These students demonstrated to have not only adequate knowledge about *Electrical Draughting*, but also to apply that knowledge to identify different types of lines and their applications in electrical engineering drawings. Those who opted for option A, *When hatching a sectional view* might have confused the thin-short dashed line with the hatching pattern used to fill sectional views. They also lacked a clear understanding that hatching lines are continuous and drawn at an angle (usually 45°) for sectional views.

On the other hand, those who opted for C, *When making centre line for cylindrical object* may associate the dashed characteristic with centre lines because centre lines use alternating long and short dashes. These students confused thin-short dashed lines with long-short dashed lines (used for centre lines). Similarly, those who opted for alternative D, *When cutting a plane of a sectional view*, might have confused the dashed line with the cutting plane line, which is typically represented by long-short-long dashed lines with arrows at both ends. This confusion reflects a misunderstanding of sectional drawing conventions.

Item (v) was set from the topic of *Electricity*. It aimed to test the students' understanding of atomic structure and its composition, which is essential for principles of electricity. The question was:

How protons differ from neutrons and electrons?

- A *They are lighter and smaller* B *They are heavier and bigger*
C *They are lighter and bigger* D *They are heavier and smaller*

The correct answer was B, *They are heavier and bigger*. The students who answered correctly demonstrated a solid understanding of atomic structure, specifically the arrangement of elements in a periodic table. However, those who opted for option A, *They are lighter and smaller*; C, *They are lighter and bigger*; and D, *They are heavier and smaller*, had limited ability to analyse and compare the physical properties of subatomic particles, particularly in terms of mass and size, and relate these to the atomic structure. This includes a failure to differentiate between mass (heaviness) and volume (size) and to correctly associate these properties with protons, neutrons, and electrons. Additionally, they struggled to apply conceptual knowledge to evaluate multiple attributes (mass and size) simultaneously.

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

What will happen to the instrument if an ammeter will be used as a voltmeter?

- A *It will indicate much higher reading.*
B *It will give extremely low reading.*
C *It will indicate no reading.*
D *The instrument will burn out.*

This question intended to assess the student's knowledge and understanding of electrical instruments and their operating principles. The item was well done by most of the students as they selected the correct alternative, which was D, *The instrument will burn out*. This implies that they had enough knowledge on the common electrical instruments used in electrical quantity measurements, particularly an ammeter, which is designed to measure current, and a voltmeter for measuring voltage. However, those who opted for alternative A *It will indicate much higher reading*; B, *It will give extremely low reading*; and C, *It will indicate no reading*, had limited knowledge of electrical instruments.

The biggest challenge is that most of them did not know the fundamental differences between an ammeter and a voltmeter; thus, they could not foresee what happens when the instruments are used interchangeably. The students were supposed to understand that an ammeter has a very low internal resistance. Using it to measure voltage (which requires high resistance) would result in incorrect readings or potentially damage the instrument. A voltmeter cannot serve this purpose correctly because it has high internal resistance to avoid altering the circuit.

Item (vii) was constructed from the topic of *Magnetism and Electromagnetism*. It intended to measure the student's ability to understand and apply the concept of electromagnetic induction, specifically the effect of a moving conductor when it is placed in a region of magnetic field. The question was as follows:

What is the effect of moving a copper wire in a magnetic field?

- A The current will be induced in a wire.*
- B The wire will become magnetic.*
- C The voltage will be induced in a wire.*
- D The wire will be damaged due to high voltage generated.*

The correct response was C, *The voltage will be induced in a wire*. A large number of the students selected this alternative. These students recognised that moving a conductor, such as a copper wire, through a magnetic field induces an electromotive force (EMF) or voltage due to the interaction between the magnetic field and the motion of the conductor. They also applied Faraday's Law of Electromagnetic Induction, which states 'that the induced voltage is directly proportional to the rate of change of magnetic flux through the conductor'. Generally, these students had a solid understanding on electromagnetic principles, as well as ability to apply theoretical knowledge to practical situations, which reflects well-developed reasoning and problem-solving skills in electrical engineering field.

However, those who opted for option A, *The current will be induced in a wire*; B, *The wire will become magnetic*; and D, *The wire will be damaged due to high voltage generated*, had insufficient knowledge of electromagnetism particularly the basics of electromagnetic induction and the application of Faraday's Law of Electromagnetic Induction. Because of this, they chose options based on false beliefs about current, magnetism, or

other effects, rather than correctly identifying voltage induction as the main result of moving a wire in a magnetic field.

Item (viii) intended to measure the students' knowledge and skills in identifying the correct units of measurement for electrical quantities. The question was,

Which are the three different ways of expressing electrical quantities?

- A *Ampere, Ohm and Volt* B *Ampere, Watt and Volt*
C *Ohm, Volt and Second* D *Metre, Ampere and Volt*

The correct response was A, *Ampere, Ohm, and Volt*, because these are three fundamental ways of expressing electrical quantities (current, resistance, voltage) in terms of their standard units of measurement. These quantities are interconnected through Ohm's Law ($V=I \times R$), where: V= Voltage (Volt); I = Current (Ampere); and R = Resistance (Ohm). Nevertheless, some students responded incorrectly by choosing either options B, *Ampere, Watt and Volt*; C, *Ohm, Volt and Second*, or D, *Metre, Ampere and Volt*. These students lacked knowledge of fundamental electrical quantities and their standard units. Also, they couldn't remember how Ohm's Law describes the relationship between voltage, current, and resistance, or how to write these values in Volts, Amperes, and Ohms. The students failed to connect the quantities to their units and evaluate the relevance of distractors.

Item (ix) was designed to test the 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* B *Carelessness and inexperience*
C *Students' lack of technical* D *Bad rules of working area*

The item was set from the topic of *Electrical Workshop Orientation*. The answer was B, *Carelessness and inexperience*. These students demonstrated to be aware of common hazards in electrical workshops, and carelessness and lack of experience are among the most frequent causes of electrical accidents in workshops. However, other students opted for the remaining alternatives A, *Lack of protective equipment*; C, *Students' lack of technical skills*; and D, *Bad rules of working area*, since they are also related to the causes of electrical accidents in the workshop.

Generally, students who selected the wrong options ignored the significance of human factors, such as carelessness and inexperience, in contributing to accidents. They focused on other aspects of safety, such as protective equipment, technical skills, or workplace rules, and underestimated the role of human behaviour in accident prevention. Moreover, these students lacked competence in understanding workplace safety and the causes of accidents in technical environments.

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

One of your fellow students needs to remove sharp edges on a metal conduit, which of the following tools will you advise him to use?

A *Chisel* B *Plier* C *Reamer* D *Pin punch*

This item intended to measure the students' knowledge of tools and their appropriate usage in a specific task. The correct response was *C, Reamer*. The students who opted for this response demonstrated to have knowledge of the subject matter and understood the task; thus, they identified the appropriate tool for the given scenario. For those who selected A, *Chisel*, B, *Pliers*, and D, *Pin Punch*, had no enough knowledge about tools and their appropriate use. Thus, they randomly selected the options without fully understanding the requirements of the question. Students might be confused about the purposes of the given tools due to a lack of familiarity to their specific applications. For example, *Chisel* (Option A) is used for cutting or shaping materials, but not for smoothing or deburring sharp edges; *Plier* (Option B) was selected due to the misconception that pliers can smooth edges since they are commonly used for gripping and bending, and *Pin Punch* (Option D) was chosen out of confusion, as it is used for aligning or driving out pins, not for removing sharp edges.

2.1.2 Question 2: Matching Items

The question was set from the topic of *Instruments and Measurements*. The question required the students to match the functions of measuring instruments in List A with their corresponding instruments in List B by writing a letter of the correct response in the table provided. The question was as follows:

Match the functions of measuring instruments in List A with their corresponding instrument in List B by writing a letter of the correct response.

<i>List A</i>	<i>List B</i>
(i) It is used to measure electric current.	A Oscilloscope B Galvanometer
(ii) It is used to measure current and voltages of small magnitude.	C Voltmeter D Moving coil instrument
(iii) It is used to measure voltage of a circuit.	E Ohmmeter F Ammeter
(iv) It can be used for both DC and A.C. measurements.	G Frequency meter H Moving iron instrument
(v) It is used to measure resistance in a circuit.	

A total of 412 (100%) students attempted this question. Among them, 9 (2.20%) scored from 0 to 1 mark; 155 (37.60%) scored from 2 to 3 marks; and 248 (60.20%) scored from 4 to 5 marks. Figure 2 illustrates the distribution of students' scores in this question.

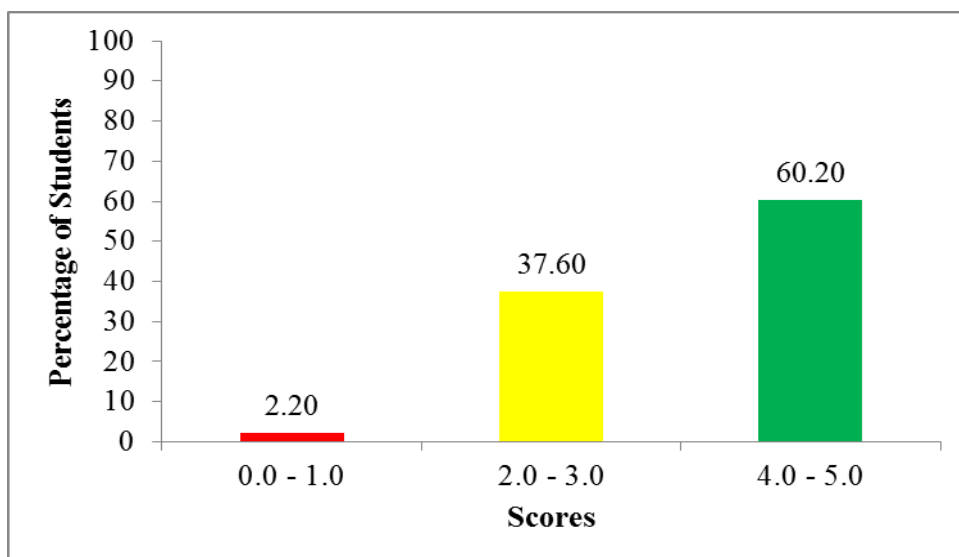


Figure 2: *The Students' Performance in Question 2*

Figure 2 indicates that the overall performance was good since 403 (97.80%) 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 *Instruments and Measurements*, especially in the area of the use of measuring instruments. On the other hand, 9 (2.20%) students had poor performance as they scored from 0 to 1 mark. These students demonstrated insufficient knowledge of the tested concepts regarding *Instruments and Measurements*. The analysis of students' responses to each item is as follows.

Item (i) stated that: *It is used to measure electric current*. The correct response was F, *Ammeter*. The students who matched the item correctly had a clear understanding about the measuring instruments, particularly the ammeter. Other students incorrectly matched with option B, *Galvanometer* or D, *Moving coil instrument* because they are both related to current but not the primary instruments for measuring electric current. Some students may not have clearly understood that an ammeter is specifically designed to measure electric current, while other instruments might measure current as part of their broader functionality (e.g., a galvanometer for detecting small currents).

Item (ii) stated that: *It is used to measure current and voltages of small magnitude*. The correct response was B, *Galvanometer*. The students who matched the item correctly demonstrated to have enough knowledge and understanding on measuring instruments, particularly galvanometers. However, some students incorrectly mismatched this item with option E, *Ohmmeter*. They could not understand that an ohmmeter is specifically designed to measure resistance in a circuit, not current or voltage. The students also lacked a clear understanding of the differences between current, voltage, and resistance, which led them to assume that an ohmmeter, which measures resistance, can also measure current and voltage.

Item (iii) stated that: *It is used to measure voltage of a circuit*. The correct response was C, *Voltmeter*. The students correctly matched the item demonstrated to have adequate understanding of measuring instruments, particularly voltmeter. However, some students incorrectly mismatched this item with response F, *Ammeter*, because they lacked experience in using voltmeters and ammeters in practical setups, and therefore confused their applications in a circuit with their respective measured quantities.

Item (v) stated that: *It is used to measure resistance in a circuit.* The correct response was E, *Ohmmeter*. The students who matched this item correctly signify having sufficient knowledge about the concepts tested from the topic of *Instruments and Measurements*. They correctly associate the ohmmeter with its specific purpose of measuring resistance in a circuit. In contrast, those who incorrectly mismatched this item with other option C, *Voltmeter*, had misconceptions about the role of the ohmmeter and lacked understanding on electrical quantity. Extract 2.1 and 2.2 are samples of students' correct and incorrect responses, respectively.

Answer

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

Extract 2.1: A sample of correct responses to Question 2

In Extract 2.1, the student correctly matched all five functions of the measuring instruments in List A with their respective instruments in List B.

Answer

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

Extract 2.2: A sample of incorrect responses to Question 2

Extract 2.2 shows that the student failed to provide correct answers to any of the items because he/she had inadequate knowledge about applications of measuring instruments.

2.2 SECTION B: SHORT ANSWER QUESTIONS

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

2.2.1 Question 3: Cells and Batteries

The question intended to evaluate students' understanding of the construction of simple and primary cells, their competence on how to modify a simple primary cell, and also their ability to identify the instrument used to measure the specific gravity of the battery. It also

intended to measure students' knowledge and skills in applying concepts related to cells and batteries. The question had two parts, (a) and (b), and was as follows:

- (a) (i) *Draw a well labelled diagram of a simple cell.*
- (ii) *Why is the modification of a simple primary cell done?*

- (b) (i) *Which materials are used as positive and negative electrodes of a Leclanch'e cell?*
- (ii) *Identify the instrument used to measure specific gravity of the battery.*
- (iii) *Why is it not recommended to use metal material on a container of Leclanch'e cell?*

A total of 412 (100%) students attempted this question. Among them, 210 (51.00%) scored from 0 to 2.5 marks, 156 (37.80%) scored from 3 to 6.5 marks, and 46 (11.20%) scored from 7 to 10 marks. The general performance was average since 202 (49.00%) of them scored from 3 to 10 marks. Figure 3 illustrates their performance on this question.

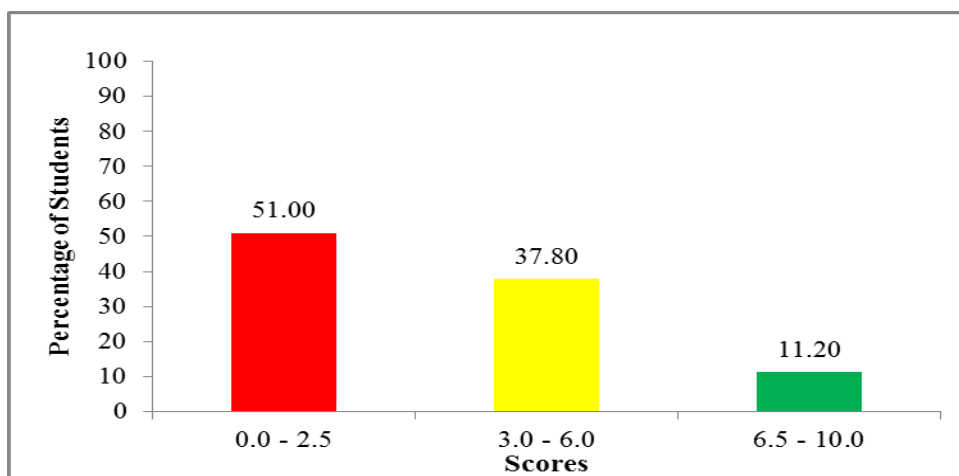
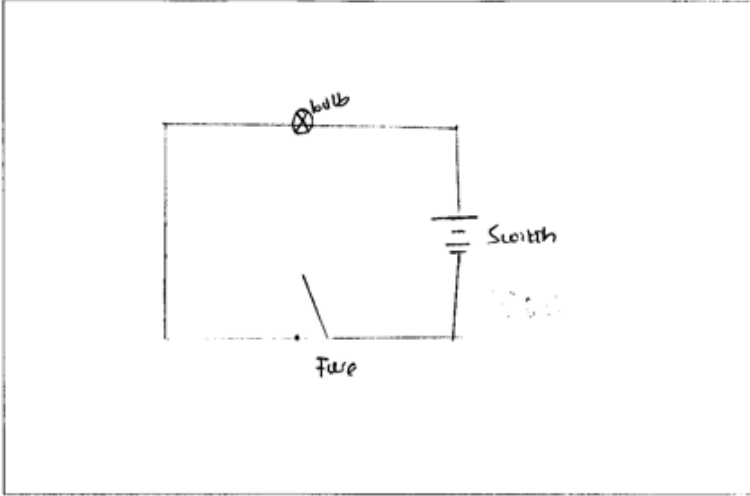


Figure 3: *The Students' Performance in Question 3*

The analysis of students' responses shows that 210 (51.00%) students had weak performance. Most of them failed to respond to a well-labelled diagram of a simple cell in part (a)(i) and to give a reason for modifying a simple primary cell in (a)(ii). However, in part (b)(i), some students were able to identify the materials used in the construction of a simple cell electrode but could not identify the instrument used to measure the specific gravity of the

battery. Extract 3.1 illustrates a sample of incorrect responses from one of the students.

3. (a) (i) Draw a well labeled diagram of a simple cell.



(ii) Why is the modification of a simple primary cell done?
 In wiring activities

(b) (i) Which materials are used as positive and negative electrodes of a Leclanché cell?
 Conductor
 Insulator
 Non Semiconductor

(ii) Identify the instrument used to measure specific gravity of the battery.
 Ammeter
 Ampere
 Voltage

(iii) Why is it not recommended to use metal material on a container of Leclanché cell?
 because they are bad conductor

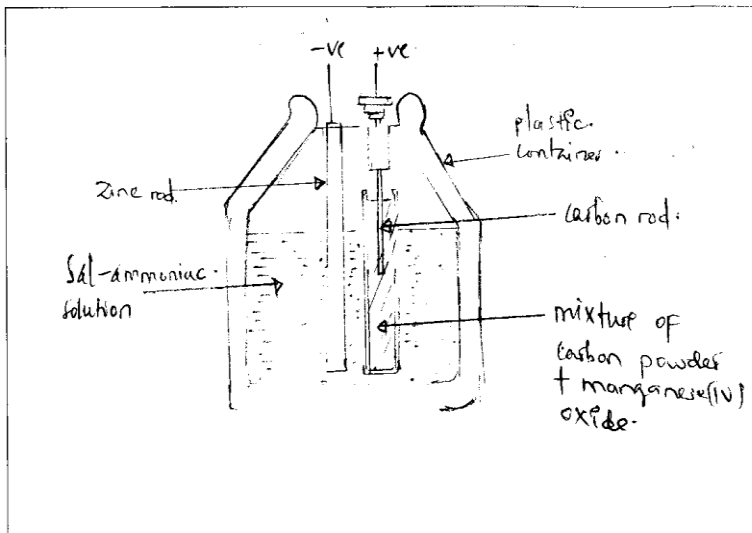
Extract 3.1: A sample of incorrect responses to Question 3

Extract 3.1 shows that, in part (a)(i), the student drew a simple electric circuit instead of a simple cell; also, the student provided an irrelevant response to part (a)(ii) by thinking that modifications of a primary cell are

made to facilitate external electrical tasks, such as wiring, instead of addressing the internal issues of the cell (e.g., polarization and local action). In part (b)(i), the student mentioned conductors, insulators and non-semiconductors as the materials used for electrodes. In the electrical engineering context, these refer to materials classified based on their ability to allow or resist the flow of electric current (conductivity) and not the materials used as electrodes. Also, in part (b)(ii), the student mentioned an *ammeter* which is an instrument for measuring current, instead of a *hydrometer*. Additionally, he/she listed *ampere* and *voltage*, which are units of current and electric potential difference, respectively. Finally, the student provided incorrect responses to part (b)(iii) by writing, “because they are bad conductors” while metals are actually good conductors. The student was supposed to understand that the metal material will corrode when it reacts with acid from the electrolyte.

However, 202 (49.00%) 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) (i) Draw a well labeled diagram of a simple cell.



- (ii) Why is the modification of a simple primary cell done?

Modification of a simple primary cell is done in order to reduce polarisation effect.

- (b) (i) Which materials are used as positive and negative electrodes of a Leclanché cell?

In a Leclanché cell carbon rod is used as positive electrode while zinc rod is used as negative electrode.

- (ii) Identify the instrument used to measure specific gravity of the battery.

The instrument used to determine specific gravity of the battery is hydrometer which is dropped inside a cell.

- (iii) Why is it not recommended to use metal material on a container of Leclanché cell?

It is not recommended to use metal materials on a container of Leclanché cell to avoid corrosion when it interact with sal-ammoniac solution.

Extract 3.2: A sample of good responses to Question 3

In Extract 3.2, the student demonstrated competence in providing a well labelled diagram of a simple cell and gave reasons for modifying a simple primary cell in 3(a) (i) and (ii), respectively. He/she identified the materials used in the construction of a simple cell electrode and the instrument used to measure the specific gravity of the battery.

2.2.2 Question 4: DC Circuit

The question intended to assess the student's ability to understand, differentiate and analyses the behaviour and properties of electrical circuits in series and parallel configurations. It was constructed as follows;

You are provided with two circuits, one is connected in series and the other in parallel. What are the five key points which distinguish the two circuits?

The question was attempted by 412 (100%) students, and their scores were as follows: 113 (27.40%) scored from 0 to 2.5 marks, 198 (48.10%) scored from 3 to 6.5 marks, and 101 (24.50%) scored from 7 to 10 marks. Figure 4 summarizes the students' performance on this question.

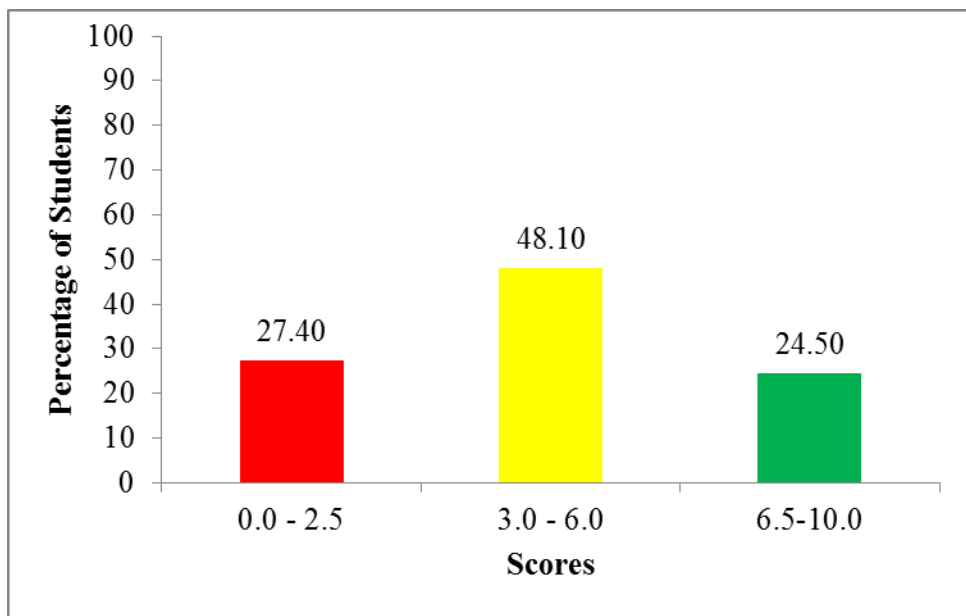


Figure 4: *The Students' Performance in Question 4*

The students' general performance on this question was good, as statistical analysis reveals that 299 (72.60%) of the students passed. This indicates that they had sufficient knowledge of the concepts related to DC circuits, which enabled them to differentiate and analyses the behaviour and properties of electrical circuits in series and parallel configurations. Extract 4.1 illustrates the students' performance.

4. You are provided with two circuits, one is connected in series and the other in parallel. What are the five key points which distinguish the two circuits?

- (a) Connection: In parallel the connection of components are connected between two common point WHILE in series the component are connected end to end.
- (b) Voltage: In parallel connection the voltage is the same in each component WHILE in series the voltage is different in each component.
- (c) Current: In parallel connection the current is changed in each component WHILE in series circuit each component have the same current.
- (d) Resistance: In parallel circuit the resistance is reduced WHILE in series connection the equivalent resistance is increasing.
- (e) In parallel connection there is no interference of another component when other damaged WHILE in series circuit there is interference of another component when one among them becomes damaged.

Extract 4.1: A sample of good responses to Question 4

Extract 4.1 shows that the student correctly differentiated between series and parallel circuit connections.

However, the analysis indicates that 113 (27.40%) of the students performed poorly. This indicates that they lacked knowledge of the concepts assessed in the *DC Circuit*. Examples of incorrect responses from some of the students are; "If one device fails in a parallel circuit, the whole circuit stops working," "The total resistance in a parallel circuit is the sum of the resistances of all devices," "Voltage is the same across all devices in a series circuit," and "Current is divided in a series circuit.". Extract 4.2 shows a sample of poor responses provided by one of the students.

4. You are provided with two circuits, one is connected in series and the other in parallel. What are the five key points which distinguish the two circuits?

(a)	It is in series connection.	It is parallel connection.
(b)	The series connected on cell, it depend to another cell.	But this parallel this is not depend in each other.
(c)	It is measure by higher voltage.	It is measure by small voltage.
(d)	It is easy to get shocked.	It is not easy to get accident.
(e)	It is used in small area.	It is used in large area.

Extract 4.2: A sample of incorrect responses to Question 4

Extract 4.2 shows that the student wrongly distinguishes series and parallel circuits based on cross-sectional area (series circuit in small area and parallel circuit in large area). Also, he/she stated that “*in parallel circuit it is easy to get accident*” which is wrong. The student failed to understand that all electric circuits are hazardous regardless of the mode of connection (series or parallel). Generally, the student lacked understanding of how voltage and current behave in series and parallel circuits.

2.2.3 Question 5: Electrical Draughting

This question was designed to measure the students' knowledge on the use of drawing tools and geometric construction competence. The question was as follows:

Construct the following triangles and indicate the values of the angles of each triangle.

- Triangle ABC whereby $AB = 52 \text{ mm}$, $BC = 45 \text{ mm}$ and $AC = 35 \text{ mm}$.
- Triangle DEF whereby $DE = 40 \text{ mm}$, $EF = 50 \text{ mm}$, $DF = 20 \text{ mm}$.

A total of 412 (100%) students attempted this question. Out of those, 170 (41.30%) scored from 0 to 2.5 marks, 135 (32.70%) scored from 3 to 6.5 marks, and 107 (26.00%) scored from 7 to 10 marks. The general performance was average, since 242 (58.70%) of them scored above the marginal level of fail. Figure 5 illustrates their performance on this question.

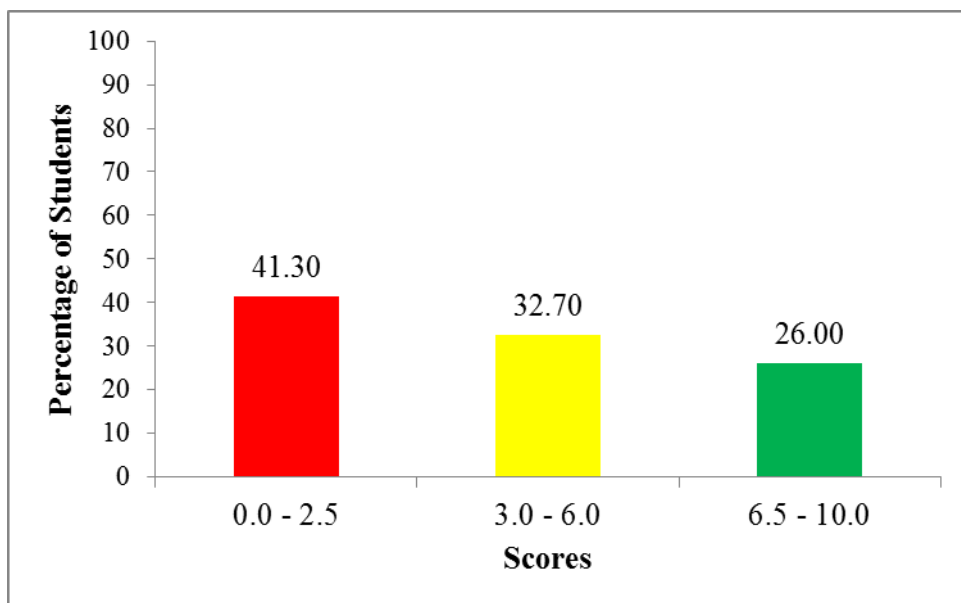
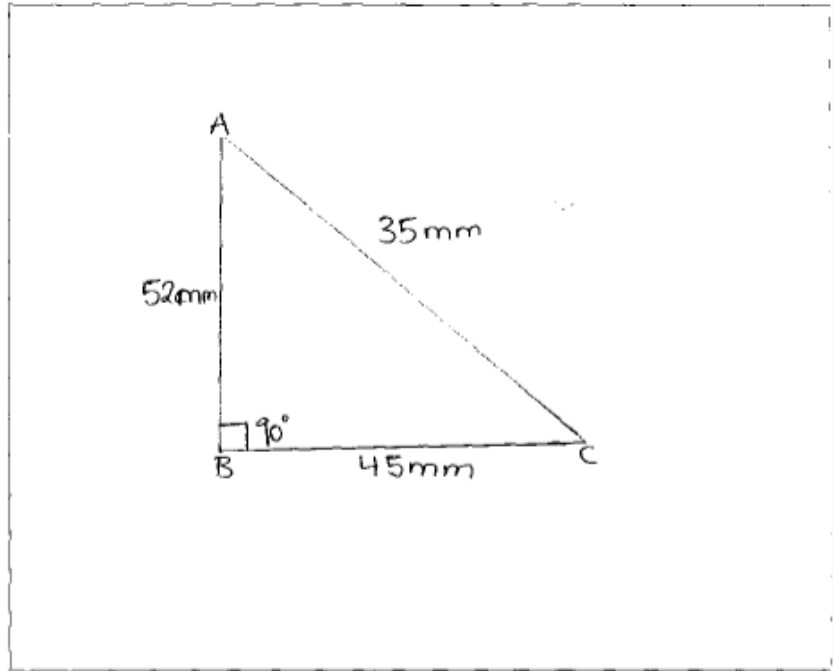


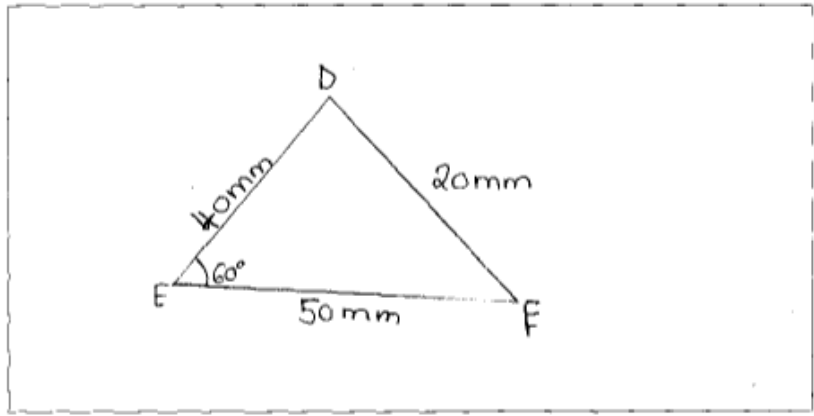
Figure 5: *The Students' Performance in Question 5*

The analysis of students' responses shows that 41.30 per cent of the students had poor performance. Most of them failed to construct the given triangles as well as indicating their values. This suggests that the students lacked knowledge about basic drawing techniques and practices. For example, one of the students constructed the triangle with incorrect angle values due to imprecise measurements of a protractor. Some students guessed the angles of the drawn triangles instead of measuring them. Extract 5.1 is a sample of the incorrect responses to the question.

5. Construct the following triangles and indicate the values of the angles of each triangle.
(a) Triangle ABC whereby $AB = 52 \text{ mm}$, $BC = 45 \text{ mm}$ and $AC = 35 \text{ mm}$.



- (b) Triangle DEF whereby $DE = 40 \text{ mm}$, $EF = 50 \text{ mm}$, $DF = 20 \text{ mm}$.



Extract 5.1: A sample of incorrect responses to Question 5

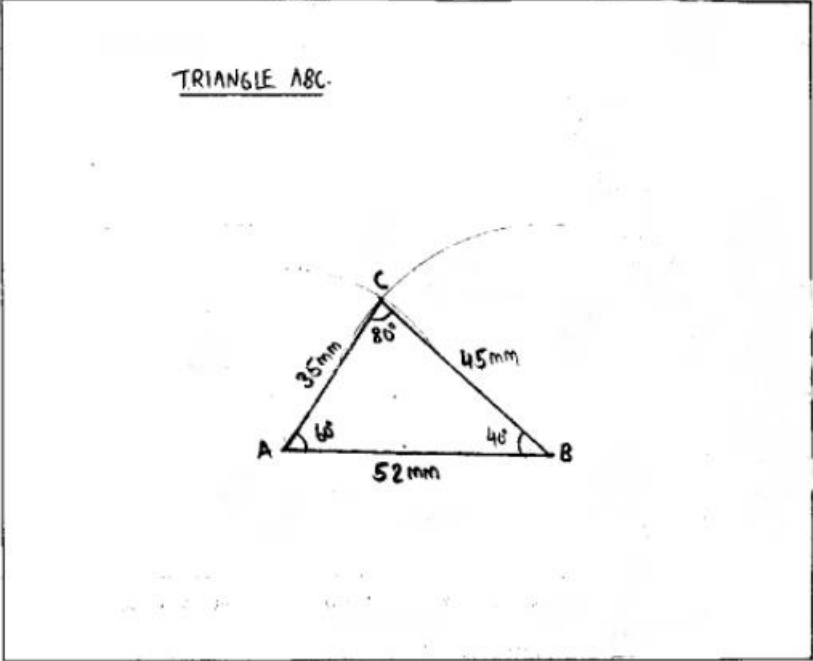
In Extract 5.1, the student drew a right-angled triangle in part (a), which was wrong because the given dimensions of the sides of the triangles cannot make a right angle in any of its angles formed. In part (b), the student misaligned the sides, resulting in a distorted triangle with incorrect angle values.

However, 58.70 percent of students performed well and scored average marks and above. This indicates that they had sufficient knowledge of the concepts of *Electrical Draughting*. They demonstrated several abilities, reflecting their competence in geometry, including the ability to use tools in constructing triangles. Extract 5.2 shows a sample of good responses provided by one of the students.

5. Construct the following triangles and indicate the values of the angles of each triangle

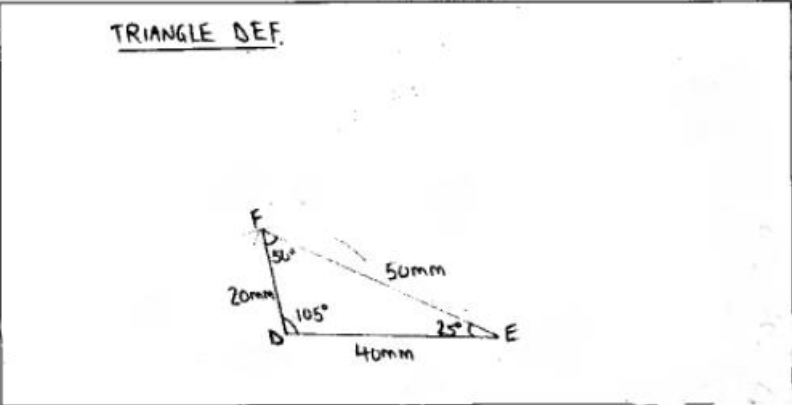
(a) Triangle ABC whereby $AB = 52 \text{ mm}$, $BC = 45 \text{ mm}$ and $AC = 35 \text{ mm}$.

TRIANGLE ABC.



(b) Triangle DEF whereby $DE = 40 \text{ mm}$, $EF = 50 \text{ mm}$, $DF = 20 \text{ mm}$.

TRIANGLE DEF.



Extract 5.2: A sample of correct responses to Question 5

In Extract 5.2, the student demonstrated the ability to draw the types of triangles as instructed in the question. Also, he/she showed mastery of using drawing tools correctly to measure the side lengths and angles to ensure an accurate construction.

2.2.4 Question 6: Instruments and Measurements

The question comprised of two parts, (a) and (b), and intended to assess the students' understanding on electrical circuits, specifically the ability to identify and correctly connect components like voltmeter, ammeter, resistive load, and power supply in a protected circuit. The question was set as follows:

- (a) *You are provided with voltmeter, ammeter, resistive load, connecting leads and 12 V.d.c power supply. Draw a protected circuit diagram showing the connection of the provided instruments.*
- (b) *If the ammeter and voltmeter read 0.5 A and 4.2 V respectively, calculate the:*
 - (i) *Load resistance.*
 - (ii) *Power dissipated at the load.*

This question was attempted by 412 (100%) students. Out of them, 17 (4.10%) scored from 0 to 2.5 marks, 79 (19.20%) scored from 3 to 6.5 marks and 316 (76.70%) scored from 7 to 10 marks. The general performance was good since 395 (95.90%) of them scored from 3 to 10 marks. These trends of performance verify that a significant number of students had good performance. Figure 6 summarizes the students' performance on this question.

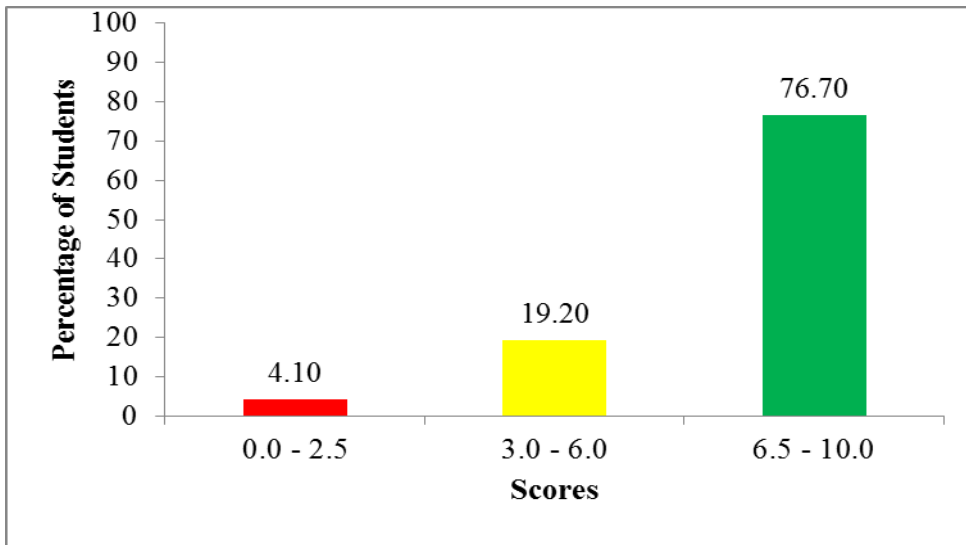
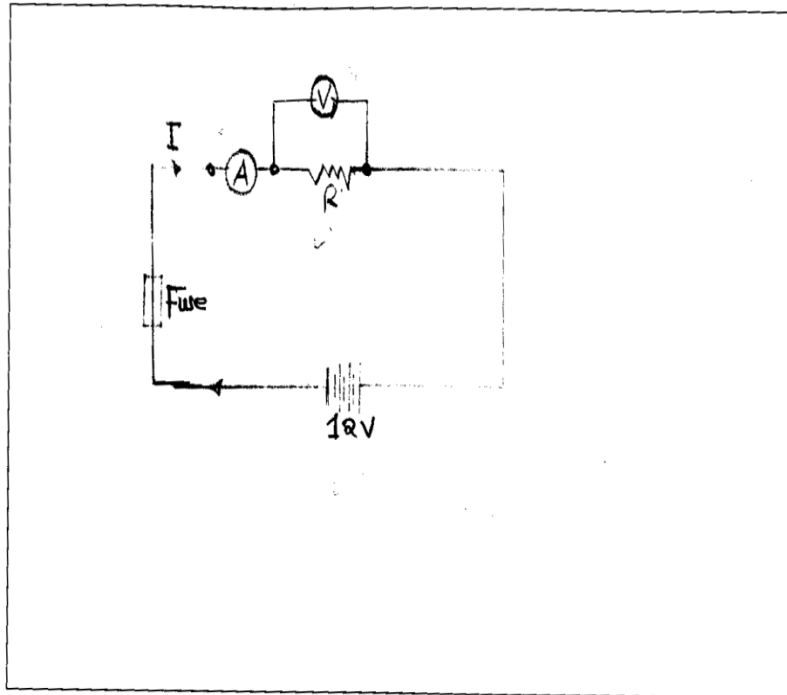


Figure 6: *The Students' Performance in Question 6*

Figure 6 depicts that the performance on this question was good. Statistical analysis reveals that 95.90 percent of the students scored average marks and above. Most of the students in this category demonstrated their ability to draw the asked circuit diagram and positioned the meters correctly. Also, they calculated the value of load resistance and power dissipated at the load as per question demand. Extract 6.1 provides a sample of such responses.

6. (a) You are provided with voltmeter, ammeter, resistive load, connecting leads and 12 V d.c power supply. Draw a protected circuit diagram showing the connection of the provided instruments.



- (b) If the ammeter and voltmeter read 0.5 A and 4.2 V respectively; calculate the:
 (i) Load resistance.

Data
 Voltage = 4.2V
 Current = 0.5A
 from

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

$$R = \frac{V}{I} \dots \text{(Voltage)}$$

$$R = \frac{4.2V}{0.5A}$$

$$R = \frac{42}{5}$$

∴ Load resistance is 8.4Ω

(ii) Power dissipated at the load.

$$P = I^2 R \text{ or } \text{Power} = IV$$

$$\text{Power} = IV \cdot \begin{array}{l} \text{from} \\ I = \text{Current} \\ V = \text{Voltage} \end{array}$$

$$P = 4.2V \times 0.5A$$

$$P = 2.1 \text{ watts}$$

$$\text{Power} = 2.1 \text{ watts}$$

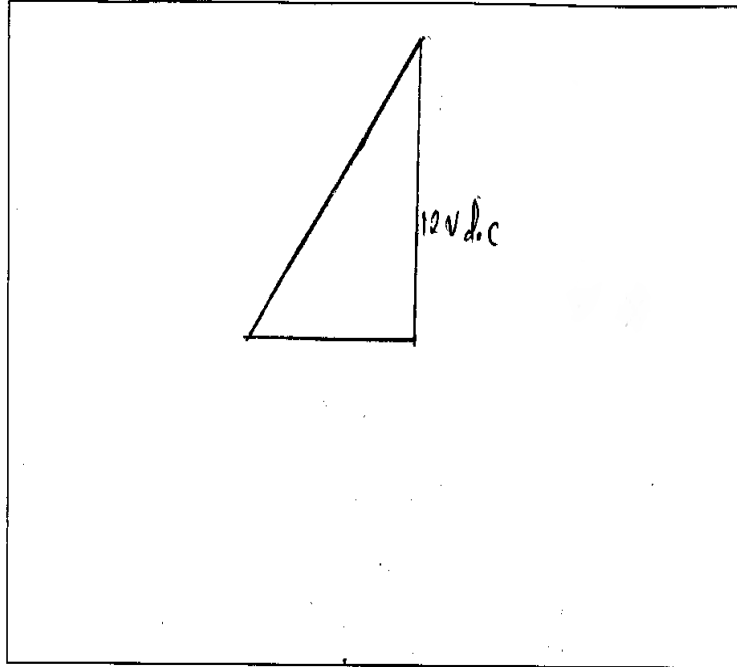
\therefore Power dissipated is 2.1 watts

Extract 6.1: A sample of correct responses to Question 6

In Extract 6.1, the student accurately drew a protected circuit diagram with the required connections in part (a). Additionally, the student correctly calculated the load resistance and the power dissipated in the load in parts (b)(i) and (b)(ii), respectively.

However, the analysis reveals that 17 (4.10%) of students performed poorly. This suggests that they lacked knowledge in *Instruments and Measurements* particularly the roles and proper placement of instruments in a circuit. Most of them failed to connect the voltmeter and ammeter in the appropriate positions. Extract 6.2 demonstrates the incorrect response to question 6.

6. (a) You are provided with voltmeter, ammeter, resistive load, connecting leads and 12 V d.c power supply. Draw a protected circuit diagram showing the connection of the provided instruments.



- (b) If the ammeter and voltmeter read 0.5 A and 4.2 V respectively; calculate the:
 (i) Load resistance.

Soln.

0.5 A
 4.2 V

Form

$$\frac{V}{A} = \frac{4.2}{0.5}$$

$$\begin{array}{r} 84 \\ 5 \overline{) 42} \\ \underline{40} \\ 20 \end{array} = 8.4 \text{ V.}$$

(ii) Power dissipated at the load.

Soln

0.5
4.2

Form $\frac{A}{V}$

$$\begin{array}{r}
 84 \\
 42 \overline{) 0.5} \\
 \underline{40} \\
 20 \\
 \underline{20} \\
 0
 \end{array}$$

8.2 A

Extract 6.2: A sample of incorrect responses to Question 6

In Extract 6.2, the student provided something like a power triangle, which is a graphical representation of the relationship between the three types of power in an A.C. (alternating current) circuit. The student represented these three quantities as sides of a right triangle. This is contrary to what was required in part (a) of the question. Similarly, in part (b)(i), he/she used an incorrect formula, $\frac{V}{A}$, instead of $I \times R$, to calculate voltage, and in (b)(ii),

he/she used the formula, $\frac{A}{V}$, instead of $I \times V$ or $\frac{V^2}{R}$, to calculate Power dissipated at the load. Where: **V** is the voltage (in volts), **I** is the current (in amperes), and **R** is the resistance (in ohms).

2.2.5 Question 7: Magnetism and Electromagnetism

The question assessed the students' comprehension of fundamental concepts related to types of magnets and their properties as well as differences between magnetic and electric circuits. It also intended to evaluate students' ability to calculate the force exerted by a moving conductor. This question had two parts, (a) and (b), and was set as follows:

- (a) (i) *Why is permanent magnet mostly used in various equipment over temporary magnet? Give two reasons.*

(ii) *What are the differences between magnetic and electric circuit?
Give three differences.*

(b) *A conductor of length 5 cm is kept in a magnetic field having the flux density of 1.8 Tesla. If the current flowing is 0.8 A, calculate the maximum force exerted by a conductor.*

This question was attempted by 412 (100%) students. Out of them, 108 (24.50%) scored from 0 to 2.5 marks, 216 (52.40%) scored from 3 to 6.0 marks and 95 (23.10%) scored from 6.5 to 10 marks. These trends of performance verify that students' performance was good since 75.50 percent of students passed. Figure 7 summarizes the students' performance on this question.

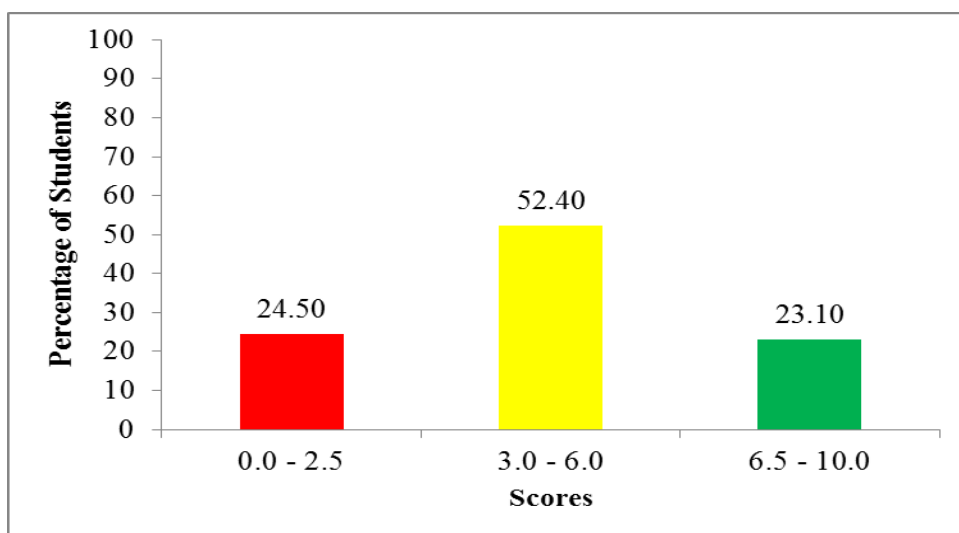


Figure 7: *The Students' Performance in Question 7*

The analysis of the students' performance in this question indicates that 311 (75.50%) of students performed well. These students demonstrated to have adequate knowledge of *Magnetism and Electromagnetism*. Majority clearly distinguished the properties of permanent over temporary magnets. Also, they revealed competence in using relevant formulas to solve numerical problems accurately. Extract 7.1 shows a sample of good responses from one of the students.

7. (a) (i) Why is permanent magnet mostly used in various equipment over temporary magnet? Give two reasons.

- Because It produce strong magnetic field that generates the force stronger.
- Because It is more sensitivity than temporary magnet.

(ii) What are the differences between magnetic and electric circuit? Give three differences.

Magnetic circuit	Electric circuit.
The force is called Magnetomotive Force.	The force is called Electromotive force.
Is the flow of magnetic flux.	Is the flow of electric current.
Magnetic field strength.	Electric field strength.

(b) A conductor of length 5 cm is kept in a magnetic field having the flux density of 1.8 Tesla. If the current flowing is 0.8 A; calculate the maximum force exerted by a conductor.

Solution.

Given. Length of conductor = 5 cm = 0.05 m.
Flux density = 1.8 Tesla.
Current = 0.8 A.

Required the maximum force.
then. From.

$$F = BIL$$
$$F = 1.8 \times 0.8 \times 0.05 \text{ (N)}$$
$$F = 144 \times 0.05 \text{ (N)}$$
$$F = 0.0720 \text{ N}$$
$$F = 72 \text{ mN}$$

Therefore the maximum force exerted by a conductor is 72 mN.

Extract 7.1: A sample of good responses to Question 7

Extract 7.1 shows that, the student provided a correct response in all parts of the question, demonstrating sufficient knowledge of the concepts tested in Magnetism and Electromagnetism.

However, 101 (24.50%) students performed poorly and scored below average marks. This indicates that they had insufficient knowledge related to *Magnetism and Electromagnetism*. Poor responses provided by the students might be due to misconception, partial knowledge, or errors in applying theoretical concepts and formulas. Also, poor unit conversion skills or neglecting SI units led to inaccurate results for some of the students. Extract 7.2 presents a sample of poor responses provided by one of the students.

7. (a) (i) Why is permanent magnet mostly used in various equipment over temporary magnet? Give two reasons.

- Circuit
- Electricity Shock

(ii) What are the differences between magnetic and electric circuit? Give three differences.

- All resistor will have the voltage
- All resistor will have the power loss
- All resistor will have the some energy

(b) A conductor of length 5 cm is kept in a magnetic field having the flux density of 1.8 Tesla. If the current flowing is 0.8 A; calculate the maximum force exerted by a conductor.

length 5cm
density 1.8
Ammeter 0.8A
soln

$$\frac{R_1 + R_2 + R_3}{R_1 - R_2 - R_3} = \frac{1.8 - 0.8A}{1.0A}$$

$$= 1.0A - 5cm$$

$$= 1.5cm$$

= density of 1.5cm

Extract 7.2: A sample of incorrect responses to Question 7

Extract 7.2 reveals that the student lacked sufficient understanding of the concepts tested in the topic of *Magnetism and Electromagnetism*. The student answered part (a)(i) using terms remembered from electrical engineering, which were incorrect in this context. Likewise, he/she relied on alternatives from question 1(ii) as answers in part (a)(ii). In part (b), he/she used an unrelated formula to calculate the force exerted by a conductor.

2.2.6 Question 8: DC Circuit

The question tested the student's understanding of the essential components required for constructing an electric circuit and the ability to apply safety precautions during electrical repair and maintenance tasks. The question was as follows:

- (a) *Identify five necessary components you would use for making an electric circuit and in each give its significance.*
- (b) *Suppose you are a technician assigned to make a major repair of the reception room at your school. What safety precautions will you adhere to when dealing with each of the following?*
 - (i) *Insulated tools.*
 - (ii) *Sharp edge tools.*
 - (iii) *Chisel.*
 - (iv) *Tools which have handle.*
 - (v) *After using tools.*

A total of 412 (100%) students attempted this question. Out of them, 31 (7.30%) scored from 0 to 2.5 marks, 147 (35.70%) scored from 3 to 6.0 marks, and 235 (57.00%) scored from 6.5 to 10 marks. Figure 8 provide a summary of the students' performance in this particular question.

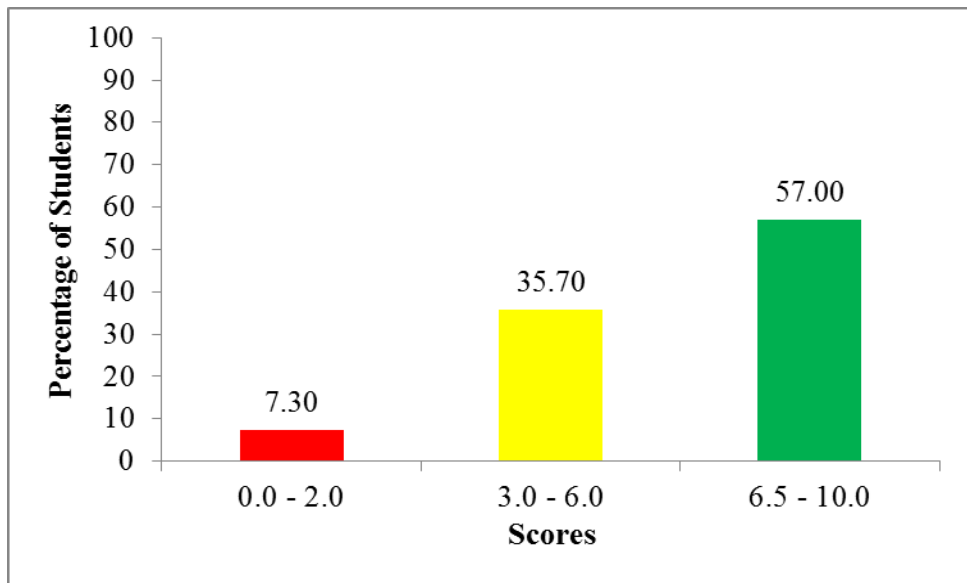


Figure 8: *The Students' Performance in Question 8.*

The analysis of the students' performance verifies that the overall performance of the students in this question was good because 382 (92.70%) of students scored from 3 to 10 marks. This indicates that they had adequate knowledge of the concepts related to *DC Circuits* as shown in Extract 8.1.

8. (a) Identify five necessary components you would use for making an electric circuit and in each give its significance.
- (i) Switch → It used to Control free flow of Current ~~and~~ within a Circuit.
 - (ii) Source Such as Battery or Cell
- Is used to produce Voltage and to Store charge in operation of circuit
 - (iii) Conductor (wire)
- Is used to allow the free flow of Current in the circuit
 - (iv) ~~used~~ fuse and earth ~~and~~ wire.
→ It use to protect the Circuit agoss an electrical fault.
 - (v) Load
→ Is Used to Consume the Electrical energy that produce in the source.
- Also most of the Load are Lamp and resistor that are used in the electric circuit.
- (b) Suppose you are a technician assigned to make a major repair of the reception room at your school. What safety precautions will you adhere to when dealing with each of the following?
- (i) Insulated tools
- Dont use ununsulated tools on the live Circuit
- Dont use with ~~the~~ wet hands during use it
 - (ii) Sharp edge tools
- Dont put pointer toward others during Use it.
- dont use for driving and tightening nails and other object.
 - (iii) Chisel
- Dont put on your pocket
- Dont use chisel for Cramping and grinding
 - (iv) Tools which have handle
- Dont use ~~any~~ insulated tools in the presrent of Current flow
- Dont use tolls which have handle with your wet hand.
 - (v) After using tools
→ Dont live any machine while are operate
→ Dont live any tools through down make sure you keep all tools clear.

Extract 8.1: A sample of good responses to Question 8

In Extract 8.1, the student correctly identified the necessary components of an electric circuit and outlined the safety precautions to follow when using tools and equipment during practical work.

Analysis shows that few 30 (7.30%) of students performed poorly as they scored from 0 to 2.5 marks. These students had insufficient knowledge of the concepts related to *DC Circuits*. Some of the students provided incorrect components for making an electric circuit by giving answers such as bulb, capacitor and motor. These students could not understand the core components of an electric circuit. Also, the students, instead of explaining the safety precautions to observe when using the mentioned tools, they described the advantages of using those tools. For example, one of the students wrote, “Insulated tools can be used without any additional care; just use them normally”. Extract 8.2 provides a sample of such responses.

8. (a) Identify five necessary components you would use for making an electric circuit and in each give its significance.
- (i) It should consume low source of power so as to allow flow of charges in highly rate.
 - (ii) Using the knowledge of ohm's law which takes part at the centre of the circuit which flows with above.
 - (iii) The use of magnetic field so as to help the production of electromagnetism to the flow of electricity easily.
 - (iv) Using appropriate energy which is produced through friction of magnet and electricity.
 - (v) Observing appropriate materials to design / making like fuse, wires and cathodes to facilitate input.
- (b) Suppose you are a technician assigned to make a major repair of the reception room at your school. What safety precautions will you adhere to when dealing with each of the following?
- (i) Insulated tools
Avoid direct transportation of electricity because it allows the flow of electricity.
 - (ii) Sharp edge tools
Being carefully and concentrate on the activity your conduct. my because it may cause accident.
 - (iii) Chisel
Using it in only one use which is removing sharp edges on a metal conduit / Being carefully when cutting the sharp edges to avoid accident.
 - (iv) Tools which have handle
Holding it at highly concentration / Holding it in clearly way to avoid it to broke down.
 - (v) After using tools
Returning on its original position to avoid accident / Keep it in a right position.

Extract 8.2: A sample of incorrect responses to Question 8

In Extract 8.2, the student failed to provide correct responses to each part of the question. In part (a), the student did not correctly identify five necessary components for making an electric circuit, nor did they provide clear explanations of their significance. In part (b), the student did not provide appropriate safety precautions for each of the listed tools.

2.2.7 Question 9: Electricity

The question aimed to assess students' understanding of the properties and advantages of copper conductors over aluminium, knowledge on electrical parameters like resistivity and current density, and the ability to apply formulas to calculate the resistance and current-carrying capacity of a conductor. The question was as follows:

- (a) *An electrical contractor planned to do wiring of a house by using aluminium conductors. Provide four facts which will convince a contractor to use copper conductors instead.*
- (b) *If a copper conductor used in (a) has a length of 100 m, cross – section area of 50 mm², current density of 40 A/cm² and resistivity of 1.7 μ – Ω – cm; Calculate:*
- (i) *Resistance of a conductor.*
- (ii) *Current carrying capacitor of a conductor.*

This question was attempted by 412 (100%) students. Out of them, 267 (64.80%) scored from 0 to 2.5 marks, 129 (31.30%) scored from 3 to 6.5 marks, and 16 (3.90%) scored from 7 to 10 marks. Figure 9 summarizes the students' performance in this question.

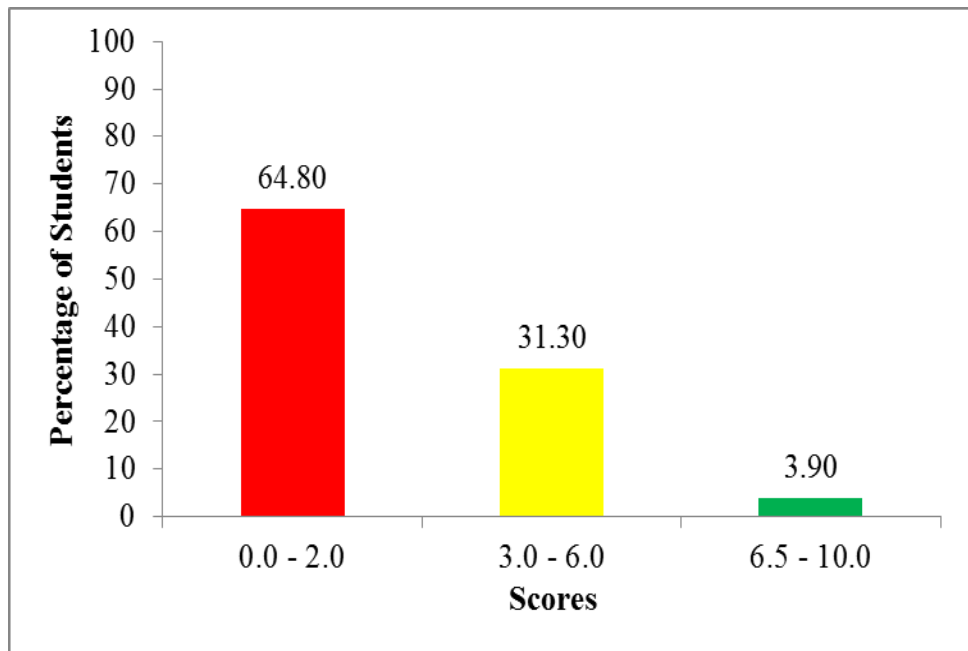


Figure 9: *The Students' Performance in Question 9*

The students' general performance in this question was average, as statistical analysis reveals that 154 (35.20%) of the students scored average marks and above. These students responded correctly to some of the items and partially to a few items, which demonstrated satisfactory understanding of the concept of electricity. Extract 9.1 presents good responses from one of the students.

9. (a) An electrical contractor planned to do wiring of a house by using aluminium conductors. Provide four facts which will convince a contractor to use copper conductors instead.

- Copper conductor has high conductivity of electricity than aluminium conductors.
- Copper conductor has high temperature coefficient which allow change of resistance with increase in temperature.
- Copper conductor are not easy to be affected by other physical condition such as humidity, temperature and pressure.
- Copper conductor are durable since they are very strong and hard this cause to sustain for long time being installed.

(b) If a copper conductor used in (a) has a length of 100 m, cross – section area of 50 mm², current density of 40 A/cm² and resistivity of 1.7 μΩ – cm; Calculate:

- Resistance of a conductor.

<p><u>Solution</u> <u>Data given</u> length (L) = 100 m Cross sectional area (A) = 50 mm² Current density = 40 A/cm² Resistivity (ρ) = 1.7 μΩ cm Resistance = ?</p> <p><u>From</u>; $R = \frac{\rho L}{A}$</p> $R = \frac{1.7 \mu\Omega \text{ cm} \times 100 \text{ m}}{50 \text{ mm}^2}$ $R = \frac{1.7 \times 10^{-6} \Omega \text{ cm} \times 10000 \text{ cm}}{50 \times 10^{-6} \text{ cm}^2}$ $R = \frac{1.7 \times 10^{-6} \Omega \text{ cm} \times 10^4 \text{ cm}}{50 \times 10^{-2} \text{ cm}^2}$	$R = \frac{1.7 \times 10^{-3} \Omega \text{ cm}^2}{5 \times 10^{-1} \text{ cm}^2}$ $R = 0.34 \times 10^{-1} \Omega$ $R = 0.034 \Omega$ <p>∴ Resistance of a conductor is 0.034 Ω</p>
--	--

- Current carrying capacitor of a conductor.

<p><u>Solution</u> <u>Data given</u> Current density = 40 A/cm² Cross sectional area (A) = 50 mm² Current (I) = ?</p> <p><u>From</u>, Current density = $\frac{\text{Current}}{\text{Area}}$</p> $40 \text{ A/cm}^2 = \frac{\text{Current (I)}}{50 \text{ mm}^2}$ $I = 40 \text{ A/cm}^2 \times 50 \times 10^{-6} \text{ m}^2$ $I = 2000 \times 10^{-2} \text{ A} = 20 \text{ A}$ <p>∴ The Current carrying capacitor of conductor is 20 Ampere.</p>

Extract 9.1: A sample of good responses to Question 9

The responses in Extract 9.1 indicate that the student acquired sufficient knowledge of the concept *Electricity*. He/she provided the reasons for choosing copper in domestic electrical installation and demonstrated computational skills in finding the values of the resistance and current carrying capacity of a conductor by applying the correct conversions and formulas.

Furthermore, the analysis shows that 16 (3.90%) of the students performed below average. This indicates that these students had little knowledge of concepts tested in *Electricity*, especially understanding about material properties such as resistivity and thermal conductivity. Also, they lacked knowledge of unit conversion and formula application. Extract 9.2 shows a sample of incorrect responses by one of the students.

9. (a) An electrical contractor planned to do wiring of a house by using aluminium conductors. Provide four facts which will convince a contractor to use copper conductors instead.

- (i) Copper it is a good conductor while Aluminium it is a bad conductor.
- (ii) Copper it allow high amount of current to pass while Aluminium does not allow high amount to pass.
- (iii) Copper it has high resistance of electricity while Aluminium has low resistance of electricity.

(b) If a copper conductor used in (a) has a length of 100 m, cross - section area of 50 mm², current density of 40 A/cm² and resistivity of 1.7 μ-Ω-cm; Calculate:

(i) Resistance of a conductor.

<p><u>Data given:</u> 100m - Length 50mm² - Area 40A/cm² - Density resistivity - 1.7μ-Ω-cm</p>	<p>$R = \frac{1.7 \times 10}{2.5 \times 10}$</p> <p>$R = \frac{17}{25}$</p> <p>$R = 0.68$</p>
<p>$R = \frac{V}{I}$</p> <p>$R = \frac{V}{2.5}$</p> <p>$\frac{R \times I}{1} = \frac{17}{2.5}$</p>	<p>\therefore The resistance of a conductor is <u>0.68 Ω</u></p>

(ii) Current carrying capacitor of a conductor.

<p>$I = \frac{40 \times 100}{40}$</p> <p>$I = 2.5$</p> <p>$\therefore$ The current carrying capacitor of a conductor is <u>2.5 ampere.</u></p>

Extract 9.2: A sample of incorrect responses to Question 9

In Extract 9.2, the student failed to provide relevant reasons for choosing copper over aluminium in domestic installations, as requested in part (a). The student wrote, "Aluminium is a poor conductor of electricity," which is incorrect since aluminium is a good conductor of electricity, though not as efficient as copper. Also, he/she claimed that copper allows more current to flow through, while aluminium does not. This is also not correct because the current-carrying capacity of a wire depends on its cross-sectional area and not solely on the material. Additionally, the student wrote, "Copper has high resistance," which is incorrect because copper has very low resistance compared to aluminium. Additionally, in part (b)(i), the student incorrectly applied Ohm's Law $\left(R = \frac{V}{I}\right)$ to calculate the resistance of the conductor instead of using the correct formula $\left(R = \frac{\rho l}{A}\right)$. In part (b)(ii), the student calculated the current-carrying capacity by dividing the length of the conductor by the current density (Length \div Current Density) instead of multiplying the cross-sectional area by the current density (Current Density \times Cross section area). These responses indicate that the student lacked sufficient knowledge and skills of the concepts assessed in *Electricity*, particularly conductivity, resistance and current-carrying capacity.

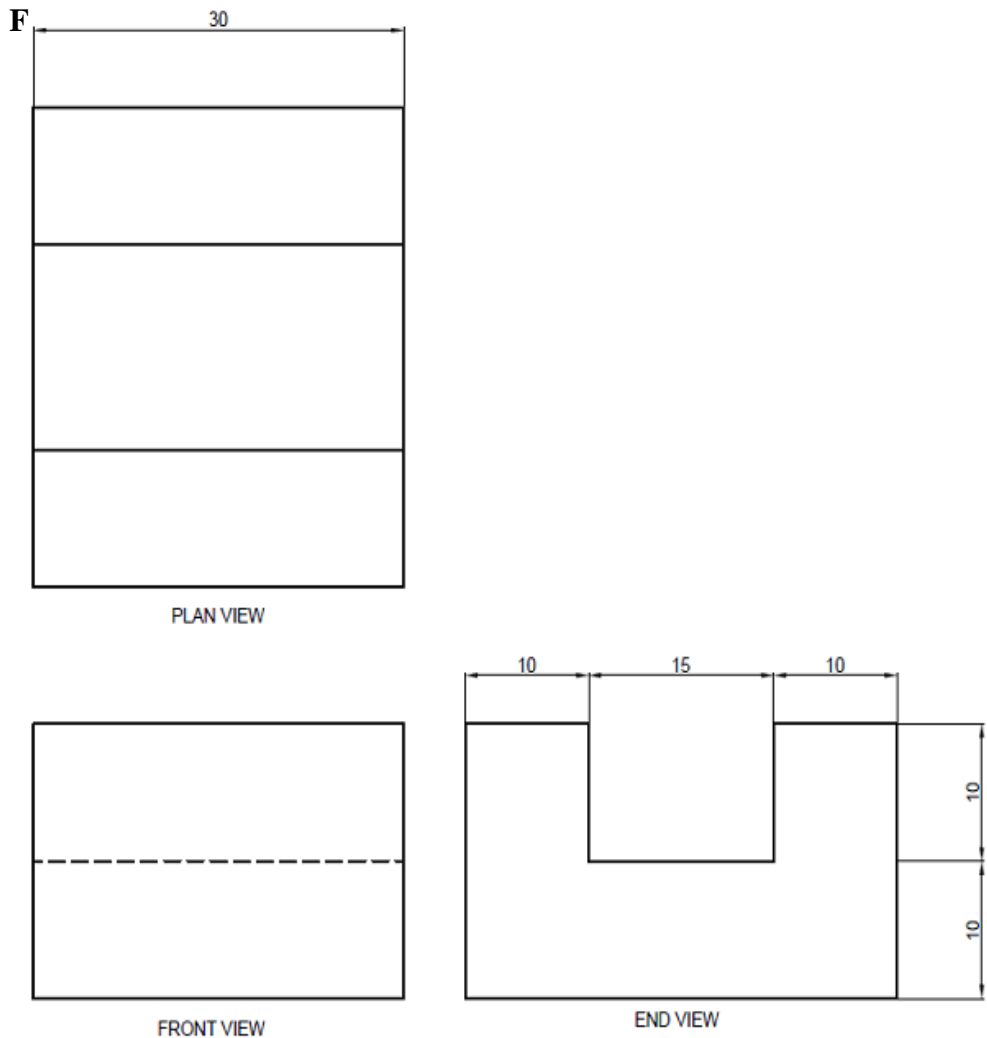
2.3 SECTION C: STRUCTURED QUESTION

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 skills in electrical drawing and isometric projections. Specifically, it evaluates their ability to interpret and visualise two-dimensional views (such as front, end, and plan) and accurately translate them into a three-dimensional isometric drawing in full-scale size. The question was as follows:

Draw an isometric drawing of the views shown in the given figure in full scale size. All dimensions are in millimeters and construction lines must not be erased.



This question was attempted by 412 (100%) students. Analysis indicates that 171 (41.50%) of the students scored from 0 to 4 marks; 69 (16.80%) scored from 4.5 to 9.5 marks; and 172 (41.70%) scored from 10 to 15 marks. Figure 10 summarizes overall students' performance in this question.

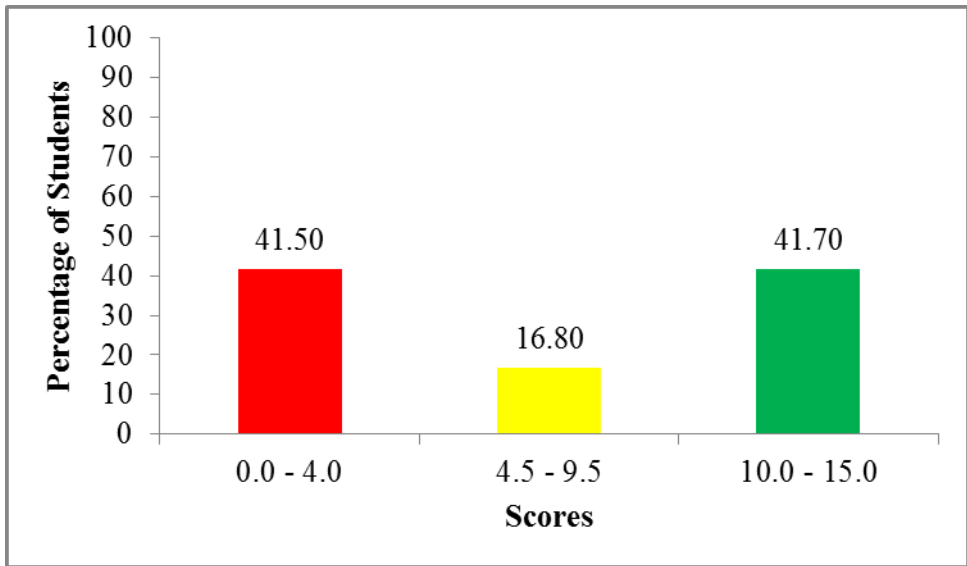
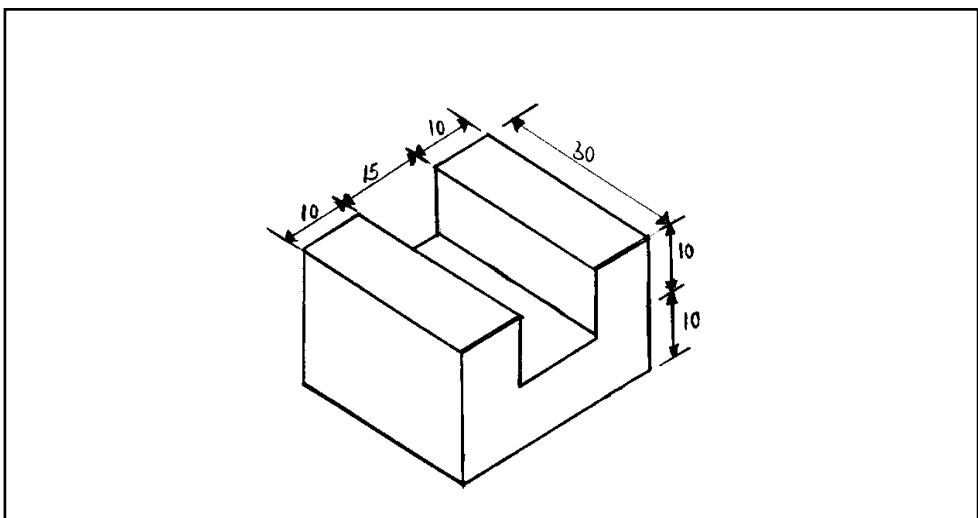


Figure 10: *The Students' Performance in Question 10*

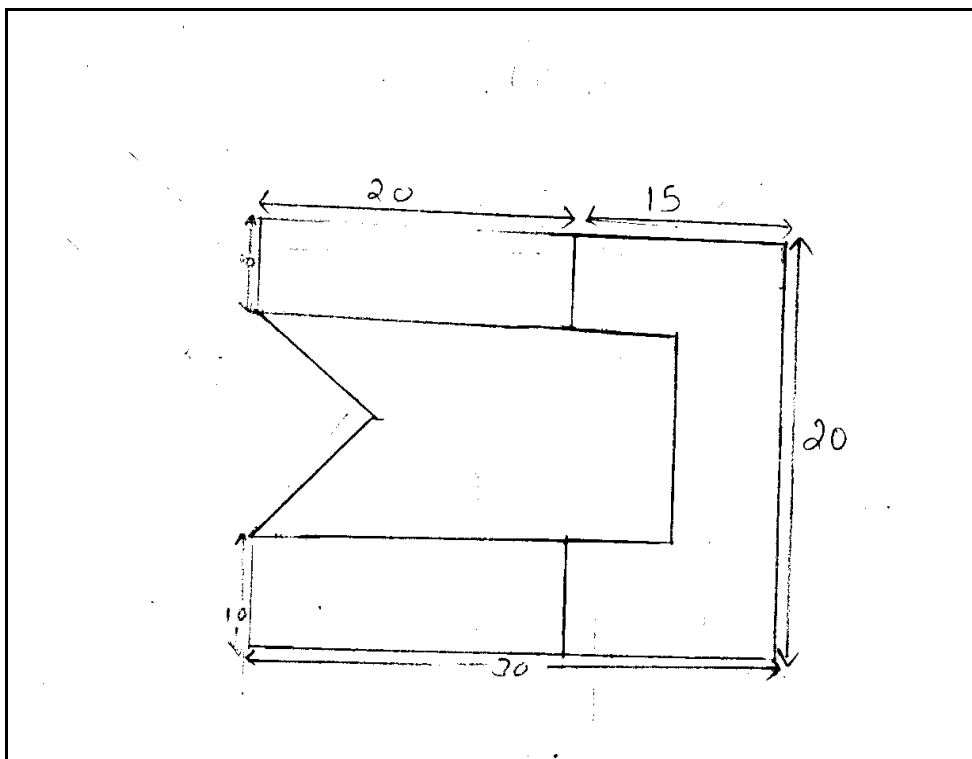
The students' general performance in this question was average, as statistical analysis reveals that 241 (58.50%) of the students scored average marks and above. Most of the students in this category demonstrated their ability to interpret the given views and draw them in isometric projection. Also, they showed competence in applying geometric construction techniques, including using construction lines effectively without erasing them as requested in the question. Extract 10.1 shows a sample of good responses from one of the students.



Extract 10.1: A sample of correct responses to Question 10

In Extract 10.1, the student demonstrated to have a good understanding of *Electrical Draughting*. In Extract 10.1, the student successfully produced an isometric drawing in full-scale size from the given views (end, plan and front) with the correct dimensions as required. This indicates that the student possessed sufficient knowledge and skills about *Electrical Draughting*.

However, it was observed that some students 171 (41.50%) performed poorly on this question as they were unable to produce the three-dimensional drawing (isometric drawing in full size) with the correct dimensions as required. They also struggled to use the drawing tools correctly and to interpret the two-dimensional views into three-dimensional drawing, leading to incorrect placement or orientation of features in the isometric drawing. This suggests that these students had partial knowledge on orthographic projection drawings. Extract 10.2 provides an illustrative example.



Extract 10.2: A sample of incorrect responses to Question 10

In Extract 10.2, the student drew the diagram incorrectly. He/she lacked knowledge and skills of isometric projection rules, accuracy in transferring dimensions, proficiency with drawing tools, and the ability to interpret two-dimension views correctly and convert them into objects.

3.0 THE STUDENT'S PERFORMANCE ON EACH TOPIC

The analysis of the student's performance in the topics that were assessed in the Electrical Engineering subject for the year 2024 indicates that the students performed well on *Instruments and Measurements* (96.85%), tested in Questions 2 and 6, *DC Circuits, Electricity, Electrical Engineering Science and Technology, Electrical Draughting, Electrical Workshop Orientation, Instruments and Measurements, Magnetism and Electromagnetism, Units, and Workshop Practice* (87.40%), tested in Question 1, which comprised 10 multiple choice items. *DC Circuits* (82.65%) tested in Questions 4 and 8, and *Magnetism and Electromagnetism* (75.50%) tested in Question 7. The good performance on these topics signifies that the students had sufficient knowledge, skills and competence in the concepts assessed. Also, it signifies that they were keen on following the assessment instructions and understanding the demands of the questions. These students had good mastery of the subject matter.

The topics on which the students had average performance were *Electrical Draughting* (60.68%) tested in Questions 5 and 10, *Cells and Batteries* (48.79%) tested in Question 3 and *Electricity* (34.07%) tested in Question 9. The average performance in these topics was attributed by some of the students failing to identify the requirements of the questions and incorrect application of calculation formulas. Moreover, some of them either gave correct points without satisfactory explanations or drawings, and some provided fewer points than those demanded by a particular question. None of the topics assessed had a weak performance. This indicates that the overall performance of students in the Electrical Engineering assessment was good.

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

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 CONCLUSION

The general performance of the students in Electrical Engineering subject for the Form Two National Assessment (FTNA) in the year 2024 was good. Out of the 412 students who sat for the paper, 345 (83.7%) passed, while 67 (16.3%) failed. Their good performance was attributed to their ability to understand the demands of the questions, sufficient knowledge, skills and competence in the subject matter, as well as their mastery of calculation and drawing skills.

However, several shortcomings have been revealed. These include the students' insufficient skills in responding to some of the questions, failure to understand the requirements of the questions, inability to interpret views related to electrical drawings, lack of practical skills, and inability to apply appropriate mathematical formulae in computations in the topics of *Electricity and Cells and Batteries*, which was averagely performed.

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 focus on learning diligently to enhance their knowledge, skills, and competence in the concepts outlined in the relevant subject syllabus.
- (b) Emphasis should be placed on competence-based teaching and learning in all topics. This approach will enable students to develop sufficient proficiency and mastery in the subject.
- (c) In the topic of *Electricity*, students should be guided to engage in extensive practice involving the application of calculation formulas to build their ability to answer questions requiring such skills. This method will help identify the challenges students face during assessments and provide effective

solutions to enhance their competence and ultimately achieve the intended objectives.

- (d) In the topic of *Cells and Batteries*, teachers should assess students' ability to connect batteries and cells through practical exercises rather than relying solely on theoretical teaching. Additionally, teachers should organize educational visits to manufacturing industries to experience real-world exposure and practical experience.
- (e) In the topic of *Electrical Drafting*, particularly isometric projection:
 - (i) Students should first be taught the basics of isometric drawings and how they differ from other projections, such as orthographic projections.
 - (ii) Students should be guided through the step-by-step process of creating isometric drawings, starting with simple objects.
 - (iii) Students should learn how to effectively use drawing tools such as set squares, compasses, and rulers.
 - (iv) Furthermore, teachers should identify and promptly address challenges students face, such as difficulty in using tools or understanding of projection concepts.

Appendix

A Summary of Students' Performance per Topic in the Electrical Engineering Subject for the year 2024

S/N	Topic	Question Number	Percentage of Students who Scored 30 Percent or above	Remarks
1.	Instruments and Measurements	2&6	96.85	Good
2.	DC Circuits, Electricity, Electrical Engineering Science and Technology, Electrical Draughting, Electrical Workshop Orientation, Instruments and Measurements, Magnetism and Electromagnetism, Units, and Workshop Practice	1	87.40	Good
3.	DC Circuits	4&8	82.65	Good
4.	Magnetism and Electromagnetism	7	75.50	Good
5.	Electrical Draughting	5&10	58.60	Average
6.	Cells and Batteries	3	49.00	Average
7.	Electricity	9	35.20	Average

