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) 2021

ELECTRICAL ENGINEERING

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080 ELECTRICAL ENGINEERING

Published by:
The National Examinations Council of Tanzania,
P. O. Box 2624,
Dar es Salaam, Tanzania.

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LIST OF SYMBOLS AND ABBREVIATIONS

D.C	Direct Current
e.m.f	Electromotive force
FTNA	Form Two National Assessment
mA	Milliampere
mWb	Milliweber
NECTA	National Examinations Council of Tanzania
P.D	Potential Difference
SIRA	Students' Items Response Analysis
V	Volt
W	Watt
Wb	Weber
Ω	Ohm

FOREWORD

The Form Two National Assessment (FTNA) is administered by the National Examinations Council of Tanzania (NECTA). It intends to show the effectiveness of the education system in particular as it is a formative evaluation of two years of instructional period of ordinary level of secondary education. The National Examinations Council of Tanzania is pleased to issue the Students' Item Response Analysis (SIRA) report in order to give feedback to students, teachers, examiners and other education stakeholders on the general performance, specific areas of weakness of the students and recommendations for improvement.

The report is based on the analysis of responses from students' scripts and statistical data. The students' responses on each question have been analysed and some of the factors which contributed to the observed students' performance have been identified. The factors which led to the students' poor performance include inability of the students to interpret the requirements of the questions, failure to apply correct formulae in solving problems and lack of enough knowledge and skills on various topics. These factors have been illustrated by using some extracts selected from the students' scripts.

The National Examinations Council of Tanzania hopes that the feedback provided in this report will be useful to education stakeholders. Also the suggestions and recommendations offered will enable them to take appropriate measures to enhance the teaching and learning strategies of the Electrical Engineering subject.

The National Examinations Council of Tanzania would like to thank various education stakeholders who devoted their time in providing important inputs that have been used to prepare this report.

Dr Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report presents a detailed analysis of the students' response on each question in the Electrical Engineering subject in the Form Two National Assessment (FTNA) 2021. The paper 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) which were set from the topics of *Cells and Batteries, D.C Circuits, Duties and Responsibilities of Electrical Engineering Personnel, Electrical Draughting, Electricity, Instruments and Measurements, Magnetism and Electromagnetism, Units, Tools and Accessories* and *Safety Management in Electrical Engineering Workshop.* Question 2 consisted of five matching items (i) to (v) set from the topic of *D.C Circuits.* The students were required to answer all items from this section. Each item carried 1 mark, to make a total of 15 marks.

Section B consisted of 7 short answer questions set from the topics of *DC Circuits, Workshop Practice, Instruments and Measurements, Electrical Draughting, Cells and Batteries* and *Magnetism and Electromagnetism*. The students were required to answer all questions from this section. Each question carried 10 marks, making a total of 70 marks.

Section C consisted of one structured question set from the topic of *Electrical Draughting* with a total of 15 marks.

A total of 437 students sat for the Electrical Engineering paper in the year 2021. Among them, 271 (62.0%) students passed while 166 (38.0%) failed. Thus, the performance of the students in the Electrical Engineering subject assessment in the year 2021 was average.

In the analysis, the performance is considered as ***weak*** if the percentage of students who scored from 30 percent of the total marks allocated to a particular question or topic lies from 00 to 29. The performance is considered ***average*** if the percentage of students who scored from 30 percent lies from 30 to 64. It is considered ***good*** if the percentage of students who scored from 30 percent is from 65 to 100. Red, Yellow and Green colours are used to represent weak, average and good performance respectively. The following section presents the analysis of students' performance in each question.

2.0 ANALYSIS OF STUDENTS' RESPONSE ON EACH QUESTION

2.1. SECTION A: OBJECTIVE QUESTIONS

2.1.1 Question 1: Multiple Choice Items

Question 1 comprised of ten (10) items, (i) – (x) constructed from the topics of *Cells and Batteries*, *D.C Circuits*, *Duties and Responsibilities of Electrical Engineering Personnel*, *Electrical Draughting*, *Electricity*, *Instruments and Measurement*s, *Magnetism and Electromagnetism*, *Units*, *Tools and Accessories* and *Safety Management in Electrical Engineering Workshop*. The students were required to choose the correct answer from the given alternatives by writing its letter in the box provided. The total marks for this question were 10 and each item carried 1 mark.

A total of 437 (100%) students attempted this question. Among them 17 (3.9%) students scored from 0 to 2 marks, 368 (84.2%) scored from 3 to 6 marks and 52 (11.9%) students scored 7 to 10 marks. The overall performance of the students in this question was good since 96.1 percent of them passed by scoring from 3 to 8 marks. Figure 1 illustrates this performance.

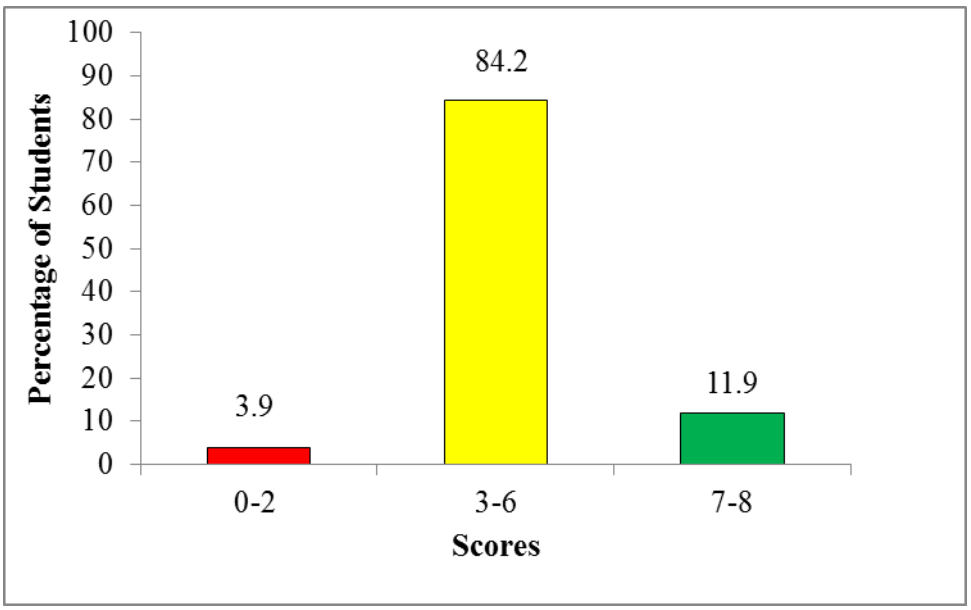
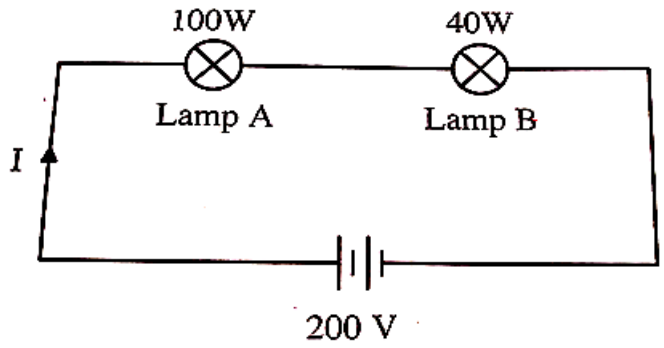


Figure 1: *Students' Performance in Question 1*

The analysis of the students' response shows that items in which most of the students performed well were (ii), (vi), (viii) and (x) which were set

from the topics of *D.C Circuits, Instruments and Measurements, Units* and *Safety Management in Electrical Engineering Workshop* respectively.

In item (ii), the students were required to compare the brightness of lamps A and B of different ratings which are connected as shown in Circuit 1.



Circuit 1

The correct response was A, *lamp A will be bright than lamp B* and most of the students selected this alternative. These students had sufficient knowledge on the concepts of D.C circuits particularly the effects of connecting lamps of different ratings either in series or parallel. A few students who opted for alternative B, *Lamp B will be brighter than lamp A* failed to recognize that a lamp with highest wattage in a series connection has higher brightness than the other. However, the students who selected alternatives C, *Lamp A and B will have the same brightness* and D, *all lamps will have higher brightness* had little knowledge on D.C circuits. These students had wrong perception; they think since two lamps which are connected in series have same current flowing in each; thus, both lamps will have either the same brightness or higher brightness.

Item (vi) required the students to select the appropriate instrument which can be used to measure the current taken by a single phase induction motor. Most of the candidates were conversant with the concepts of instrument and measurements; hence, they confidently selected the correct alternative C, *Ammeter*. Other alternatives were A, *Voltmeter*, B, *Ohmmete*r and D, *Wattmeter*. Those who selected these options were uncertain on the terms as all of them are instruments used to measure different electrical quantities.

In item (viii), the students were required to convert the value of the generated power of 46,000,000 W in Megawatt. The correct answer is A, *46.* The students who chose this alternative were competent in the topic of units specifically unit conversion. Those who opted for alternative B, *460*; C, *4.6* and D, 0.*46* probably used wrong formula of unit conversion which led them to wrong answers.

Item (x) required the students to give a reason for applying safety rules in a working place. Most of them selected alternative D, *To take safety measure early* instead of B, *To prevent accidents* which is the correct answer. These students were aware on the importance of taking safety measures early in relation to safety rules but failed to recognize that the reason behind is to prevent accidents. However, a few students opted for alternatives A, *To avoid burning* and C, *To put on workshop gear.* These students had ideas about things to take into consideration when applying safety rules, but did forget the necessity of applying safety rule.

The analysis further indicates that average number of students performed well in items (iii), (v), (vii) and (ix). In these items, most of the students had considerable knowledge of the concepts tested on the topics of *Duties and Responsibilities of Electrical Engineering Personnel*, *Electricity*, *Magnetism and Electromagnetism* and *Tools and Accessories* respectively.

In item (iii), the students were required to state the responsibility of a craftsman at a certain electrical company. The correct answer is D, *To be a leader of a small team*. The students who chose this alternative were knowledgeable enough about duties and responsibilities of electrical engineering personnel. Students who opted for alternative A, *To prepare design specification* were confused with the duties of an electrical engineer. Likewise, those who selected alternatives B, *To attend meeting with other trades as the representative of the company* and C, *To be more office based than site based* demonstrated insufficient knowledge about the duties and responsibilities of a craftsman as one of the electrical engineering personnel.

Item (v) required the students to select the material which has a negative temperature coefficient of resistance. Some of the students selected option D, *Carbon* which is the correct response. These students indicated to master the characteristics of different materials specifically temperature coefficient

of resistance which determines their conductivity. Other students wrongly selected option B, *Aluminium* and C, *Silver.* These students did forget that aluminium and silver are pure metals which bear positive temperature coefficient and not negative temperature coefficient. Those who opted for alternative A, *Silcon* confused it with "Silicon" which has negative temperature coefficient.

Item (ix) required the students to select the appropriate tool for marking out the trunking before cutting. Some students selected alternative C, *Try Square* which is the correct answer. Others chose option B, *Centre punch* which is wrong. Students who opted for this alternative did not understand that a centre punch is used for marking the centre of a hole before drilling holes. Few students who selected options A, *Hacksaw* and D, *Chisel* lacked knowledge of various tools and accessories used in electrical works as they selected tools which are used for cutting rather than marking the trunking before cutting.

On the other hand, items (i) and (iv) from the topics of *Cells and Batteries* and *Electrical Draughting* respectively were poorly performed.

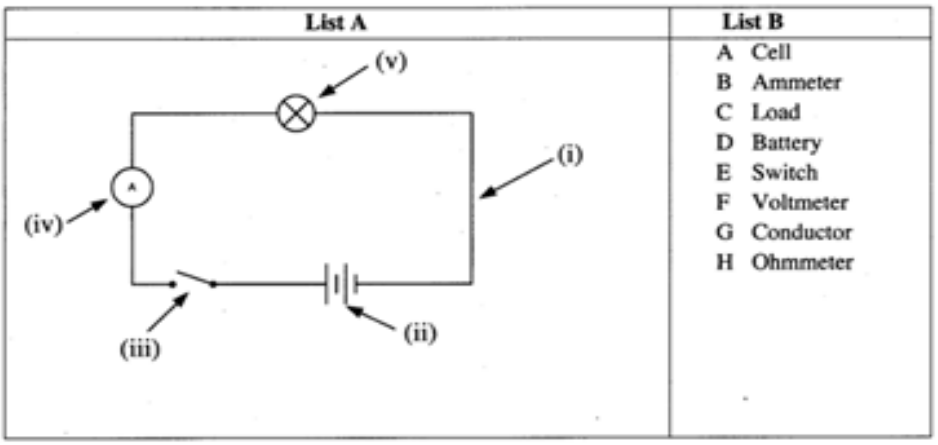
In item (i) the students were required to identify an indicator for a weak accumulator which is affected by polarization. Most of them failed to recognize that *less* or *no* current from the accumulator is among the symptoms of malfunctioning of accumulator, as a result they selected alternatives A, *There is no electrolyte in the cell*, B, *The accumulator terminals are whitish*, and C, *The maximum current is flowing through the ammeter* instead of the correct alternative A, *There is no flowing of current through the ammeter*. These candidates had little knowledge of the topic of cells and batteries.

In item (iv), the students were asked to identify the size of A3 paper in millimetres according to international standards organization. Most of the students opted for alternative D, *297* x *210* instead of A, *420* x *297*. These students had misconception between A3 and A4 paper sizes as they identified them interchangeably. Those who selected options B, *841* x *1189* and C, *594* x *420*, could not remember that the paper sizes they selected were for A0 and A2 respectively and not A3 as required.

This response signifies that the students lacked practical knowledge of basic principles of electrical draughting.

2.1.2 Question 2: Matching Items

The question was set from the topic *D.C Circuits* and required the students to match the parts of the given electric circuit labeled (i) to (v) in list A with their corresponding names in list B by writing the letter of the correct response below the corresponding item number in the table provided .



The question was attempted by 437 (100%) students. Out of these students 2 (0.5%) scored from 0 to 1 mark, 60 (13.7%) scored from 2 to 3 marks and 375 (85.8%) scored from 4 to 5 marks. The performance of the students in this question was good since 99.5 per cent of the students passed by scoring 2 to 5 marks. Table 1 summarizes the students' performance in question 2.

Table 1: Students' Performance in Question 2

Scores	Number of Students	Percentage (%)	Remarks
0-1	2	0.5	Weak
2-3	60	13.7	Average
4-5	375	85.8	Good
Total	**437**	**100**	

The analysis of responses in Table 1 shows that the students who scored from 4 to 5 marks managed to match correctly at least four of the items. This implies that they had sufficient knowledge of concepts tested from the topic of D.C circuits, particularly electrical components and how they are connected in the circuit. Extract 2.1 is a sample of good response from one of the students.

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

Extract 2.1: A sample of good responses to question 2

In Extract 2.1, the student properly matched the parts of an electric circuit in List A with their corresponding names in List B by writing the letter of the correct response.

On the other hand, 14.2 per cent of the students scored lower marks from 01 to 03 as most of them mismatched the items. For example, one student wrongly matched item (ii) in list A with a response A, *Cell* in list B instead of D, *Battery*. This student failed to recognize that, once there are more than one cell, these are no longer called a cell but a battery, hence, *a battery is a collection of cells.* However, there was no student who scored zero in this question. Extract 2.2 illustrate poor responses on question 2.

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

Extract 2.2: A sample of poor responses to question 2

In Extract 2.2 the student failed to match correctly four items (i), (ii), (iii) and (v) from list A with the corresponding names in list B.

2.2 SECTION B: SHORT ANSWER QUESTIONS

2.2.1 Question 3: Electricity

The question required the students to give five differences between electromotive force (e.m.f) and the potential difference (p.d), as both are electrical quantities associated with electric circuit and are measured in volts.

The question was attempted by 437 (100%) students. Among them, 333 (76.2%) scored from 0 to 2 marks; 100 (22.9%) scored from 3 to 6 marks, and 4 (0.9%) scored from 7 to 8 marks. Therefore, the students' performance in this question was poor because only 23.8 per cent of the students passed. Table 2 summarizes the performance of the students in this question.

Table 2: Students' Performance in Question 3

Scores	Number of Students	Percentage (%)	Remarks
0-2	333	76.2	Weak
3-6	100	22.9	Average
7-8	4	0.9	Good
Total	**437**	**100**	

Table 2 shows that 76.2 per cent of the students scored low marks. Most of the student provided less than three correct points to differentiate between Electromotive Force and potential difference. The major reason for the low score is lack of sufficient knowledge on the concepts tested. Some of the students provided the difference between electromotive force (e.m.f) and potential difference (p.d) interchangeably because both are the quantities of electricity and both are associated with an electric circuit. This shows that the students confused the terms due to their similarities since both of them are measured by using the same unit and same measuring instrument which is Volt (V) and voltmeter respectively. Others provided irrelevant responses. Extract 3.1 is a sample of incorrect response from one of the students.

S/n	E.m.f	P.d
(i)	deals with Magnetism	Potential deference is not dealing with the ~~electro~~ Magnetism
(ii)	uses electrolyte	does not use electrolyte
(iii)	e.m.f. is not the same as p.d.	Potential differences is not the same as E.M.f.
(iv)	Different formula	different formula
(v)	Its SI unit is columbs	Its SI unit is candela

Extract 3.1: A sample of poor responses to question 3

Extract 3.1 shows that the student provided irrelevant responses in all items.

Although most of the students performed poorly in this question, there were some of them who responded correctly by mentioning five points which differentiate electromotive force from potential difference. There are 104 (23.8%) students who scored from 6 to 8 marks. Extract 3.2 shows a sample of correct response from a student who provided a reasonable response.

S/n	E.m.f	P.d
(i)	Electromotive force is the potential difference across the cell terminal when there is no current flowing through it	Potential difference is the energy produced when charge flows in a conductor
(ii)	Electromotive force is the force causing the electrons to flow in a conductor	Potential difference is the energy produced when charge flows in a conductor
(iii)	Electromotive force is independent of the resistance.	Potential difference is directly proportional to the resistance
(iv)	Electromotive force is greater than Potential difference	Potential difference is smaller than electromotive force.
(v)	Electromotive force is present even when there is no current is flowing in the circuit	Potential difference is not present when there is no current flowing in the circuit

Extract 3.2: A sample of good responses to question 3

In Extract 3.2, the student managed to differentiate correctly electromotive force from potential difference. This student acquired adequate knowledge on the topic of Batteries and Cells.

2.2.2 Question 4: Electrical Draughting

The question was as follows: *You are given a task of fixing two indicator lamps outside the door of your school workshop. One lamp is green to indicate that there is an activity in the workshop and another lamp is red to indicate that there is no activity in the workshop. The circuit should have a master switch which controls the circuit. Available components are: one-way switch, two way switch, two lamp holders, junction box, two lamps and a main switch. Design a wiring diagram to meet the operation.*

A total of 437 (100%) students attempted this question. The performance analysis of this question indicates that 283 (64.8%) students scored from 0 to 2.5 marks. Also 137 (31.8%) students scored from 3 to 8 marks and 17 (3.9%) scored from 6.5 to 8.5 marks. The students' performance in this question was average because 35.2 per cent of the students passed by

scoring from 3 to 8.5 marks. Figure 2 summarizes the performance of the students.

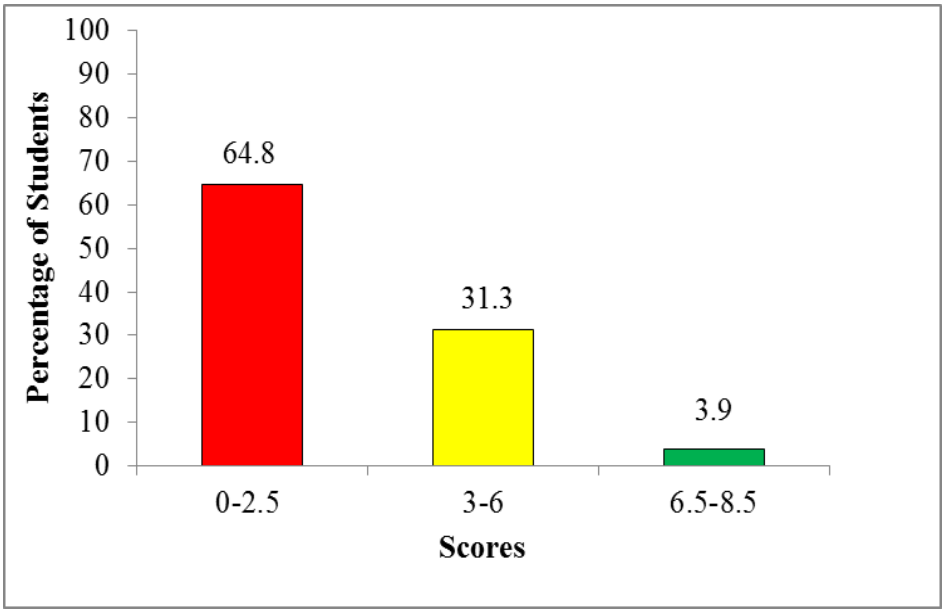
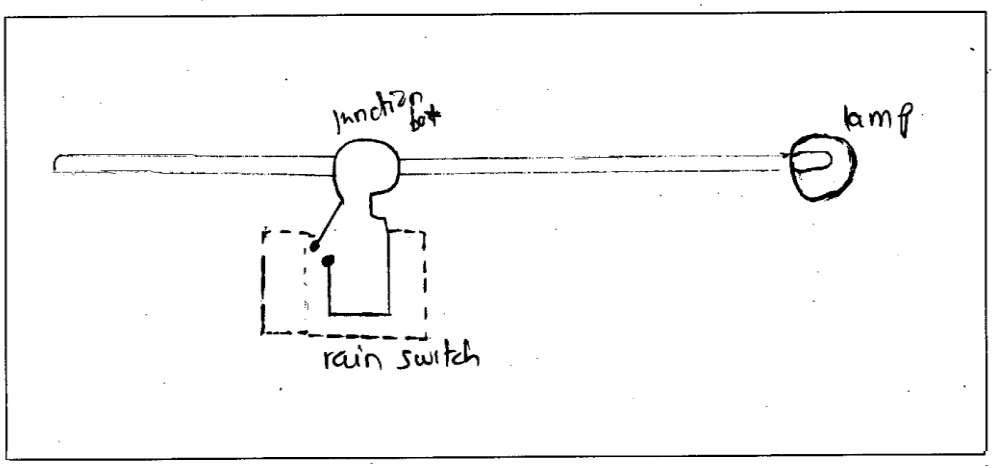


Figure 2: *Students' Performance in Question 4*

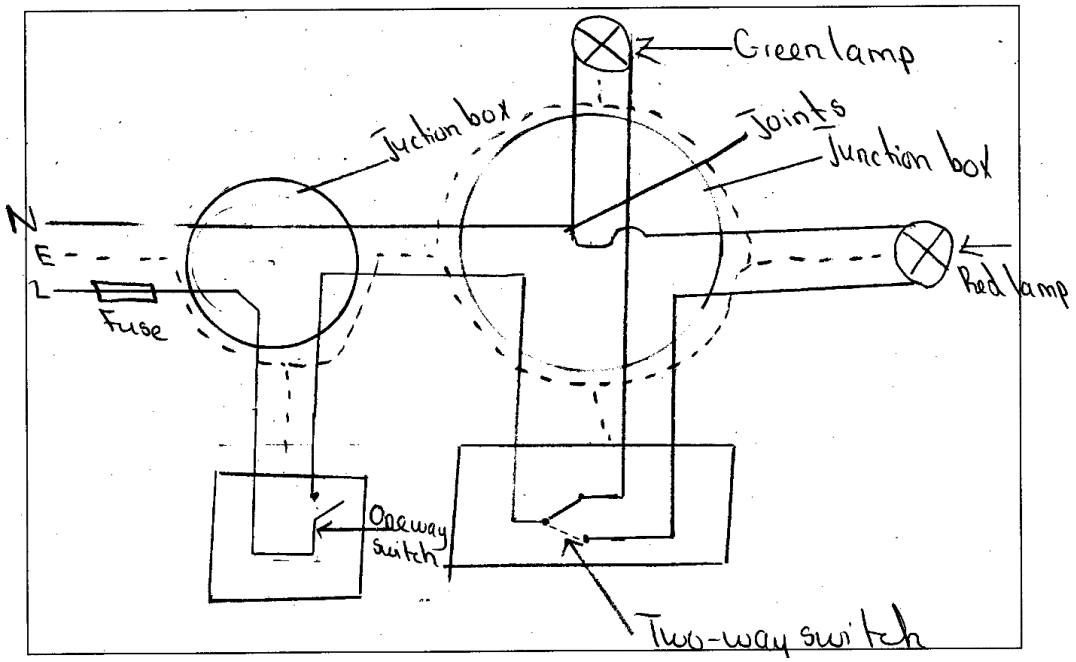
The analysis of the students' responses shows that most of them were not able to design properly a wiring diagram by using the given components to meet the required operation. These students lacked skills in circuit designing as well as the use of electrical components symbols in the circuit. Extract 4.1 shows a sample of a poor response from one of the students.



Extract 4.1: A sample of poor responses to question 4

In Extract 4.1, the student presented irrelevant diagram to the expected wiring diagram to meet the required operation.

Performance analysis further indicates that 35.2 per cent of the students who scored above average managed to design a wiring diagram by using the given components to meet the intended operation. These students seemed to have enough knowledge concerning the concepts of the topic Electrical Draughting. Extract 4.2 shows a sample of good response from one of the students.

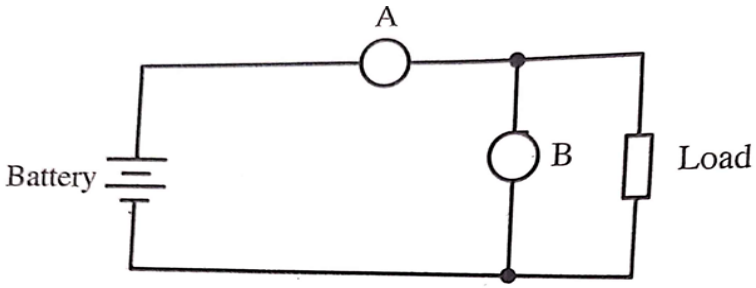


Extract 4.2: A sample of good responses to question 4

In Extract 4.2, the student demonstrated high ability in designing a wiring diagram from the given components to meet the specified operation. The student also was capable of applying correctly electrical component symbols in the diagram.

2.2.3 Question 5: Instruments and Measurements

The question was as follows: *Suppose you are required to perform an experiment related to measuring electrical quantities. The following circuit is provided for the experiment.*



(a) Identify the measuring instruments A and B.
(b) Examine the function of the instruments A and B.
(c) How can you determine the resistance by using readings of instruments A and B?

A total of 437 (100%) students attempted this question. Their scores are categorized as follows: 128 (29.3%) students scored from 0 to 2 marks; 96 (22.0%) scored from 3 to 6 marks, and 213 (48.7%) scored from 6.5 to 10 marks. The students' performance in this question was good since 70.7 per cent of them scored from 3 to 10 marks. Figure 3 summarizes this performance.

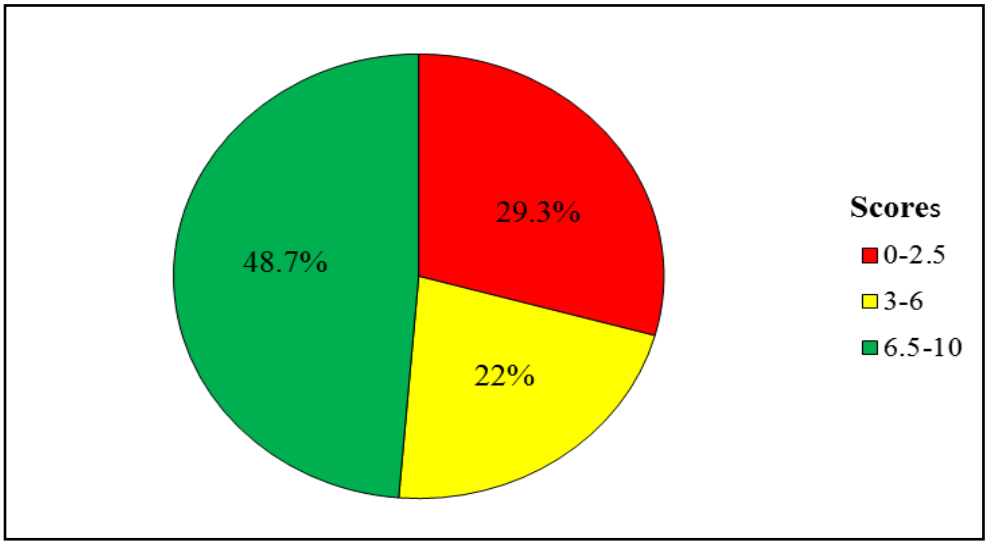


Figure 3: *Students' Performance in Question 5*

The analysis of students' performance in this question shows that most of the students demonstrated the ability to identify the electrical instruments and their functions. Also they were able to recall the practical methods of determining the resistance of a conductor from recorded data using measuring instruments. In this case voltmeter and ammeter are used to record voltage and current respectively.

Furthermore, the analysis indicates that although a good number of students had good performance, there were a few (29.3%) students who performed poorly. This indicates that some of the students lacked enough knowledge particularly on the uses of measuring instruments. For example, one of the students responded part (a) by identifying instruments A and B interchangeably by writing Voltmeter and Ammeter instead of Ammeter and Voltmeter respectively. This student failed to examine correctly the functions of the instruments A and B in part (b) as well as procedures of determining the resistance by using readings of instruments A and B in part (c).

An example of poor response to this question is shown in Extract 5.1.

5. Suppose you are required to perform an experiment related to measuring electrical quantities. The circuit shown in Figure 3 is provided for the experiment.

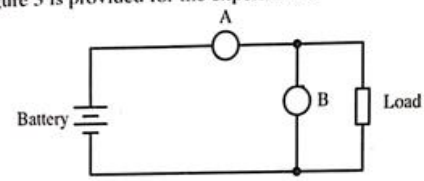


Figure 3

(a) Identify the measuring instruments A and B.

The measuring instrument A and B is is Ampere [A] in the current to flow.

(b) Examine the function of the instruments A and B.

The function of the instrument A and B is used to to lighting in the ~~ate~~ night to produce light in the current.

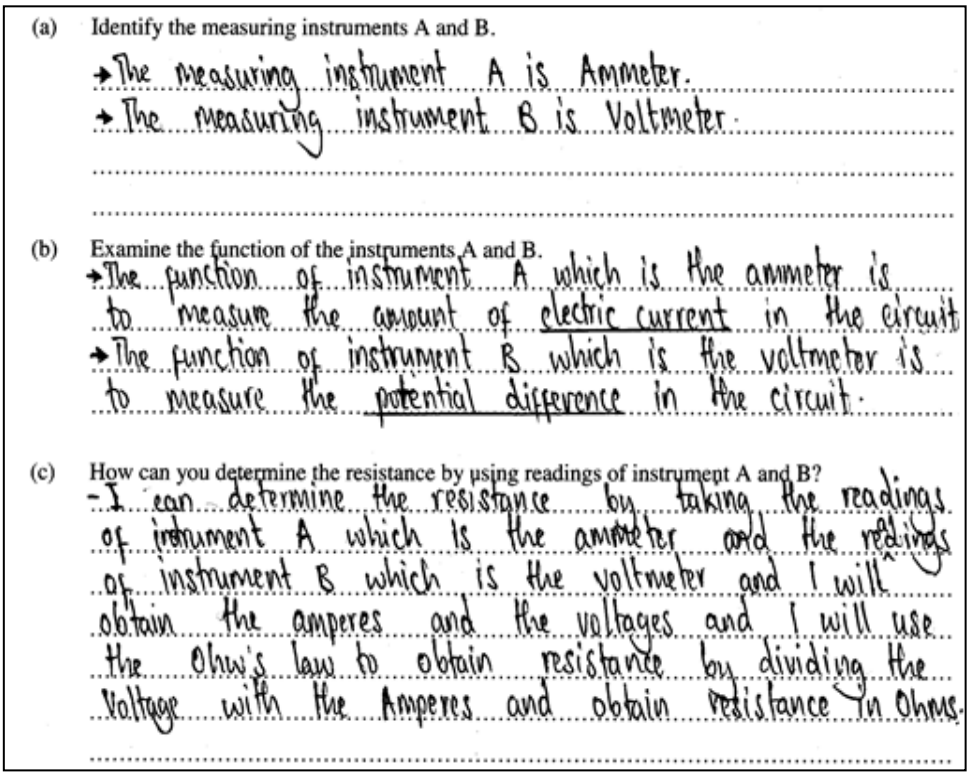
(c) How can you determine the resistance by using readings of instrument A and B?

The resistance by using reading of instrument A and B to use of the current electricity, to flow resistance of the current in the lamp.

Extract 5.1: A sample of poor responses to question 5

In Extract 5.1, the students provided responses that are not relevant to measuring instruments as per the given circuit. The student's performance signifies that he/she lacked knowledge of the concepts tested on the prescribed area.

However, performance analysis of this question indicates that 309 (70.7%) students scored average and above. This justifies that the students in this group had enough knowledge concerning the topic of Instruments and Measurement which enabled them to produce positive reflection towards the question requirement. Extract 5.2 shows a sample of good response from one of the students.


(a) Identify the measuring instruments A and B.

→ The measuring instrument A is Ammeter.

→ The measuring instrument B is Voltmeter.

(b) Examine the function of the instruments A and B.

→ The function of instrument A which is the ammeter is to measure the amount of electric current in the circuit

→ The function of instrument B which is the voltmeter is to measure the potential difference in the circuit.

(c) How can you determine the resistance by using readings of instrument A and B?

- I can determine the resistance by taking the readings of instrument A which is the ammeter and the readings of instrument B which is the voltmeter and I will obtain the amperes and the voltages and I will use the Ohm's law to obtain resistance by dividing the Voltage with the Amperes and obtain resistance in Ohms.

Extract 5.2: A sample of good responses to question 5

In Extract 5.2, the student managed to identify the provided measuring instruments A and B in part (a), examined correctly the function of the instruments A and B in part (b) also explained the correct procedures of determining the resistance by using the readings obtained from the instrument A and B as required in part (c).

2.2.4 Question 6: Electrical Draughting

The question had two parts namely part (a) and (b). The students were required to: (a) give the meaning of free hand drawing (b) illustrate the significance of lines in a drawing by sketching the following lines (i) heavy unbroken line, (ii) light unbroken line, (iii) broken line of short dashes and (iv) broken line of long and short dashes; and give their application in a drawing.

This question was attempted by 437 (100%) students. The performance analysis indicates that 145 (33.2%) students scored from 0 to 2.5 marks, 228 (52.2%) scored from 3 to 6.5 marks and 64 (14.6%) scored from 7 to 10 marks. Figure 4 summarizes the overall performance of the students.

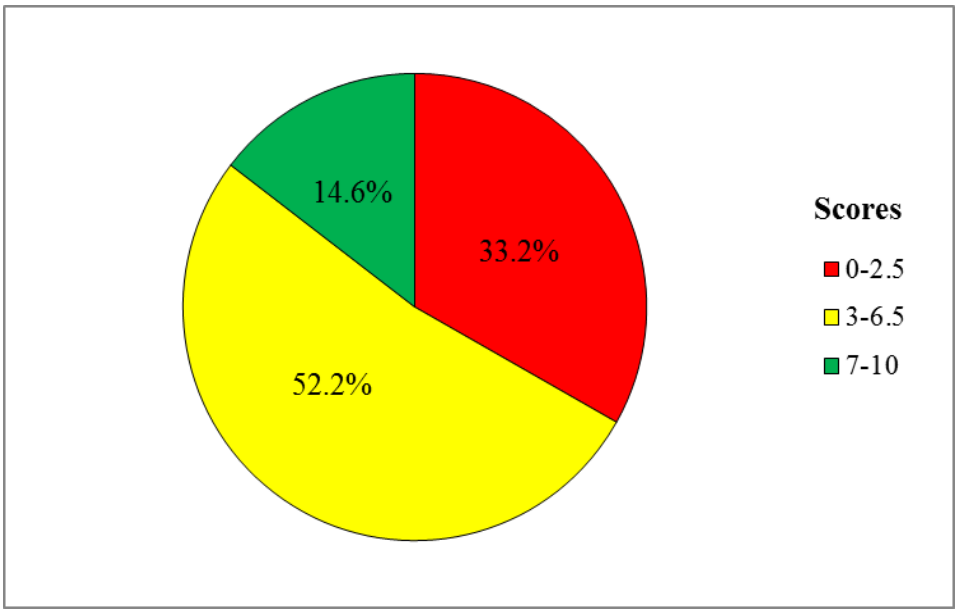
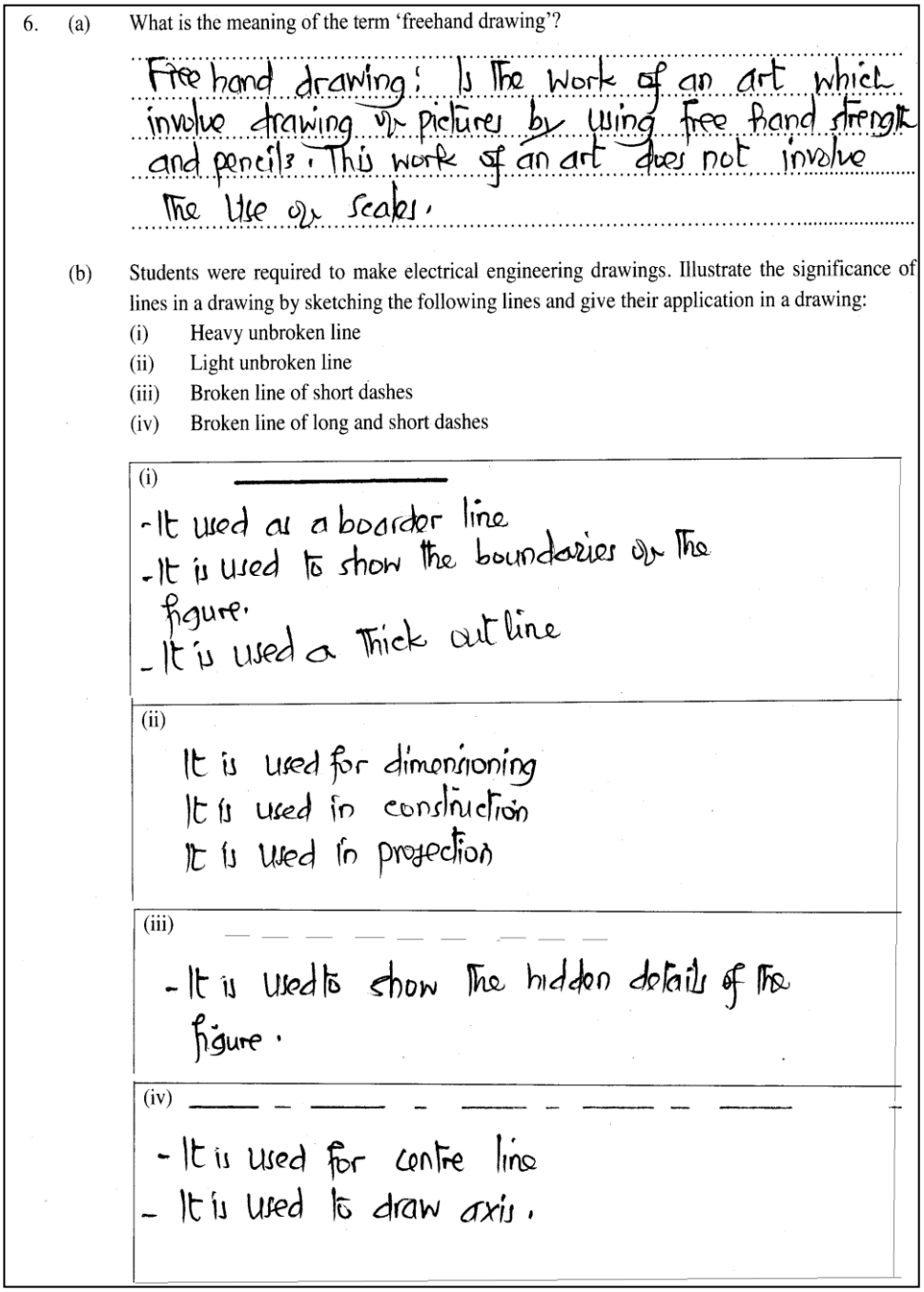


Figure 4: *Students' Performance in Question 6*

The general performance of the students in this question was good, because 292 (66.8%) students performed average and above. Three (7.0%) students who scored full marks were able to provide correct response in all parts of the question. These students had acquired sufficient knowledge about basic principles of electrical daughting. Other students who performed averagely managed to provide correct responses to some parts of the question but failed the other parts. These students had partial knowledge of the concepts

tested on the topic of electrical draughting. Extract 6.1 presents the good responses from one of the students.



6. (a) What is the meaning of the term 'freehand drawing'?

Free hand drawing: Is the work of an art which involve drawing or pictures by using free hand strength and pencils. This work of an art does not involve the use of scales.

(b) Students were required to make electrical engineering drawings. Illustrate the significance of lines in a drawing by sketching the following lines and give their application in a drawing:

(i) Heavy unbroken line
(ii) Light unbroken line
(iii) Broken line of short dashes
(iv) Broken line of long and short dashes

(i) ——————

- It used as a boarder line
- It is used to show the boundaries of the figure.
- It is used a Thick out line

(ii)

It is used for dimensioning
It is used in construction
It is used in projection

(iii) — — — — — — — — —

- It is used to show the hidden details of the figure.

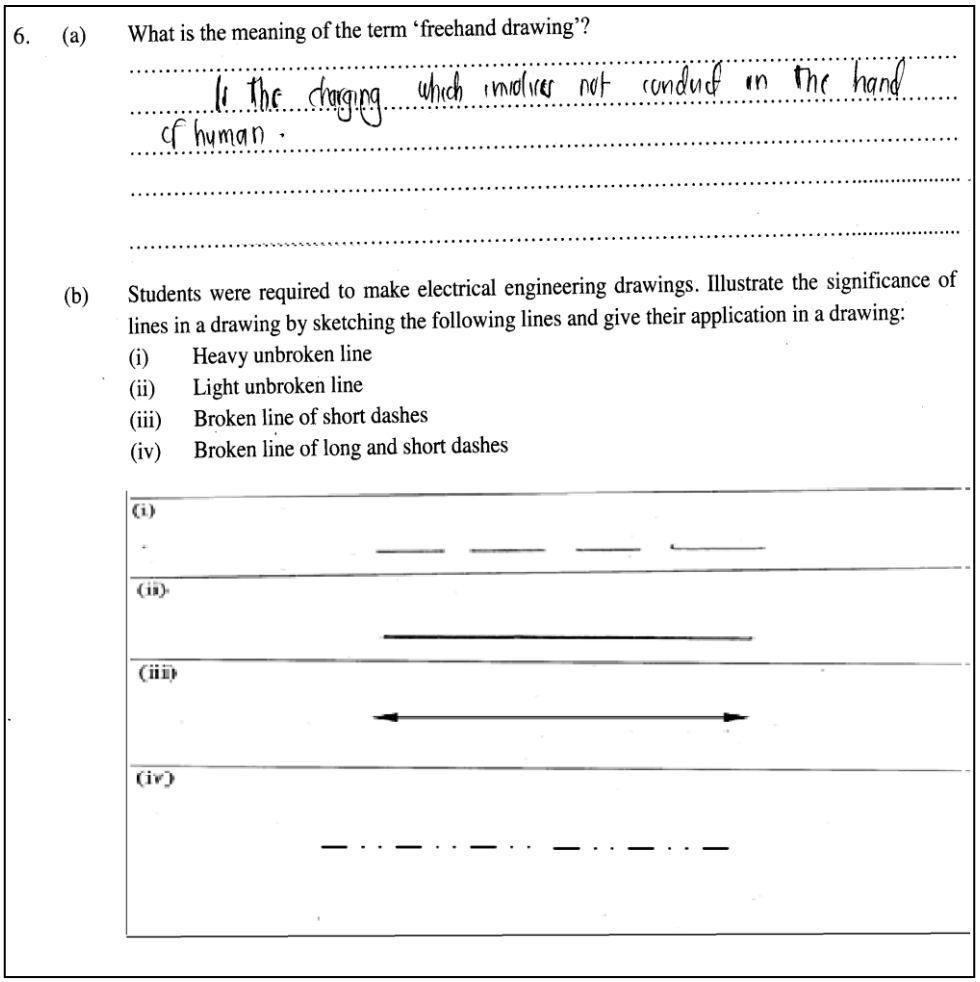
(iv) —— – —— – —— – —— – ——

- It is used for centre line
- It is used to draw axis.

Extract 6.1: A sample of good responses to question 6

Extract 6.1 shows that the student managed to correctly give the meaning of freehand drawing and draw the required lines as per question demand.

The analysis further shows that 145 (33.2%) students who scored low marks had inadequate knowledge on the subtopic of Electrical Drawing. They mainly failed to give correct responses either in all parts of the question or gave correct responses in a very few items. Extract 6.2 indicates a sample of poor response from one of the students.



Extract 6.2: A sample of incorrect responses to question 6

In Extract 6.2, the student provided wrong meaning of freehand drawing in part (a). In part (b)(i)-(iv), the student drew heavy broken line, heavy unbroken line, a double arrow line and dash-dotted line instead of heavy

unbroken line, light unbroken line, broken line of short dashes and broken line of long and short dashes respectively. These responses led her/him to irrelevant applications.

2.2.5 Question 7: Cells and Batteries

The question comprised of three parts (a), (b) and (c). In part (a), the students were required to give four components of lead acid battery. Part (b) (i) required the students to respond as to what does the whitish deposit on a battery imply and in part (b) (ii) the students where to give three ways of minimizing the problem in (b) (i). Part (c) of the question had two items in which the students were given the e.m.f of a cell when brand new is 2 V with an internal resistance of 0.2 Ω; then, in item (c) (i), they were required to draw a circuit diagram with connection of an external load of 10 Ω; and calculate the current flow when connected to an external load of 10 Ω in (c) (ii).

This question was attempted by 437 (100%) students, out of which 181 (41.4%) scored from 0 to 2.5 marks, 239 (54.7 %) scored from 3 to 6.5 marks and 17 (3.9%) scored from 6.5 to 9 marks. Figure 5 summarizes the overall performance of the students in this question.

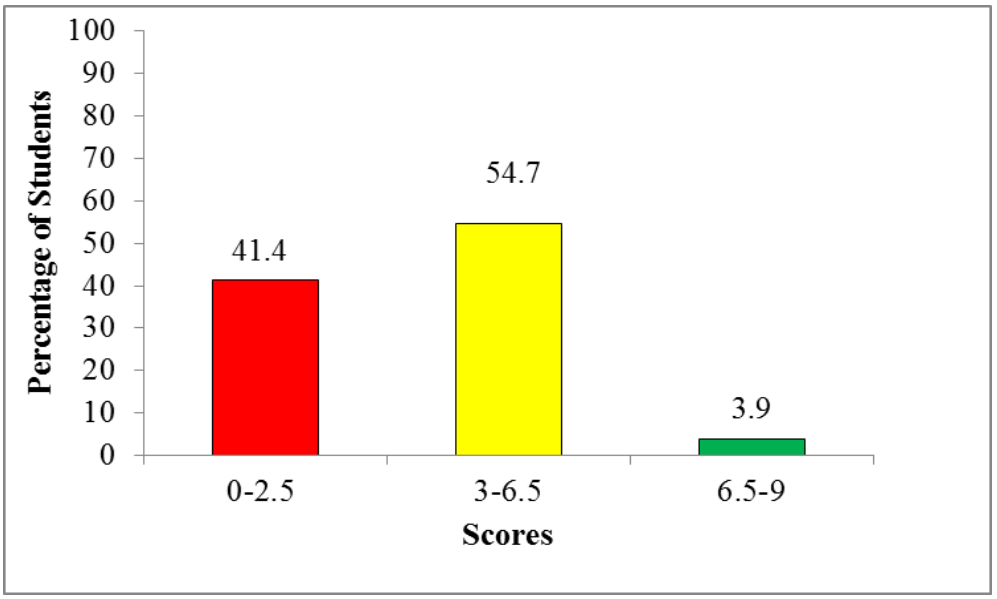


Figure 5: *Students' Performance in Question 7*

Figure 5 shows that the general performance in this question was average since 256 (58.6 %) of the students scored above the marginal fail. Despite the students' average performance, there were some students 181 (41.4%) who scored below average and out of which 6.6 per cent scored zero. These students had insufficient knowledge concerning the topic Batteries and Cells. Extract 7.1 shows a sample of poor response from one of the students.

7. Suppose you are a store keeper of a room which stores lead acid batteries and cells at your schoo
One day you noted that one of the batteries has a whitish deposit on its terminals.

(a) What are the four components of the lead acid battery?

(i) Cars battery
(ii) Alkaline battery
(iii) Motorcycle battery
(iv) lead acid battery

(b) (i) What does the whitish deposit on a battery imply?

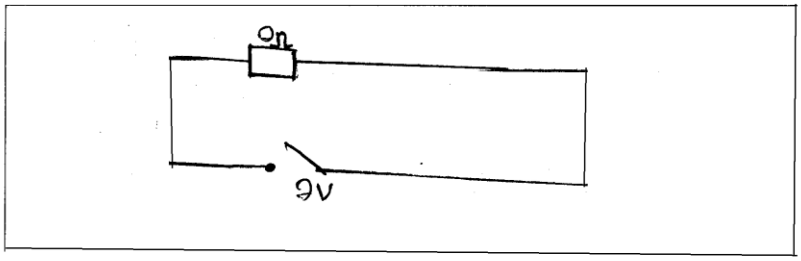
That battery will be heavy unbroken line are equal charged

(ii) How can you minimize the problem in (b)(i)? Give three ways.

(i) I will ensure that heavy unbroken line are equal
(ii) I will ensure that heavy Ubroken line are support to join another line without need help of from another line.

(b) The e.m.f of a cell when brand new is 2 V with an internal resistance of 0.2 Ω:

(i) Draw a circuit diagram with the connection of external load of 10 Ω.



(ii) Calculate the current flow when connected to an external load of 10 Ω.

Soln
Data given
Internal resistance (R) 10.2Ω
Electromotive force (e.m.f) 2V
Current I= ?
from the I = Em / R+Em

I = 2 x 10 / 10+10x2
I = 20 / 10+20
I = 20 / 30
I = 2/3

Extract 7.1: A sample of incorrect responses to question 7

In Extract 7.1, the student provided something related to types of batteries instead of components of lead-acid battery as required in part (a) .In part (b), the student provided irrelevant responses in all items as he/she copied some sentences that appeared in question 6. Similarly, the student applied wrong formula to calculate the current flow when connected to an external load of 10 Ω. This response indicates inability of the student to apply what he/she learned in the topic of batteries and cells.

Nevertheless, the performance analysis indicates that 17 (3.9%) students scored above average. This indicates that the students were knowledgeable about the concepts tested on batteries and cells. Extract 7.2 shows a sample of a good response to the question.

7. Suppose you are a store keeper of a room which stores lead acid batteries and cells at your school. One day you noted that one of the batteries has a whitish deposit on its terminals.

(a) What are the four components of the lead acid battery?

Electrodes (cathode and Anode).
Electrolyte.
Separator.
Container.

(b) (i) What does the whitish deposit on a battery imply?

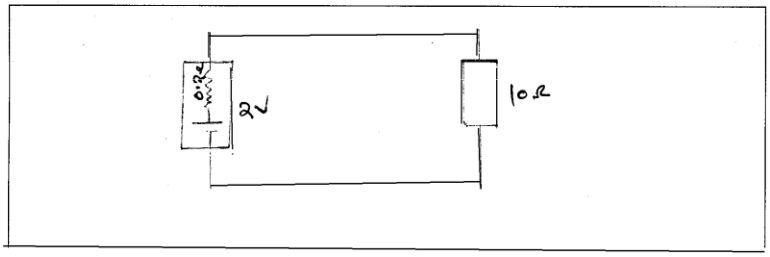
- It imply that there is no flow of current in the circuit or an Ammeter. And whitish deposit occur after the reaction between electrolyte and and electrodes.

(ii) How can you minimize the problem in (b)(i)? Give three ways.

i. Make regular charging of battery
ii. Smear the battery terminals with petroleum jelly.
iii. Change the battery when specific gravity is low.

(b) The e.m.f of a cell when brand new is 2 V with an internal resistance of 0.2 Ω:

(i) Draw a circuit diagram with the connection of external load of 10 Ω.



(ii) Calculate the current flow when connected to an external load of 10 Ω.

Data
Emf = 2V
$R_T = r + R = (10 + 0.2)\Omega = 10.2\Omega$
I = ?
from $I = V/R$
$I = 2/10.2 = 20/102$
$I = 20/102 = 0.19A$
∴ the current required was 0.19A.

Extract 7.2: A sample of good responses to question 7

In Extract 7.2**,** the student managed to list four components of lead acid batteries and correctly calculated the current. However, he/she drew the required circuit diagram but failed to indicate the direction of current flow.

2.2.6 Question 8: Magnetism and Electromagnetism

This question had three parts, namely part (a), (b) and (c). In part (a), the students were required to give two reasons as to why the circuit should have an air gap. Part (b) required the students to calculate the self-inductance of the coil from the given parameters while in part (c), the students were provided with two identical coils having 2000 turns lie in parallel plane such that 80% of the flax produced by one coil links with other coil and vice versa. A current of 20 A in coil A produces a flux of 0.12 mWb in it and asked to calculate mutual inductance and the inductance in coil A.

A total of 437 students attempted this question. Out of these 404 (92.4%) scored from 0 to 2.5 marks; 29 (6.7%) students scored from 3 to 6.5 marks; and 4 (0.9%) student scored from 7 to 8 marks. The general performance of the students on this question was poor because only 33 (7.6%) students scored average and above. Table 3 summarizes the overall performance of the students on this question.

Table 3: Students' Performance in Question 8

Scores	Number of Students	Percentage (%)	Remarks
0-2.5	404	92.4	Weak
3-6.5	29	6.7	Average
7-8	4	0.9	Good
Total	**437**	**100**	

As shown in Table 3, only 7.6 per cent of the students responded well to the question while 92.4 per cent had weak performance. The major weakness of the students in responding to the question was failure to interpret the term *air gap* in relation to magnetic circuit. Also the students were unable to apply correct formulae to calculate the asked parameters in part (b) and (c) of the question. This performance is illustrated in Extract 8.1.

8. (a) Assume you are employed as an electrical technician and you are assigned to construct a magnetic circuit with air gap which can be used in different activities. Why the circuit should have an air gap? Give two reasons.

(i) To avoid interference between magnetic fields

(ii) To avoid short circuit when magnetic fields of a magnet and of an electric current get into contact

(b) The field winding of a D.C electromagnet is wound with 1000 turns and has resistance of 40 Ω. When exciting voltage is 250 V, the magnetic flux linking the coil is 0.008 Wb. Calculate the self-inductance of the coil.

Solution

Data given

Resistance(R) = 40Ω , Turns = 1000

Voltage (V) = 250V

Magnetic flux linking = 0.008wb

Required is self inductance

Self inductance = $\frac{250 \times 0.008 \times 1000}{40}$

$= \frac{25 \times 8}{4}$

$= 50$

∴ self inductance = 50

(c) Two identical coils A and B each having 2000 turns lie in parallel planes such that 80% of the flux produced by one coil links with the other coil and vice versa. A current of 20 A in coil A produces a flux of 0.12 mWb in it. Calculate;

(i) Mutual inductance.

(ii) The inductance in coil A.

Solution

Data given

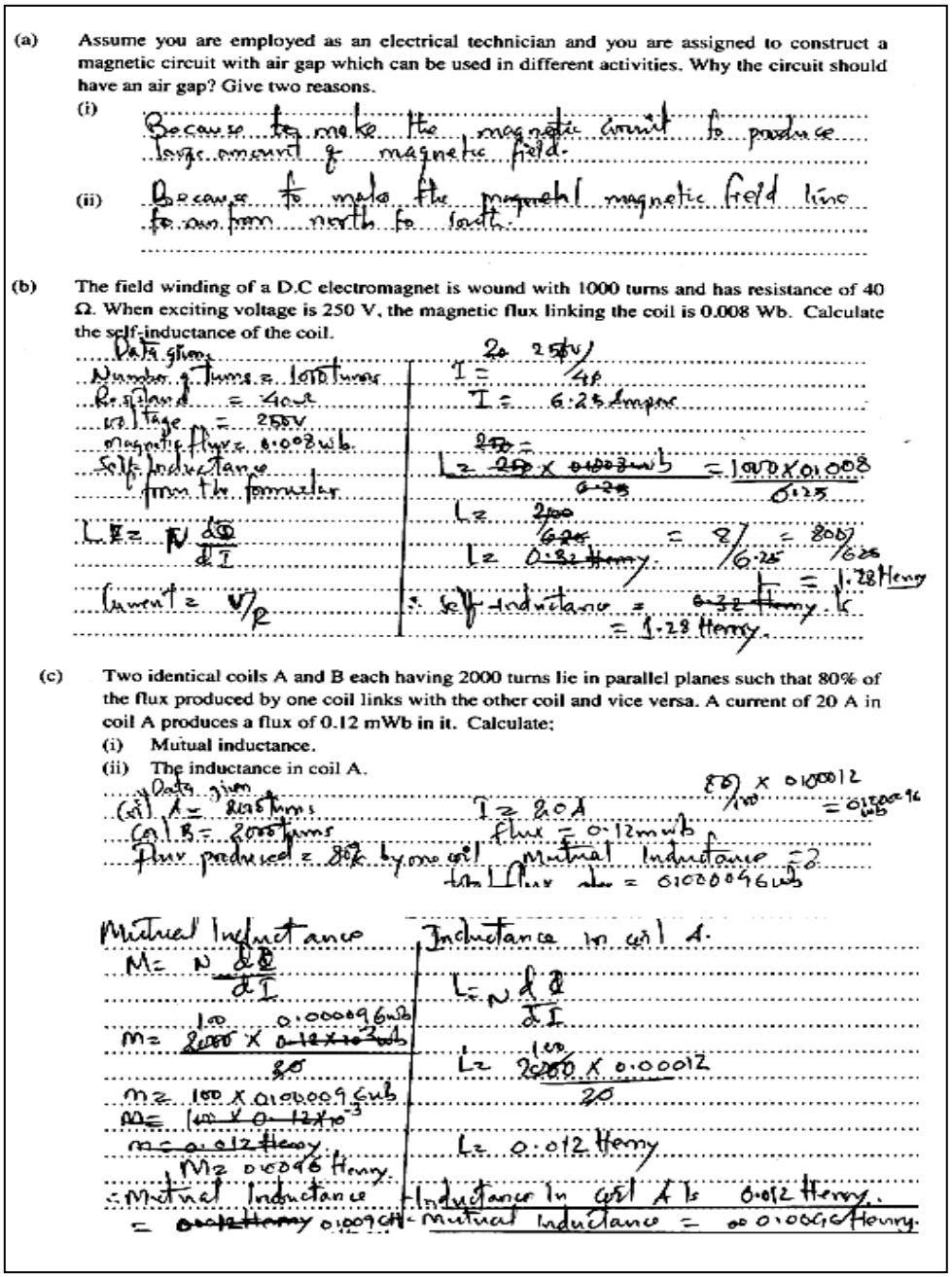
Turns = 2000 , Magnetic flux = 0.12mWb

Current = 20A , Efficiency = 80%

Extract 8.1: A sample of poor responses to question 8

Extract 8.1 shows that the student provided irrelevant reasons of the necessity of putting an air gap in a magnetic circuit and used inappropriate formula to calculate the mutual inductance and inductance of the coil.

On the other hand, the performance analysis shows that, 33 (7.6%) students were able to provide relevant responses which met the requirement of the question. The students demonstrated to have sufficient knowledge of concepts tested about the topic of magnetism and electromagnetism. A sample of good response from one of the students is presented in Extract 8.2.



Extract 8.2: A sample of good responses to question 8

In Extract 8.2, the student managed to give two reasons as to why a magnetic circuit should have an air gap. He/she also used the given parameters to substitute in the correct formulae to calculate mutual

inductance and inductance of the coil. This student seemed to have enough knowledge of the topic of magnetism and electromagnetism.

2.2.7 Question 9: Instruments and Measurements

This question had two parts (a) and (b). In part (a) the students were required to state the use of voltmeter, ammeter, ohmmeter and megger in electric circuit. In part (b), the students were required to draw the circuit which shows the connection of voltmeter, ammeter, and wattmeter with respect to the load.

The question was attempted by 437 (100%). Out of these, 21 (4.8%) scored from 0 to 2 marks, 175 (40.1%) students scored from 3 to 6 marks and 241 (55.1%) students scored from 6.5 to 10 marks. The overall students' performance is summarized in Figure 6.

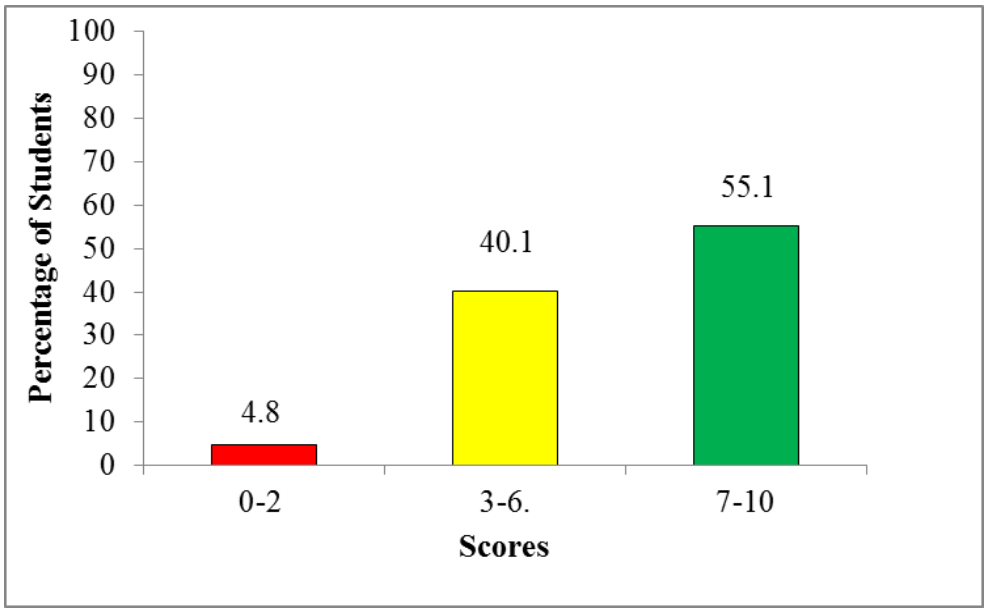


Figure 6: *Students' Performance in Question 9*

The general performance of the students on this question was good because 416 (95.2%) passed as they scored average and above. These students had adequate knowledge of instruments and measurements. Extract 9.2 shows a sample of good responses from one of the students.

(i) **Voltmeter**

Is used for measuring voltage (potential difference) in an electrical circuit

(ii) **Ammeter**

Is used to measure electric current through the circuit

(iii) **Ohmmeter**

Is used to measure electrical resistance through the circuit

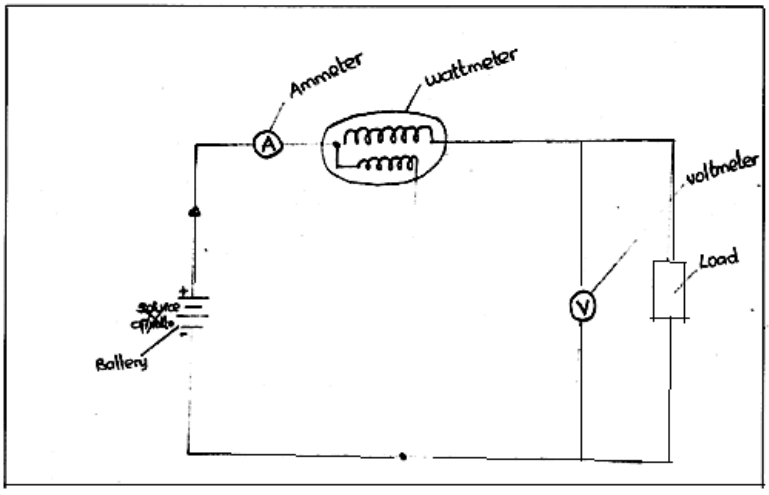
(iv) **Wattmeter**

Is used to measure power dissipated in the circuit

(v) **Megger**

Is used to measure insulation resistance

(b) **Draw a circuit which shows the connection of voltmeter, ammeter and wattmeter with respect to the load.**



Extract 9.1: A sample of good responses to question 9

In Extract 9.1, the student managed to provide the correct use of each instrument provided and drew the circuit which shows the connection of ammeter, voltmeter and wattmeter with respect to the load.

However, 21 (4.8%) students failed to provide the correct use of the listed measuring instruments as well as drawing the circuit which shows their connection with respect to the load. Other students provided the uses of the instruments interchangeably. Moreover, most of them failed to incorporate

the given instruments in a single diagram; hence, they drew separate diagrams for each instrument. These students indicated to have little knowledge concerning the topic of measurements and instruments. Extract 9.2 is a sample of an incorrect response from one of the students.

9. (a) Suppose you are provided with an electric circuit with the following measuring instruments: Voltmeter, Ammeter, Ohmmeter, Wattmeter and Megger. What is the use of each measuring instrument provided in the circuit?

(i) Voltmeter

Is the ~~sense of the~~ branch of ~~the~~ Electer magnet to Sense of Selectrical

(ii) Ammeter

Is the branch of put Conection of be the Electrical magnets.

(iii) Ohmmeter

Is the Conection of resistance ~~of~~ the Electrical & ~~for~~ Current

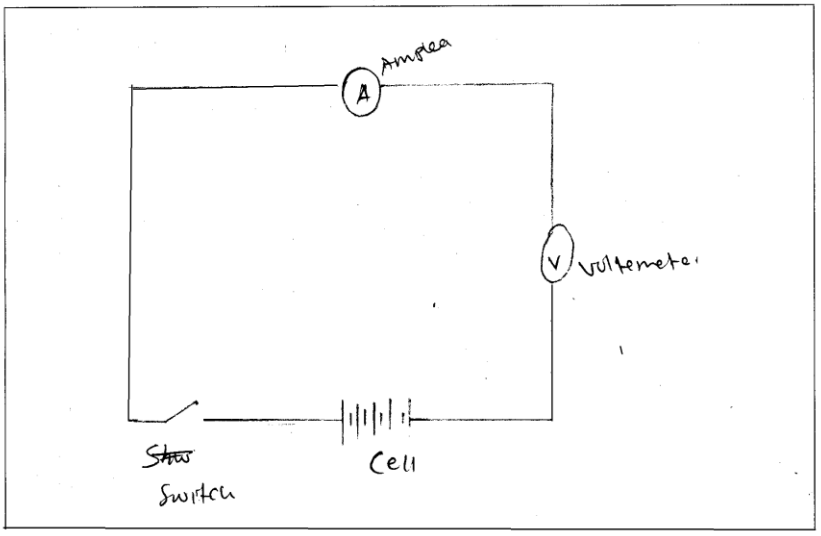
(iv) Wattmeter

Is the ~~one~~ conection of the Ampra to gonve ~~a~~ to lines heve balanced.

(v) Megger

Is the ~~mag~~ branches of magnete ~~of~~ or magnetisms of the conection of Battery.

(b) Draw a circuit which shows the connection of voltmeter, ammeter and wattmeter with respect to the load.



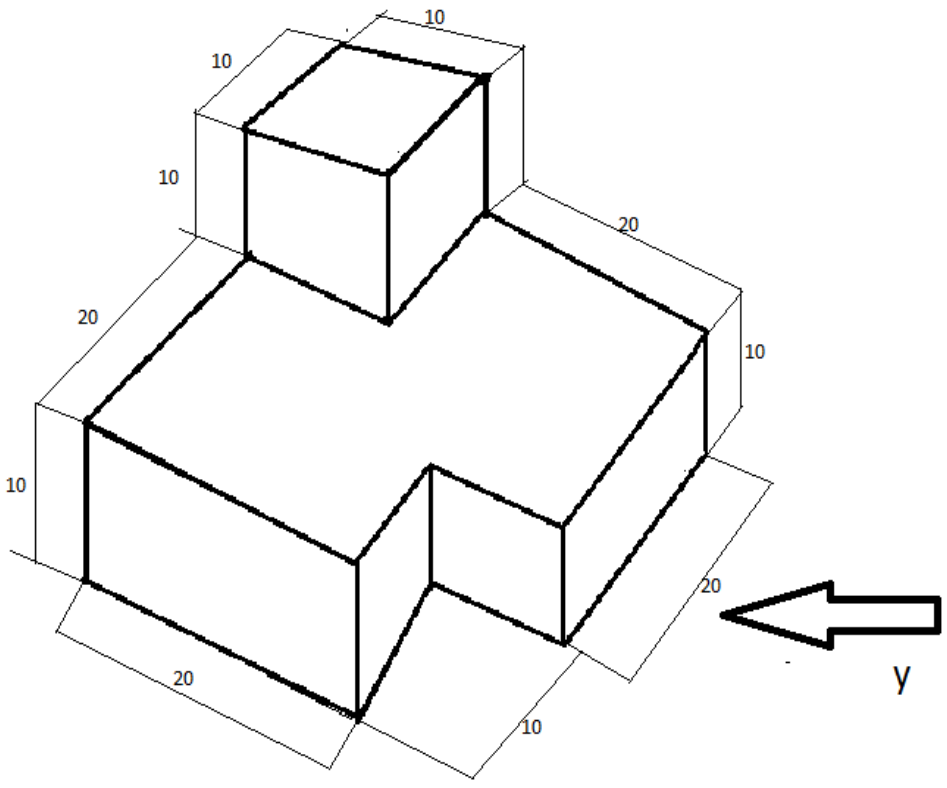
Extract 9.2: A sample of incorrect responses to question 9

Extract 9.2 shows that the student gave irrelevant responses regarding the use of the given measuring instruments. Also the student tried to accommodate the given instruments in a single circuit but he/she failed to place them in the proper position. Hence, came up with an incorrect circuit diagram.

2.3 SECTION C: STRUCTURED QUESTION

2.3.1 Question 10: Electrical Draughting

Students were provided with a model figure for the development and from it, they were required to use first angle projection to produce: (a) Front view in direction of Y (b) End view and (c) Plan view. The views should be in full scale size and all dimensions are in millimeters. The students were required to consider that construction lines must not be erased and all drawings should be neatly shown.



This question was attempted by 437 (100%) students. The analysis indicates that 370 (84.7%) students scored from 0 to 4 marks 40 (9.1%) scored from 4.5 to 9.5 marks and 27 (6.2%) scored from 10 to 15 marks. Figure 7 summarizes the students' overall performance in the question.

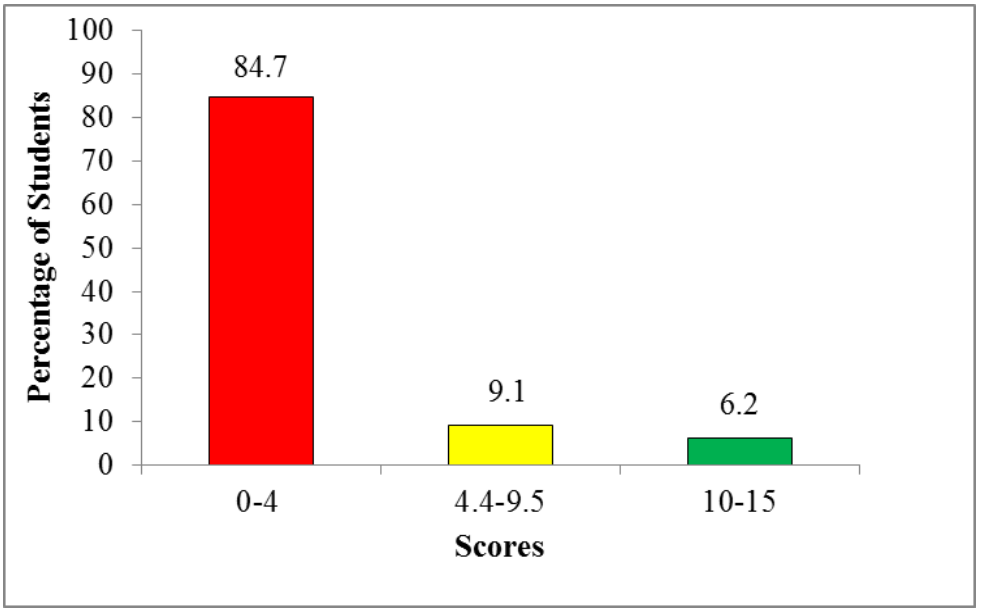
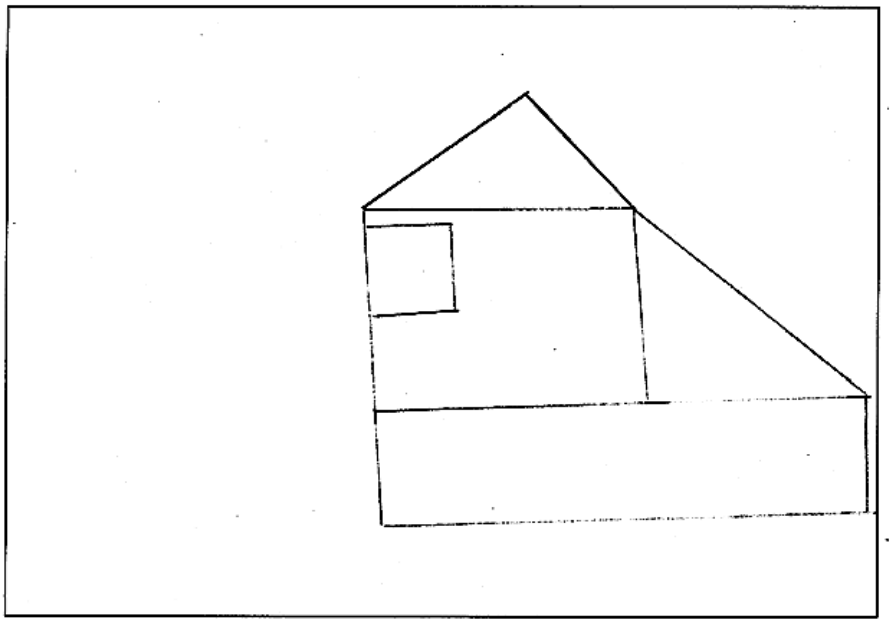


Figure 7: *Students' Performance in Question 10*

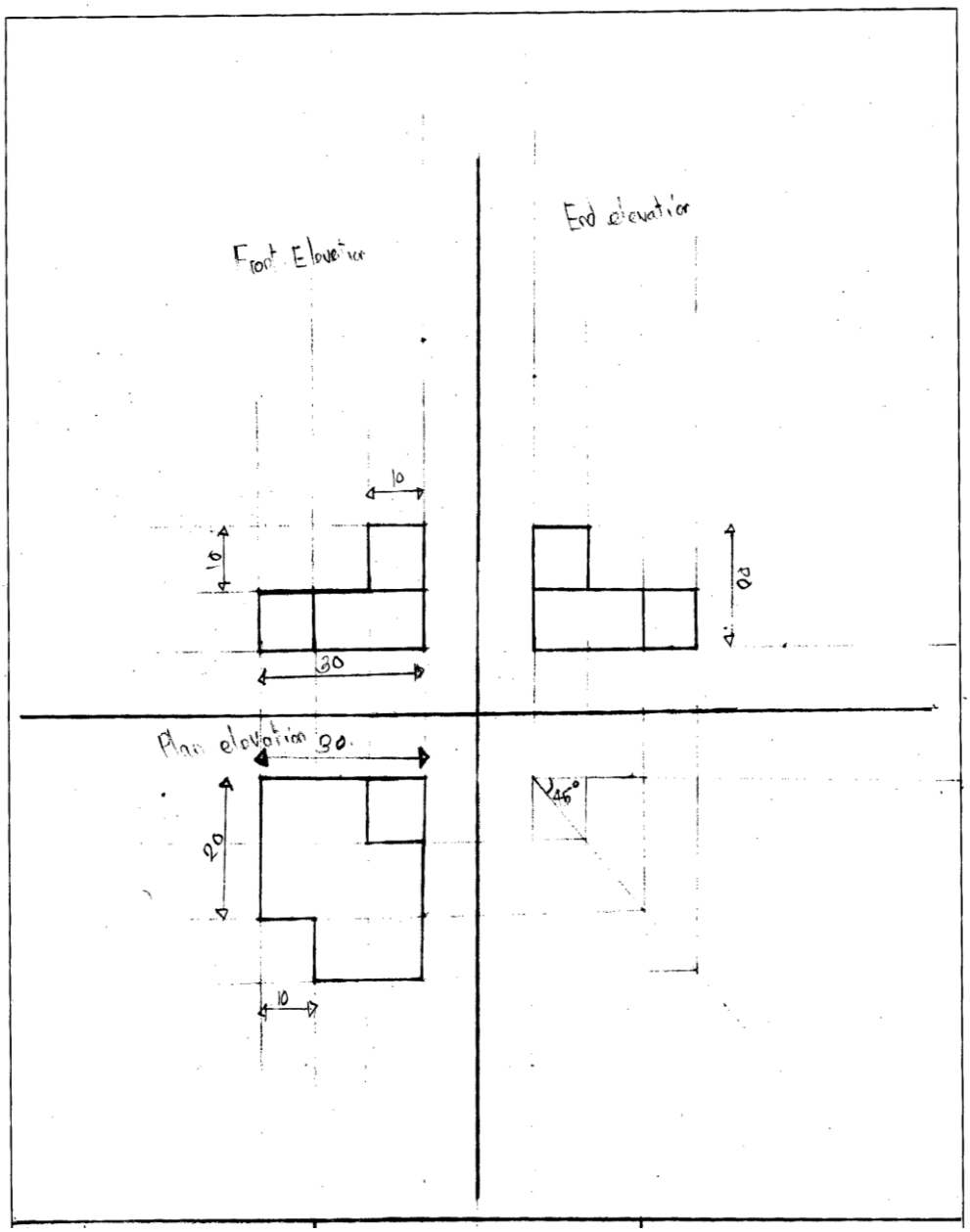
The general performance of the students on this question was poor because 253 (79.06%) students scored 0 to 4 which is below average. Some of them provided irrelevant drawings while others presented figures in third angle projection instead of first angle projection. Such students lacked appropriate knowledge of Electrical Draughting specifically in designing and developing orthographic diagrams. Extract 10.1 shows a sample of poor responses.



Extract 10.1: A sample of incorrect responses to question 10

In Extract 10.1, the student provided the figure which is irrelevant to designing and development of orthographic diagrams. This signifies that, the student lacked knowledge of the concepts tested from electrical draughting.

Nevertheless, there were some students who did well in this question because they were able to produce the asked views in full size scale using first angle projection. This indicates that the student had acquired a wide knowledge specifically in the area of orthographic projection. Extract 10.2 illustrates this performance.



Extract 10.2: A sample of good responses to question 10

Extract 10.2 shows that the student managed to draw the development in full scale size by using first angle projection to produce correct front view in direction of Y, end view and plan view. The construction lines were not erased and the drawings were neatly shown.

3.0 THE STUDENTS' PERFORMANCE ON EACH TOPIC

The analysis of performance on the topics which were assessed in the Electrical Engineering subject for the year 2021 indicates that students performed well in 3 topics, average in 2 topics and weak in 2 topics.

The topics that were performed well include *D.C Circuits (99.5%)* (from which the matching items were constructed) and *Instruments & Measurement* (82.7%). The good performance of the students in these topics signifies that they had enough knowledge, skills and competence on the concepts tested.

The topics in which the students performed averagely were *Batteries & Cells* (58.6%) and *Electrical Drawing* (39.1%) The average performance shows that, the students had partial knowledge and skills on the prescribed topics.

The students responded poorly to the topics of *Electricity* (23.8%) and *Magnetism and Electromagnetism* (7.6%). The students seemed to have acquired inadequate knowledge on these topics.

The Appendix presents a summary of the students' performance in each topic using *green*, *yellow* and *red* colours to represent *good*, *average* and *weak* performance 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 2021 was average. Out of 437 students who sat for the paper 271 (62.0%) passed, while 166 (38.0%) failed and their grade scores are presented in Table 4.

Table 4: Students' Grade Scores in the Year 2021

Total Number of Students	**Students' Grade Scores**				
	A	**B**	**C**	**D**	**F**
437	00	04	102	165	166

The analysis of the students' responses reveals some few shortcomings. These include the students' insufficient knowledge in responding to some of the questions and lack of practical skills particularly in the topic *Electrical Draughting* which was poorly performed.

Another weakness observed was inability of some of the students to apply appropriate mathematical formulae in computations as it was observed in the topic *Magnetism and Electromagnetisms*. This goes together with the failure of the students to understand the requirements of the questions.

It is therefore suggested that the weaknesses noted in this report will be taken as a reminder to teachers, students and other education stakeholders for the purpose of enhancing teaching and learning processes for future improvement of students' performance in Electrical Engineering subject.

4.2 Recommendations

Based on the challenges identified in the analysis of the students' item response, students are advised to:

(a) be very keen in studying in order to acquire sufficient knowledge of the concepts in the syllabus.

(b) be oriented to various terms and concepts used in composing questions for easy understanding of the requirements of the questions.

(c) undertake different computation exercises to strengthen their ability to tackle questions which require applications of formulae and calculations as observed in the topic *Magnetism and Electromagnetisms.*

(d) use drawing rooms to learn much and practice on how to construct figures in various views of orthographic projection. This will enable them to be conversant on the topic *Electrical Draughting*.

Appendix

A Summary of Students' Performance on Each Topic in Electrical Engineering Subject for the Year 2021

S/N	Topic	Question Number	Percentage of Students who Scored 30 Per cent or More	Remarks
1	D.C Circuits	2	99.5	Good
2	Cells and Batteries, D.C Circuits, Duties and Responsibilities of Electrical Engineering Personnel, Electrical Draughting, Electricity, Instruments and Measurements, Magnetism and Electromagnetism, Units, Tools and Accessories and Safety Management in Electrical Engineering Workshop.	1	96.1	Good
3	Instrument and Measurements	5 & 9	82.7	Good
4	Cells and Batteries	7	58.6	Average
5	Electrical Drawing	4, 6 &10	39.1	Average
6	Electricity	3	23.8	Weak
7	Magnetism and Electromagnesm	8	7.6	Weak