THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEM RESPONSE ANALYSIS REPORTON THE FORM TWO NATIONAL ASSESSMENT(FTNA) 2024

PHYSICS

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031 PHYSICS

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FOREWORD

The 2024 FTNA in Physics subject was administered based on the competencies outlined in the 2007 Ordinary Level Secondary School Syllabus at Form Two level.

NECTA has prepared this Students' Item Response Analysis (SIRA) report to provide feedback to various stakeholders about students’ performance in the Physics subject. The report provides a detailed analysis of students' strengths and weaknesses in terms of competency mastery, ability to interpret questions’ demands and manipulate both theoretical and numerical inquiries.

The students' performance in Physics was weak, and this was attributed to several factors. These include difficulties in interpreting and understanding the tasks presented in the questions, challenges in solving numerical problems, and issues related to English language proficiency and drawing skills.

The National Examinations Council of Tanzania (NECTA) expects that the feedback provided in this report will shed light on the challenges for which stakeholders in education should take proper measures to improve teaching and learning of the Physics subject. Consequently, students will acquire knowledge, skills and competencies indicated in the syllabus for their overall benefits and better performance in future assessments and examinations.

The National Examinations Council of Tanzania expresses its sincere appreciation to all who contributed towards preparing this report.

Dr. Said Ally Mohamed

EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report details the students' performance on each question in the Form Two National Assessment (FTNA) 2024 in Physics subject. The FTNA assessment aims to evaluate the skills and knowledge students have gained after completing two years of secondary school level. The Physics assessment covered both Form One and Form Two topics, measuring various competencies as outlined in the 2019 assessment format which was developed from the Physics syllabus for Ordinary Secondary Education of 2007.

The assessment consisted of three sections: A, B, and C, with a total of ten (10) questions. These sections were weighed as follows: Section A – 15 marks, Section B – 70 marks, and Section C – 15 marks. Section A comprised ten (10) multiple-choice items and five matching items, while Section B consisted of seven short-answer questions. Section C contained one structured question. Students were required to answer all the questions.

The assessment covered 18 topics. These were: *Introduction to Physics; Introduction to Laboratory Practice; Measurement; Force; Archimedes' Principle and the Law of Floatation; Structure and Properties of Matter; Pressure; Light; Work, Energy and Power; Static Electricity; Motion in a Straight Line; Magnetism; Temperature; Newton's Laws of Motion; Simple Machines; Forces in Equilibrium; Sustainable Energy Sources* and *Current Electricity.*

A total of 794,493 students sat for the Physics assessment in 2024, of whom 184,847 (23.29%) passed and 609,647 (76.71%) failed. In 2023, 691,924 students sat for the assessment of which 132,561 (19.16%) passed. Comparatively, the performance has increased by 4.13% in 2024.

The analysis outlines what the students were required to do in each question and provides a numerical analysis of the students' performance. It further specifies students' strengths and weaknesses in answering the questions along with extracts of their responses to exemplify the cases presented. Finally, the report includes an analysis of the students' performance by topic, followed by the conclusion and recommendations.

In this report, three colours; green, yellow, and red have been used to represent good, average, and weak performance, respectively. Performance is considered good if students score is from 65 to 100 per cent, average if the score is from 30 to 64 per cent, and weak if the score ranges from 0 to 29 per cent of the total marks allotted to a particular question or topic.

2.0 ANALYSIS OF THE STUDENTS' PERFORMANCE IN EACH QUESTION

The analysis clarifies the type of a question, the topic from which it was derived, its requirements, and the performance status.

2.1. Section A: Objective Questions

This section consisted of two objective questions: Question One and Question Two. Question One included ten multiple-choice items, each weighing 1 mark, while Question Two contained five matching items, each weighing 1 mark. The section contributed a total of 15 marks.

2.1.1 Question 1: Multiple Choice Items

This question consisted of ten (10) multiple-choice items, numbered from (i) to (x), each with four alternatives. Students were required to choose the correct answer from among the given alternatives (A, B, C, or D) and write the corresponding letter in the box provided. The items were constructed from the following ten (10) topics: *Introduction to Physics, Introduction to Laboratory Practice; Measurement; Force; Archimedes' Principle and the Law of Floatation; Structure and Properties of Matter; Pressure; Work, Energy and Power, Light* and *Static Electricity*.

A total of 794,493 (100%) students attempted the question such that 200,806 (25.27%) scored from 0.0 to 2.0 marks, 465,919 (58.65%) scored from 3.0 to 6.0 marks and 127,768 (16.08 %) scored from 7.0 to 10.0 marks. The general performance was good since 593,687 (74.73 %) scored from 3.0 to 10.0 marks. Figure 1 shows the students' performance in Question 1.

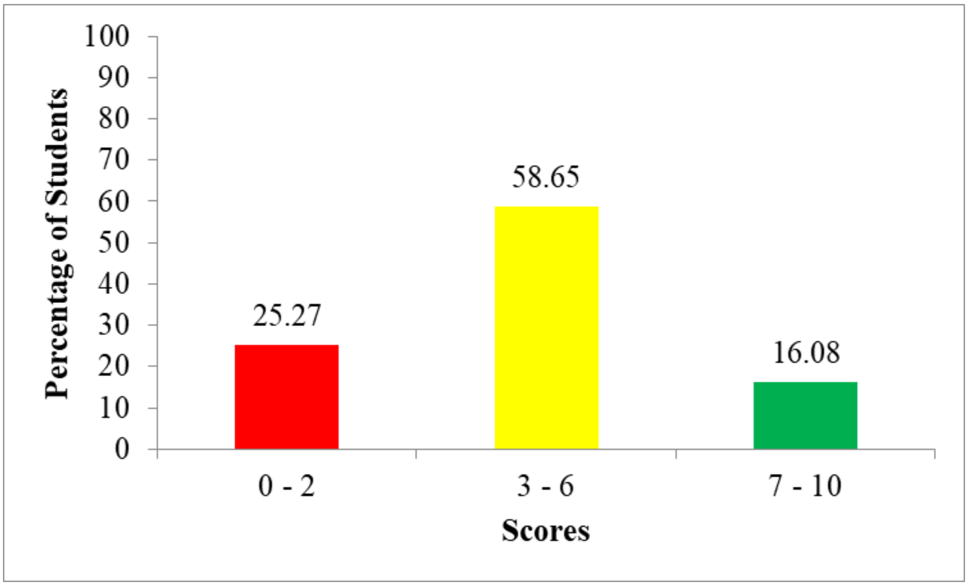


Figure 1: *The Performance of Students in Question 1*

Item (i) was derived from the topic "*Introduction to Laboratory Practice*". The item read: Which set of equipment represents the application of Physics in schools? The alternatives were:

A Voltmeter, tongs, and tripod stand

B X-rays, CT scanner, and ultrasound

C Cooking pans, binoculars, and mosquito coils

D Fax machines, airplanes, and trains.

The correct response was A (Voltmeter, Tongs, and Tripod Stand). Students who selected this answer demonstrated sufficient knowledge of laboratory practice, particularly the instruments and apparatuses used in school laboratories. They were able to recognize that the given set represents common equipment found in Physics laboratory.

Some of the students chose alternative B (X-rays, CT scanner, and ultrasound). This was an incorrect response. Students in this category failed to understand that these types of equipment are primarily used for diagnosis in hospitals. Some of the students opted for alternative C (Cooking pans, binoculars, and mosquito coils). This was the wrong response. These students were supposed to realize that mosquito coils are not used in the Physics laboratory; they can be used to kill mosquitoes in our houses. Moreover, the students in this category were supposed to realize that the cooking pan can be improvised in the Physics laboratory to demonstrate different concepts of temperature, heat and thermal expansion, and not standard equipment in the Physics laboratory.

Some of the students selected alternative D (Fax machines, airplanes, and trains) which was an incorrect response. These students failed to realize that airplanes and trains are transport vessels and not laboratory equipment. On the other hand, the students in this category were supposed to realized that fax machines are office equipment and not laboratory equipment as they cannot be used to determine any physics quantities. It can be said that students who chose alternatives B, C, or D lacked adequate knowledge and skills on the topic of *Introduction to Laboratory Practice.*

Item (ii) assessed the ability of students to handle electrical faults. The item stated that, "How would you immediately stop the hazards caused by electrical faults?" The alternatives were:

A Remove the plugs
B Switch off the socket key
C Cut off all connecting wires
D Switch off the main switch

Most of the students selected alternative D (Switch off the main switch) which was the correct response. These students demonstrated their ability to handle electrical faults. The students in this category were able to realize the primary function of the main switch in the electrical circuit. When the main switch is off, the electrical supply is disconnected in the circuit, thus, reducing the risk of electrical shock and the likelihood of electrical fire.

However, some students selected incorrect alternative A (Remove the plugs). These students assumed that removing the electrical plug would stop the flow of electrical current, consequently preventing electrical shock as well as the possibility of electrical fire. This is not always true. It is always advised to assess the severity of the electrical hazard before removing the electrical plug. That is to say that switching off the main switch would be a more efficient safety measure than removing the plugs. Some of the students chose alternative B (Switch off the socket key) which was an incorrect response. These students failed to differentiate the function of the socket key and the main switch. Few students selected alternative C (cut off the connecting wires). It was an incorrect response. Students in this category assumed that cutting a connecting wire means a disconnected electrical circuit. This is true; however, this attempt may lead to electrical shock or the possibility of an electrical fire.

Item (iii) was derived from the topic of *Measurement* and aimed to assess ability of the students to differentiate density and relative density. The item read: Both density and relative density are physical quantities. How do they differ? The responses were:

A Density is the basic quantity, while relative density is a derived quantity

B Density has units, but relative density has no units

C Density has no units, while relative density has units

D Density is a derived quantity, while relative density is a basic quantity

Option B (Density has units, but relative density has no units) was the correct response. Students who chose this option demonstrated a solid understanding of physical quantities, their definitions, and their differences in terms of SI units. They recognized that density is the ratio of mass to volume, hence it has units, while relative density is the ratio of the density of a substance to the density of water, and therefore, it is a unit less.

Students who selected alternatives A (Density is the basic quantity, while relative density is a derived quantity) lacked adequate knowledge and skills on the concepts of physical quantities and their units. The students were supposed to know that the density can be mathematically defined as:

$\text{Density} = \dfrac{\text{mass of a substance}}{\text{volume}}$. Thus, it is a derived quantity. However, the relative density (RD) is defined as $\text{R.D} = \dfrac{\text{Density of a substance}}{\text{Density of water}}$. Thus, it is a derived quantity and not basic quantity. It can be concluded that students who selected this alternative lacked enough knowledge of the concepts of physical quantities. The analysis revealed that some of the students selected alternative C (Density has no units, while relative density has units). This was not a correct answer. This suggested that the students had insufficient knowledge and skills in the concepts of density and relative density. They were supposed to know that density is the mass of a substance divided by its volume. Thus, it has a unit. On the contrary, relative density is the ratio of two densities, thus, it has no unit.

In item (iv), students were assessed on their ability to identify the effects of the gravitational force on the moving bodies. This item was derived from the topic of Force. The question stated:

Why do scientists prefer sending a rocket to Mars from the Moon rather than from the Earth? The alternatives were:

A The gravitational attraction on the Moon is larger than on the Earth.
B The Moon's shape is smoother compared to the Earth.
C The Moon is at a higher position compared to the Earth.
D The gravitational constant of the Moon is less than that of the Earth.

Some of the students selected the correct response which was alternative D (The gravitational constant of the Moon is less than that of the Earth). These students were able to compare the magnitudes of gravitational force on the Earth and on the Moon. Thus, they were able to realize that the Moon's gravitational attraction is weaker than that of the Earth. As a result, the binding effect on objects on the Moon is minimal compared to the Earth. Thus, it is much easier to launch rockets from the Moon than from the Earth.

However, some students chose an alternative A (The gravitational attraction on the Moon is larger than on the Earth). This was an incorrect response. These students lacked adequate knowledge and skills on the topic of *Force*, particularly gravitational force. (Some of the students chose alternative B (The Moon's shape is smoother compared to the Earth) which was an incorrect response. These students were supposed to realize that the smoothness of the body does not influence gravitational attraction and it has no effect on launching the rockets. The analysis further revealed that some of the students opted for alternative C (The Moon is at a higher position compared to the Earth). This was an incorrect response. These students lacked adequate knowledge and skills on the topic of *Force*.

Item (v) was derived from the topic of Archimedes' Principle and the Law of Flotation. The item read: A body weighs 0.52 N in air, 0.32 N when completely immersed in water, and 0.36 N when completely immersed in another liquid. What is the density of the other liquid? The alternatives were:

A 1.25 g/cm^3
B 0.8 g/cm^3
C 80 g/cm^3
D 3250 g/cm^3

The correct answer was B (0.8 g/cm³). Students who selected this option correctly applied the mathematical formula and calculated the relative density (R.D.).

Some of the students selected alternative A (1.25 g/cm³) which was an incorrect response. The analysis revealed that students in this category applied an incorrect mathematical formula. Other students selected alternative C (80 g/cm³). This suggested that the students applied the correct formula but failed to correctly compute the value of relative density as they lacked enough knowledge and skills on the concept of units and their conversions. Some of the students selected D (3250 g/cm³) which was a wrong response. The analysis suggested that these students applied incorrect mathematical formula for calculating the density of the liquid. Looking at their choice, it is evident that these students defined relative density as:

$RD = \frac{\text{weight of a body in air}}{\text{Loss of weight in the liquid}} = \frac{\text{density of a body}}{\text{density of water}}$. This is not the correct mathematical formula. This suggested that these students lacked enough mathematical skills in expressing physics concepts. These students were supposed to know that the relative density can be defined as

$$RD = \frac{\text{Loss of weight in a liquid}}{\text{Loss of weight in water}} = \frac{\text{density of a body}}{\text{density of water}}.$$

Item (vii) was derived from the topic of Pressure. The item aimed at assessing the ability of students to apply the concepts of pressure in real-life situations. The item stated as follows: Why are the walls of a dam made thicker at the bottom than at the top? The alternatives to this item were:

A The height of water at the bottom is less
B The pressure of water at the bottom is less
C The weight of water at the bottom is less
D The pressure of water at the bottom is greater

The analysis revealed that some of the students chose alternative D (The pressure of water at the bottom is greater). This was a correct response. Students who selected this response demonstrated an understanding of the concept of pressure, particularly the factors that affect pressure in liquids and apply it to the real-life situations. They recognized that at the bottom of the dam, the water is much deeper, resulting in a higher pressure.

Consequently, the walls of the dam must be thicker at the bottom to withstand the greater pressure exerted by the water.

On the contrary, some students chose alternative A (height of water at the bottom is less). This was an incorrect response. Some of the students opted for alternative B (Pressure of water at the bottom is less). This was an incorrect answer. These students failed to establish the correct reference point for measuring the depth of the dam. They should have recognized that the depth is measured from the top of the dam. Therefore, it can be concluded that the maximum depth of the dam is at its bottom. Thus, the pressure of water is maximum at the bottom.

Some students selected alternative C (the weight of water at the bottom is greater). Although it is true that pressure increases with the increase in the weight of the water (since weight is the force), these students did not fully grasp the difference between pressure and weight. Unlike pressure in liquids, which acts equally in all directions, weight is a unidirectional force acting toward the centre of the earth, and not towards the walls of the dam. Therefore, if weight were the cause, there would be no need for thicker walls at the bottom of the dam. This directional difference in force disqualifies weight as the reason for the thicker walls. Therefore, it can be concluded that these students lack enough knowledge of the concepts of pressure, particularly the factors that affect the pressure of the liquids.

Item (viii) was derived from the topic of Light. The items assessed the ability of the students to identify sources of light. The item stated as: "Which one is a natural source of light?" The alternatives were:

A Electrical bulbs
B Lightning
C Candles
D Torch

The correct alternative was B (Lightning). Students who selected this response demonstrated a clear understanding of natural sources of light. They recognized that lightning is a natural phenomenon that occurs without human intervention.

Other students selected alternative A (Electrical bulbs), which was an incorrect response. Some of the students chose alternative C (Candles). This was an incorrect answer. Other students opted for alternative D

(Torch). These students failed to differentiate the natural sources of light and artificial sources of light. As a result, they failed to identify examples of natural sources of light. They were supposed to realize that natural sources of light emit light without human intervention, while, artificial sources of light are human-made sources.

Item (ix) was derived from the topic of Work, Energy, and Power. The item stated: Which statement is true about a body for which the work done is zero? The alternatives were:

A Its displacement is in the opposite direction to the force applied.

B Its displacement is in the same direction as that of the applied force.

C Its displacement is in the direction perpendicular to the applied force.

D Its displacement is at an angle to the direction of the applied force.

The correct alternative was C (Its displacement is in the direction perpendicular to the applied force). Students who selected this response demonstrated an understanding of the conditions under which work is done. They knew that work can only be done when there is displacement in the direction of the applied force. When displacement is perpendicular to the applied force, no work is done because the component of force in the direction of displacement is zero.

Some students selected incorrect alternatives: A (Its displacement is in the opposite direction to the force applied), B (Its displacement is in the same direction as that of the applied force), and D (Its displacement is at an angle to the direction of the applied force). These students failed to understand the need for the item. Instead of identifying the condition under which no work is done (work done is zero), they chose conditions when work is non-zero.

In item (x), students were assessed on their ability to identify the SI unit of different physical quantities, specifically capacitance. This item was extracted from the topic of *Static electricity*. The item read:

What is the SI unit of capacitance? The alternatives were:

A Coulomb
B Ampere
C Farad
D Volts

The correct alternative was C (Farad). Students who selected this response demonstrated the ability to identify the correct unit for capacitance. Some of the students chose alternative A (Coulomb). This was an incorrect response. These students were supposed to realize that coulomb is the unit of electric charge.

Others selected alternative B (Ampere) which was not a correct response. Ampere is the unit of electrical current. Some of the students chose alternative D (Volts). This was an incorrect response as volts is the unit of voltage or potential difference/or electromotive force.

2.1.2 Question 2: Matching Items

This question comprised five (5) homogeneous items constructed from the topic of *Motion in a Straight Line*. Each item was weighing one (1) mark, contributing a total of five (5) marks. Students were required to match each item in List A with its corresponding concept in List B. The question read: "Match the descriptions in List A with the name of the corresponding concept related to motion in a straight line in List B by writing the letter of the concept below the item number in the table provided.

List A	*List B*
(i) *The distance covered by an object in a given direction in metres.* (ii) *The length of path that is followed by an object and has a magnitude only.* (iii) *A set of axes from which an observer can measure the position of points in a system.* (iv) *The rate of change in displacement measured in metres per second.* (v) *The rate of change in velocity.*	A. *Acceleration* B. *A frame of reference* C. *A position* D. *Average speed* E. *Displacement* F. *Distance* G. *Maximum altitude* H. *Velocity*

A total of 794,493(100%) students attempted the question out of which 410,470 (51.66%) scored from 0.0 to 1.0 mark, 223,440 (28.12%) scored from 2.0 to 3.0 marks and 160,583 (20.22%) scoring from 4.0 to 5.0 marks. The overall performance was average, as 384,023 (48.34%) of the students scored from 2.0 to 5.0 marks. Figure 2 illustrates the students' performance in Question 2.

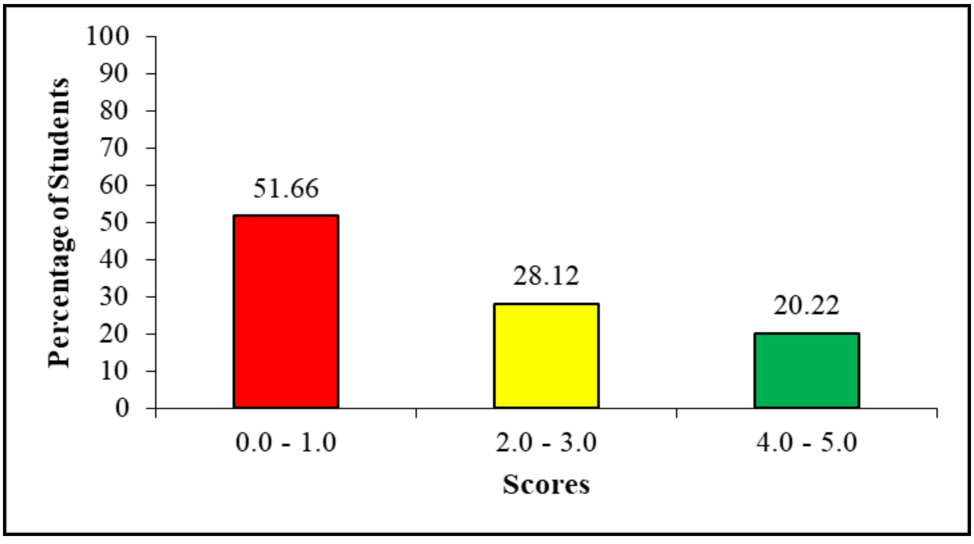


Figure 2: *The Performance of Students in Question 2*

In item (i), students were required to provide the correct response that matched the phrase, *The distance covered by an object in a given direction in meters*. The correct response was E (Displacement). Students who selected the correct match demonstrated an understanding of displacement as the directional length. However, a number of students chose incorrect responses. For example, those who selected F (Distance). These students were supposed to realize that a distance is a scalar physical quantity while displacement is a vector quantity, it has both magnitude and direction. Some of the students matched the phrase with C (Position). This was an incorrect response because a position refers to the location between two points, rather than the directional distance covered.

In item (ii), students were asked to select the correct match for the description *The length of the path followed by an object and has magnitude only*. The correct match was F (Distance). Students who selected this response correctly identified the characteristics of distance. These students were able to realize that distance has magnitude only. This feature distinguishes distance from other physical quantities. However, some students chose E (Displacement). This was an incorrect response because displacement has both magnitude and direction, it is a vector quantity. Other students matched the phrase with C (Position). This was not a correct response. Students in this category were supposed to realize that position is the point in the space relative to the coordinate system or a frame of reference, while distance is the path length.

In item (iii), the description *A set of axes from which an observer can measure the position of points in a system* was correctly matched with the letter B (A frame of reference). Students who made the correct match were able to break down the phrase and recognize the relationship between the set of axes and the position of points. They understood that this relationship provides a point of reference during observation.

However, some students provided incorrect matches. For instance, those who selected C (A position). The students in this category failed to critically differentiate between a frame of reference and position. Frame of reference refers to a set of coordinates used to measure and describe the behaviour of the object. On the contrary, the position is a point space relative to the reference point (frame of reference). Other students matched with E (Displacement) or F (Distance). These were incorrect responses.

In item (iv), students were required to select the response that correctly matched the statement, *the rate of change in displacement measured in metres per second*. The correct response was H (Velocity). Students who made the correct match demonstrated good understanding of the different terms in List B. They were able to distinguish velocity from speed. This revealed that the students realize that velocity is a vector quantity and is described as the rate of change of displacement.

However, some students matched the description with the letter D (Average speed). These students incorrectly interpreted the terms speed and velocity interchangeably.

Item (v) required students to select the letter that correctly matched the description, *The rate of change in velocity*. The correct response was A (Acceleration). Students who selected this response demonstrated a clear understanding of the basic concept of acceleration. Conversely, some students chose incorrect responses. For example, those who selected D (Average speed) confused the concept of the rate of distance (speed) with the rate of change in velocity (acceleration), failing to distinguish the two.

2.2. Section B: Short Answer Questions

This section consists of seven (7) questions based on Form Two topics stipulated in the Physics syllabus for ordinary secondary education of 2010. These topics include *Magnetism, Temperature, Newton's Laws of Motion, Motion in a straight line, Simple machines, Forces in equilibrium* and *Sustainable energy sources.* Each question carried ten (10) marks contributing a total of 70 marks. Students were required to answer all questions from this section.

2.2.1 Question 3: Magnetism

This question had two parts: (a) and (b), both based on the topic of *Magnetism*. In part (a), students were required to name four types of magnets based on their shapes. In part (b), students were asked to state three properties of magnetic lines of force.

A total of 794,493 (100%) of students attempted the question out which 674,489 (84.90%) scored from 0.0 to 2.5 marks, 26,963 (11.71%) scored from 3.0 to 6.0 marks and 93,041 (3.39%) scored from 4.0 to 5.0 marks. The general performance was weak since 120,004 (15.10%) scored from

3.0 to 10.0 marks. Figure 3 shows the performance of the students in Question 3.

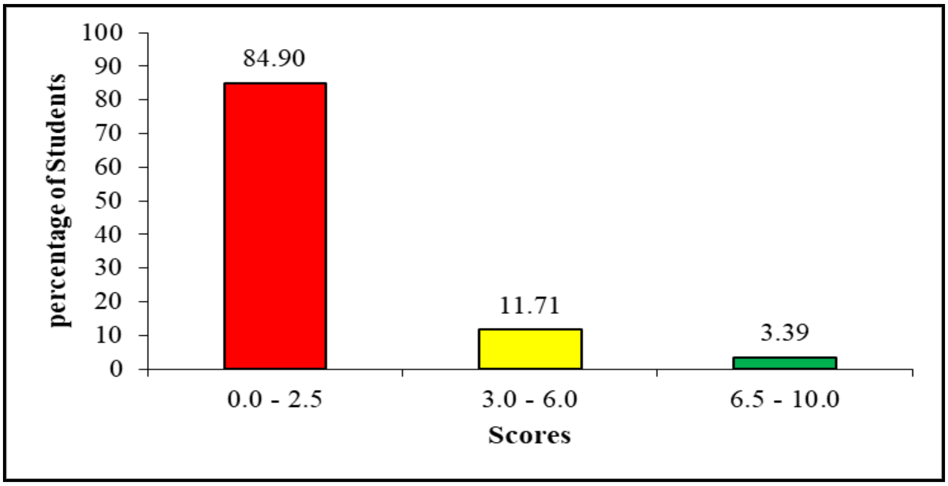


Figure 3: *Students' Performance in Question 3*

The majority of students (84.90%) failed to provide correct responses in both parts (a) and (b). This suggests that most of the students had inadequate knowledge and skills in the topic of *Magnetism*. In part (a), most of the students who failed this part provided irrelevant responses as per question context. For example, in part (a), some of the students wrote *ferromagnetic materials, diamagnetic materials, and paramagnetic materials*. Students in this category were supposed to realize that those are magnetic materials which are classified based on their magnetic susceptibility. Others wrote *temporary magnet* and *permanent magnet* which was an incorrect response as per question context. Some of the students wrote *triangular shape*. This was an incorrect response. These students were supposed to know that there are no naturally occurring triangular-shaped magnets. This is because the distribution of magnetic domains will be uneven thus, the field distribution will also be uneven, the nature does not support this type of magnetic shape.

These students were supposed to understand that types of magnets with reference to their shapes include: Bar Magnet: A simple, rectangular-shaped magnet that has two poles—north and south—at opposite ends. Horseshoe Magnet: Shaped like a horseshoe, this magnet has its poles at the curved ends, commonly used in experiments and for industrial applications. Circular or Disc Magnet: A flat, circular magnet with uniform magnetization, often used in electronic devices. Cylinder Magnet: A magnet shaped like a cylinder, with a uniform magnetic field along its length. Ring Magnet: Shaped like a ring, this magnet has poles on the inner and outer edges and is used in various applications. These shapes are based on the physical configuration of the magnet, which then affects its magnetic properties and uses.

In part (b), students who responded incorrectly were not familiar with the properties of magnetic lines. The analysis revealed that some of the students wrote properties of magnetic instead of magnetic lines. For instance, one student wrote *like poles repel, while unlike poles attract*. This is a law of magnet and not a property of magnetic lines. Another student wrote *magnets attract magnetic materials*. Some of the students wrote *it helps to show you the north direction*, or *it is used in ATM machines, speakers, televisions, and monitors*. These are applications of magnets and not the properties of magnetic lines. These students were supposed to know that magnetic lines have the following properties:

(a). Magnetic lines of force are continuous and closed loops: They form closed curves, exiting from the north pole of a magnet entering the south pole, and continuing through the magnet to return to the north pole.

(b). They do not intersect: Magnetic lines of force never cross each other. If they did, it would imply two directions of the magnetic field at a single point, which is not possible.

(c). They are denser near the poles: The magnetic lines of force are closer together near the poles of a magnet, indicating a stronger magnetic field in that area. They spread out as they move away from the poles, showing a weaker magnetic field further from the magnet.

Extract 3.1 is a sample of the incorrect responses from one of the students in Question 3.

3. (a) Mention four types of magnets according to their shapes. **(4 marks)**

Ferromagnetic magnets example Steel

Paramagnetic magnets example Iron

Diamagnetic magnets example Copper

Electromagnetic magnets example Cabon

(b) Give three properties of magnetic lines of force. **(6 marks)**

The unlike poles attract each other

-The like poles repel each other

-They have the magnetic Shielding

Extract 3.1: A sample of incorrect responses in Question 3

In extract 3.1, a student mentioned the types of magnetic materials instead of the types of magnets based on their shapes. Also, the student failed to provide the properties of magnetic lines.

The analysis showed that only 3.39% of the students correctly responded to this question. The students who managed to score full marks had sufficient knowledge and skills in the concept of Magnetism. They were able to identify magnets based on their shape. They also had a deep understanding of the properties of magnetic lines. Thus, they successfully provided three properties of magnetic lines of force. Extract 3.2 presents a sample of correct responses from Question 3.

3. (a) Mention four types of magnets according to their shapes. **(4 marks)**

i. Bar magnet
ii Ring magnet
iii Horseshoe magnet
iv. Cylindrical magnet

(b) Give three properties of magnetic lines of force. **(6 marks)**

i. Magnetic lines of force start from North pole of the magnet towards South pole of a magnet
ii. Magnetic lines of force are parallel. They never cross each other.
iii. Magnetic lines are concetrated at the poles/ where magnetism is strong and few where magnetism is weaker.

Extract 3.2: A sample of the correct responses in Question 3

In extract 3.2, a student had sufficient knowledge on the topic of Magnetism.

2.2.2 Question 4: Temperature

This question consisted of parts (a) and (b). In part (a) (i), students were required to mention three temperature scales that are commonly used. In part (a) (ii), the students were required to identify the best thermometric liquid between Mercury, Alcohol, and Water. In part (b), students were required to state one (1) limitation and two (2) precautions needed when using a clinical thermometer.

A total of 794,493 (100%) students attempted the question, with 599,720 (75.48%) scoring from 0.0 to 2.5 marks, 121,866 (15.34%) scoring from 3.0 to 6.0 marks and 72,907 (9.18%) scoring from 6.5 to 10.0 marks. The general performance was weak as 194,773 (24.15%) scored from 3.0 to 10 marks. Figure 4 summarizes the performance of students in Question 4.

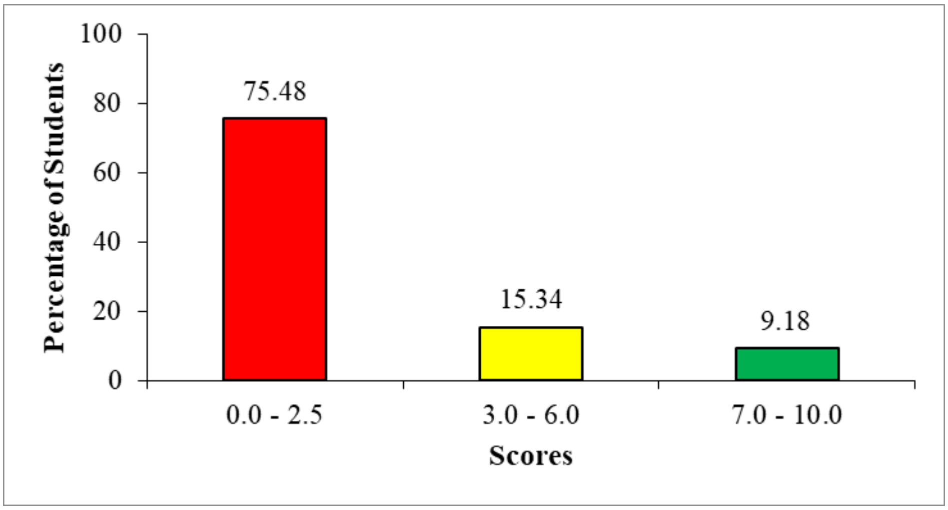


Figure 4: *Students' Performance in Question 4*

The analysis showed that most of the students scored low marks (0.0-2.5), suggesting that they lacked adequate knowledge and skills about the topic of Temperature. Students who failed to provide appropriate answers to part (a) (i) of this question demonstrated a poor understanding of temperature scales. Some of the students provided a wrong response. For example, one student wrote *the vernier scale, linear scale, and main scale*. This was not correct. This student was supposed to know that the vernier scale and main scale are part of the vernier calliper. Some of the students provided irrelevant responses. For instance, one student wrote *representative scale, large scale, small scale, and statement scale*. Another student wrote *laboratory temperature scale, school temperature scale, and clinical temperature scale.* These responses make no sense in a physics context, particularly on the topic of Temperature. Some of the students provided a mathematical formula related to temperature scale conversions. This was not the correct response. These students were supposed to realize that there are three temperature scales, named Celsius, Fahrenheit, and Kelvin scales.

The analysis further revealed that most of the students who scored low marks (0.0-2.5) failed to correctly respond to part (a) (ii). This suggests that they had insufficient knowledge of the concepts of thermometric properties of different liquids. Some of the students selected water as the best thermometric property. While others chose alcohol as the best thermometric property. Students of this category were required to know that water is not a suitable thermometric liquid, while alcohol and mercury are both viable options. However, when comparing mercury and alcohol; mercury is the best choice due to its larger fundamental temperature range, higher sensitivity (resulting from its low specific heat capacity), and its ability to not wet the glass, as it experiences a stronger cohesive force than adhesive force. Other students provided irrelevant statements. For instance, one of the students stated that *water is the best because it dissolves in alcohol*. Another student wrote *mercury has a high value of tension or it consumes time due to limitations*. This is an indication of a lack of knowledge of the concept of thermometric property.

Most of the students who scored low marks failed to give a correct response to part (b) of this question. Most of them provided wrong and irrelevant responses. For instance, one student wrote *do not use a broken thermometer*. Indeed, it is correct, we are advised not to use a broken thermometer and glassware in the laboratory. However, the student was required to provide the limitation of clinical thermometer and not laboratory rules. Another student wrote *it wets the glass*. This was the wrong response. The student provided the limitation of water when used as a thermometric liquid. Some of the students provided irrelevant responses. For instance, one student wrote *If you use alcohol, you may become drunk*. This student viewed alcohol as a beverage, and not as a thermometric liquid.

This suggests that these students did not fully understand the limitations and precautions of using the clinical thermometer. Extract 4.1 is a sample of the incorrect responses in Question 4.

4. (a) (i) What are the three temperature scales that are commonly used? **(3 marks)**

- Large temperature Scale
- Small temperature Scale
- Natural temperature Scale.

(ii) Which liquid would you use to construct a simple liquid-in-glass thermometer using mercury, alcohol and water as thermometric liquids? Give a reason for your answer. **(4 marks)**

- Because it is ~~not~~ Liquid.
- It is Construct in the body.
- It is not mercury.
- It is Natural Liquid.

(b) Write a limitation and two precautions of using the clinical thermometer. **(3 marks)**

Limitation

It is used for measuring Liquid.

Precautions

(i) Is Used for measuring ~~of~~ temperature of the body.

(ii) It is used for measuring Chemical.

Extract 4.1: A sample of a student's incorrect responses in question 4

In extract 4.1, a student provided incorrect responses to all parts of the question.

Conversely, analytical observation realized that some of the students scored high marks (7.0-10.0). Students in this category demonstrated their mastery skills on the concepts and theories related to the topic of *Temperature*. They were able to identify three types of temperature scales and with scientific reason, they chose the best thermometric liquid. Furthermore, they provided a clear response on limitations and precautions needed when using clinical thermometers in part (b). Extract 4.2 shows a sample of correct responses in Question 4.

4. (a) (i) What are the three temperature scales that are commonly used? **(3 marks)**

(a) Celcius scale (°C)
(b) Fahrenheit Scale (°F)
(c) Kelvin Scale (K)

(ii) Which liquid would you use to construct a simple liquid-in-glass thermometer using mercury, alcohol and water as thermometric liquids? Give a reason for your answer. **(4 marks)**

I would use mercury to construct a simple liquid-in-glass thermometer because of the following reasons.

- Mercury does not wet glass while water and alcohol wets glass.
- Mercury is a good conductor of heat while water and alcohol are poor conductor of heat.

That is why I would use mercury rather than alcohol and water.

(b) Write a limitation and two precautions of using the clinical thermometer. **(3 marks)**

Limitation

The clinical thermometer is delicate and can break easily.

Precautions

(i) Keep the thermometer away from unsupervised children.

(ii) Sterilize after use to avoid contamination.

Extract 4.2: A sample of correct responses in Question 4

In extract 4.2, a student managed to provide appropriate answers to almost all parts of the question.

2.2.3 Question 5: Newton's Laws of Motion

This question consists of part (a), (b), and (c). Part (a): Explain why a person falls in the direction of a slow-moving car when they jump from it. Part (b): Briefly explain two examples of real-life situations where Newton's Third Law of Motion is applied. Part (c): Provide reasons why action and reaction forces do not cancel each other out.

A total of 794,493 (100%) students attempted the question out of which 770,905 (97.03%) scored from 0.0 to 2.5 marks, 18,373 (2.31%) scored from 3.0 to 6.0 marks and 5,215 (0.66%) scored from 6.5 to 10.0 marks. The general performance was weak since 770,905 (97.03%) scored from 0.0 to 2.5 marks. Figure 5 denotes the performance of students in Question 5.

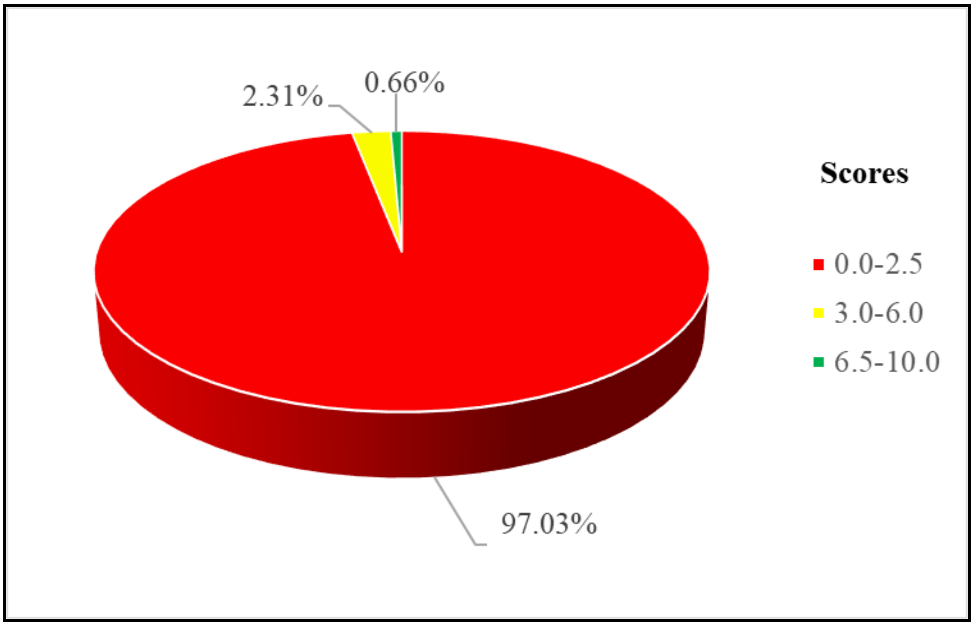


Figure 5: *Students' Performance in Question 5*

Most of the students scored low marks (0.0-2.5) on this question. This suggests that lacked adequate knowledge and skills related to the laws of motion. Most of them provided wrong arguments. For example, one student wrote *the person did not resist the change in motion of the car since it is moving at a slow speed*. This was a wrong response. The student was supposed to know that if the person does not resist the change in motion, they will remain in uniform motion and will not fall forward. Some of the students provided irrelevant responses. For instance, one student wrote *a person falls in the direction of a slow moving car id he/she jumps from it because the pressure applied when he/she jumps is direct proportion to the direction*. This is not a correct response and makes no sense in Physics.

In part (b), students provided examples but failed to explain them correctly. For instance, one student wrote, "Newton's third law of motion is applied when a person shoots a gun; the force from the gun pulls him forward." These students only acknowledged the action force that pushes the gun forward, neglecting the reaction force that pushes the person backwards. This indicates a lack of competence in applying Newton's third law of motion.

The students who failed to score high marks also provided incorrect responses in part (c) as well. Some of the students *Action and reaction do not cancel because they occur in pairs*. Looking at this response, it can be said that these students know that the two forces exist in pairs. These students were supposed to know that according to Newton's third law of motion, two forces are equal in magnitude but act in opposite directions. They do not cancel because they act on different bodies. Some students provided irrelevant responses. For example, *one student wrote action and reaction forces do not cancel each other because both action and reaction forces depend on each properties. So, if the action has its properties and the reaction forces have it's properties that can not mix with action forces.* This response is irrelevant and makes no sense in the laws of motion. Extract 5.1 provides a sample of incorrect responses from Question 5.

5. (a) Why does a person falls in the direction of a slow moving car if he/she jumps from it? **(2 marks)**

A person falls in the direction of a slow moving car if he/she jumps from it be-cause the pressure applied when he/she jumps is direct propotional to the directio n.

(b) Briefly explain two examples that show the applications of Newton's third law of motion in real life situations. **(3 marks)**

i/. The first example of aplication of Newton's third law of motion is when a bus or car stop without known. ~~immedietly~~ ~~immediately~~, the passangers move ~~ford~~ foward to the bus or car.
ii/. Second example is when you push a body at backward, the body go with same direction to force.

(c) Why action and reaction forces do not cancel each other? **(5 marks)**

~~The action and reaction forces do not cancel each other because ~~other~~ each other have it's properties and rule for happenning. So does not cancel each other.~~

Action and reaction forces do not can-cell each other because both action and reaction forces depend on each properties. So, if the action has it's properties and the reaction forces have it's prope rties that can not mix with action forces.

Extract 5.1: A sample of the incorrect responses in Question 5

Observations revealed that only a few students (2.97%) answered this question correctly. Those who provided the correct responses demonstrated their mastery skills of the concepts, theories and laws of motion. For example, in part (a) these students applied the law of inertia to give the correct response. They correctly responded part (b) by applying Newton's third law in a real-life situation. Similarly, in part (c), students understood that action and reaction forces are distinct forces that act on different bodies. Extract 5.2 provides a sample of correct responses for Question 5.

5. (a) Why does a person falls in the direction of a slow moving car if he/she jumps from it? (2 marks)

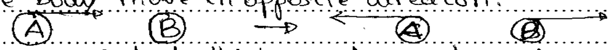
At a time when a car moving with a person, the person's body adopt the inertia of motion. Therefore when he or she jumps to the ground from a moving car, his or her feets are forced to stop by the ground but other parts of the body continue with motion. So, this cause a person to fall in direction of moving car.

(b) Briefly explain two examples that show the applications of Newton's third law of motion in real life situations. (3 marks)

(i) Rocket propulsion: A rocket propel gas out of it as a result a gas exert a force to the rocket and push it upward.
(ii) Walking: While walking, feet exert a force to the ground as a result ground exert a reaction force by pushing the body forward.

(c) Why action and reaction forces do not cancel each other? (5 marks)

Action and reaction forces do not cancel each other because they act onto different bodies. For example, A body "A" which is in motion collide with a body "B" which is at rest, After collision those body move in opposite direction.



Therefore, A body "A" exert a action force to a body "B". Then, a body "B" react with a reaction force over body "A". Therefore, these forces can not cancel each other because they exerted to different bodies. Also, they are only in opposite direction.

Extract 5.2: A sample of the correct responses in Question 5

2.2.4 Question 6: Motion in a Straight Line

This question had two parts: (a) and (b). This question was a numerical question that intended to assess the ability of students to use mathematical skills to assess the motion of a body under gravity to determine the height of the tree from the ground to the top, where a bird had been perched before it fell to the ground with a velocity of 80 m/s.

A total of 794,493 (100%) of students attempted the question such that 710,844 (89.47%) scored from 0.0 to 2.5 marks, 43,238 (5.44%) scored from 3.0 to 6.0 marks and 40,411 (5.09%) scored from 6.5 to 10.0 marks. The general performance was weak since 83,649 (10.53%) scored from 3.0 to 10.0 marks. Figure 6 shows the performance of students in Question 6.

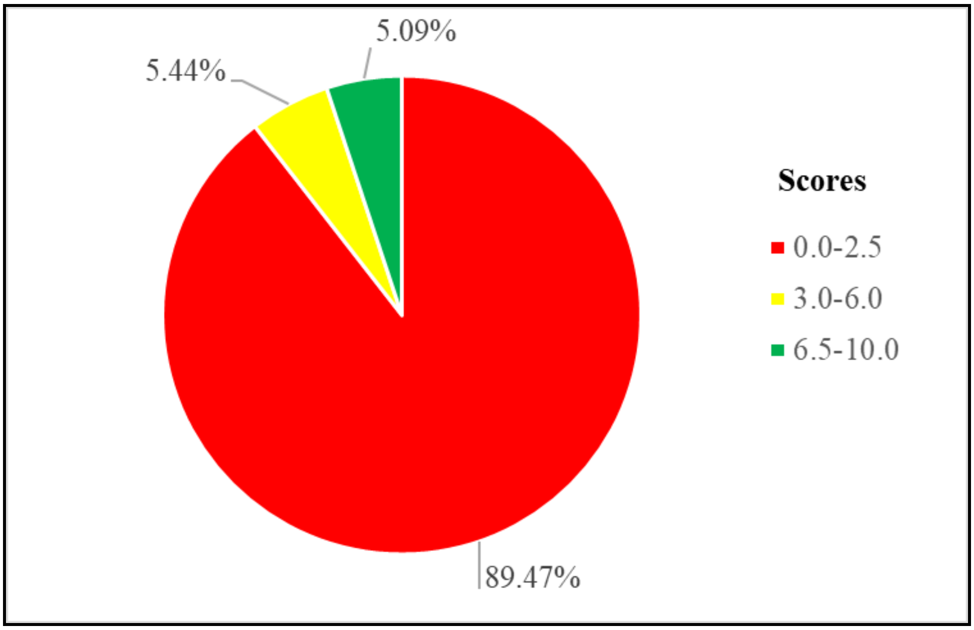


Figure 6: *Students' Performance in Question 6*

In this question, the majority of students (89.47%) scored low marks (0.0-2.5). Students of this category failed to apply mathematical skills to analysis physical phenomena, particularly motion of a body under gravity. Most of the students applied the wrong mathematical equations. For example, one student used a mathematical formula $h = ut - \frac{1}{2}gt^2$. This is a correct mathematical motion to describe the motion of a body. However, this student was supposed to realize that the body was moving in the same direction of gravity. Thus, the acceleration due to gravity is supposed to be positive. The student was supposed to use the equation $h = ut + \frac{1}{2}gt^2$ to describe motion of the body. Some students wrote irrelevant mathematical formula. For instance, one student used the formula $v = u + gh$ to find the height (h) of the tree. Another student used the formula $v^2 = u + 2gt$. This was wrong expression and make no sense in physics because they not dimensionally correct. Another student plotted the velocity time graph instead of applying the equations of motion to analyze the motion of a body under gravity. Extract 6.1 shows a sample of incorrect responses in Question 6.

6. Suppose a bird is on top of a tree and a boy who is at rest throws a stone to hit it such that the bird falls and strikes the ground with a velocity of 80 m/s:

(a) Determine the height of the tree from the ground to its top. **(5 marks)**

~~Data~~ Solution
Velocity = 30m/s
bird is on top
height of the tree =?
formular
$h = \pi r^2$
$80m/s = 3.14 \times x^2$
$\frac{80m/s}{3.14} = \frac{3.14x}{3.14}$
$x = 25.11$
The height of the tree is 25.11

(b) Calculate the time taken by the bird to hit the ground. **(5 marks)**

Solution
$Time = \frac{height}{weight}$
$\frac{Time}{1} = \frac{25.11}{80m/s}$
$80m/s\,T = 25.11 \times 1$
$\frac{80T}{80} = \frac{25.11m}{80m/s}$
$T = \frac{2511}{8000}$
$T = 1208.8s$

Extract 6.1: A sample of the incorrect response in Question 6

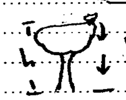
In Extract 6.1, a student applied incorrect and irrelevant mathematical equation to analyze the motion of a body under gravity.

On the other hand, a few numbers of students (10.53%) scored high marks (6.5-10.0). These students applied correct mathematical formula and computed required values correctly. Interestingly, one of the students applied the law of conservation of energy to predict the motion of the body. The student used $\frac{1}{2}mv^2 = mgh$ to determine the value of the height of the tree. Moreover, these students were able to apply correct formula to determine the time taken for a bird to hit the ground. Thus, it can be concluded that these students had ability to use mathematical equation to describe the motion of a body under gravity correctly. Extract 6.2 shows a sample of correct responses to Question 6.

6. Suppose a bird is on top of a tree and a boy who is at rest throws a stone to hit it such that the bird falls and strikes the ground with a velocity of 80 m/s:

(a) Determine the height of the tree from the ground to its top. **(5 marks)**

soln



Data given

$u = 0\ m/s$

$v = 80\ m/s$

Final velocity = 80 m/s

Initial velocity = 0 m/s

Reqd: height, s

From third equation

$v^2 = u^2 + 2as$

$(80\ m/s)^2 = (0\ m/s)^2 + 2 \times 10\ m/s^2 \times s$

$\frac{6400\ m^2/s^2}{20\ m/s^2} = \frac{20\ m/s^2\ s}{20\ m/s^2}$

$s = 320\ m$

height = 320 m

The height of the tree is 320 metres.

∴ The height of the tree from the ground to its top is 320 metres.

(b) Calculate the time taken by the bird to hit the ground. **(5 marks)**

soln

Data given

Initial velocity = 0 m/s

Final velocity = 80 m/s

Height = 320 m

Reqd: Time taken

From the first equation of motion

$v = u + at$

$80\ m/s = 0\ m/s + 10\ m/s^2 \times t$

$\frac{80\ m/s}{10\ m/s^2} = \frac{10\ m/s^2\ t}{10\ m/s^2}$

$t = 8\ s$

Time taken = 8 s

∴ The time taken by the bird to hit the ground is 8 seconds.

Extract 6.2: A sample of the correct response in Question 6

2.2.5 Question 7: Simple Machines

The question consisted of two parts: (a) and (b). Part (a) required students to outline four types of simple machines. Part (b) focused on the concept of the pulley system and was designed to assess the ability of students to apply mathematics skills to evaluate the mechanical advantage and efficiency of the pulley system.

A total of 794,493 (100%) of students attempted the question out of which 488,205 (61.45%) scored from 0.0 to 2.5 marks, 155,207 (19.54%) scored from 3.0 to 6.0 marks and 151,081 (19.01%) scored from 6.5 to 10.0 marks. The general performance was average since 306,288 (38.55%) of the students scored from 3.0 to 10.0 marks. Figure 7 portrays the performance of students in Question 7.

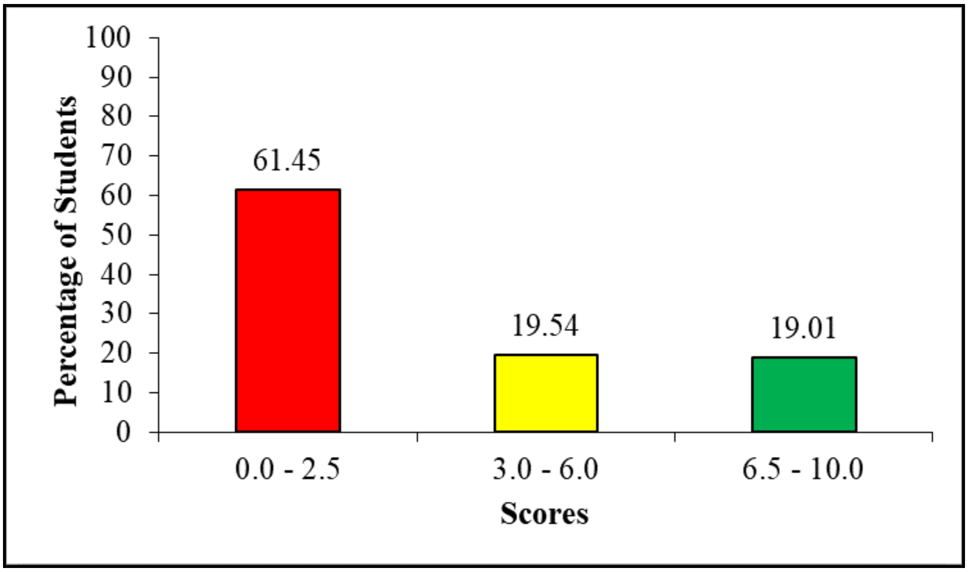


Figure 7: *Students' Performance in Question 7*

Students who scored 3.0-10.0 marks had adequate knowledge and skills on the topic of simple machine. Most of them were able to identity type of the simple machines. Moreover, they were able to apply mathematical formula to evaluate the mechanical advantage and efficiency of a given simple machines. They wrote parts $M.A = \frac{Load}{Effort}$ and $e = \frac{M.A}{V.R} \times 100\%$. Moreover, they were able to substitute data and perform mathematical computations correctly. Extract 7.1 shows a sample of correct responses to Question 7.

7. (a) Outline four types of simple machines. **(4 marks)**

(i) Inclined plane

(ii) Pulley

(iii) Lever

(iv) Wheel and axle

(b) The block and tackle pulley system has a velocity ratio of 4. If a load of 225 N is raised by using a force of 75 N; Determine:

(i) The mechanical advantage of the system. **(3 marks)**

Solution

Data given:

Load = 225N

velocity ratio = 4

Effort = 75

from: $M \cdot A = \frac{\text{Load}}{\text{Effort}} = \frac{225N}{75N} = 3$

∴ The Mechanical Advantage of the system is 3

(ii) The efficiency of the system. **(3 marks)**

from: $\text{Efficiency} = \frac{M \cdot A}{V \cdot R} \times 100\%$

$= \frac{3}{4} \times 100\%$

$= 3 \times 25\%$

$\text{Efficiency} = 75\%$

∴ Therefore, the Efficiency of the system is 75%

Extract 7.1: A sample of correct responses in Question 7

However, most of the students scored low marks (0.0-2.5). These students had insufficient knowledge and skills on the topic of Simple machines. In part (a), most of the students in this category failed to outlined types of simple machine. Some students cited items such as *wheelbarrows,* *nutcrackers, bottle openers, and pairs of scissors*. These students were supposed to know that those were examples of levers and not types of simple machines. confusing examples of levers with the types of simple machines. Some of the students mentioned *tractors, motorcycles, and cars*. This was an incorrect response as the mentioned machines are complex and not types of simple machines. Another wrote *simple electric circuit and simple ammeter circuit*. This was incorrect response and make no sense as per simple machine context. These students were supposed to realize that there are six types of simple machines levers, inclined planes, wheel and axle, hydraulic press, pulleys, and screws.

In parts (b) (i) and (ii), these students used incorrect formulas to calculate the mechanical advantage and efficiency of a machine.

They used $Efficiency = \frac{V.R}{M.A} \times 100\%$ instead of $Efficiency = \frac{M.A}{V.R} \times 100\%$. One student used an incorrect formula, "$M.A = Load \times force$ *and* $\mathrm{e} = \frac{\text{load} \times \text{force}}{\text{velocity}}$*.*" All of these formulas are incorrect and do not enable students to obtain the expected values of both the mechanical advantage and efficiency of a machine. Extract 7.2 presents a sample of incorrect responses to Question 7.

7. (a) Outline four types of simple machines. **(4 marks)**

(i) Single movapo pule

(ii) Single fixid pule

(iii) nife

(iv) ho

(b) The block and tackle pulley system has a velocity ratio of 4. If a load of 225 N is raised by using a force of 75 N; Determine:

(i) The mechanical advantage of the system. **(3 marks)**

Data given

velocity ratio 4

Load of 225 N

force of 75 N

mechanical advantage = $\frac{Ed}{Ld}$

$m.A = \frac{75}{225}$

$MA = 0.333$

(ii) The efficiency of the system. **(3 marks)**

Data given

VR = 4

load 225 N

force of 75 N

formulea

efficiency = $\frac{\text{work input}}{\text{work output}} \times 100\%$

efficiency = $\frac{225}{4} \times 100\%$

efficiency = $\frac{225}{4} \times 100\%$ $\frac{400}{225} = \frac{225}{225}$

efficiency = 56.25 x 100

efficiency = 5625.0

Extract 7.2: A sample of incorrect responses in Question 7

In Extract 7.2, the candidate incorrectly referred to pulleys as simple machines, rather than as types of simple machines. Additionally, the candidate applied an incorrect formula to calculate mechanical advantage by dividing effort distance by load distance, which is the formula for calculating the velocity ratio. As a result, the candidate came up with incorrect answers.

2.2.6 Question 8: Forces in Equilibrium

This question consists of two parts: (a) and (b). In part (a), students are required to explain the relationship between the stability of a bus and its center of gravity. Part (b) is divided into two items: (i) and (ii). In part (b) (i), students were asked to suggest materials that could be used to measure the weight of a metre rule using the concepts of equilibrium. In part (b) (ii), students were required to sketch and describe an experimental setup that could be used to determine the weight of the metre rule, again applying the concept of equilibrium.

A total of 794,493 (100%) students attempted the question, out of which 722,035 (90.88%) scored from 0.0 to 2.5 marks, 65,236 (8.21%) scored from 3.0 to 6.0 marks and 7,222 (0.91%) scored from 6.5 to 10.0 marks. The general performance was weak since 722,035 (90.88%) scored from 0.0 to 2.5 marks. Figure 8 shows the performance of students in Question 8.

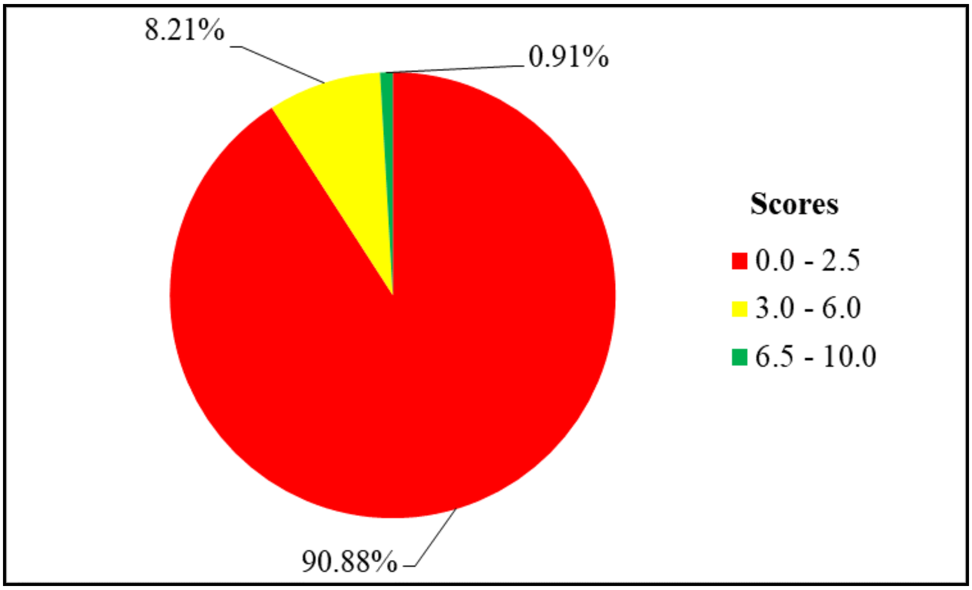


Figure 8: *Students' Performance in Question 8*

The analysis revealed that the students whose scores ranged from 0.0 to 2.5 marks had insufficient knowledge and skills on the topic of Force in equilibrium. Most of them failed to provide the correct response. For example, in part (a) some of the students failed to describe the relationship between the position of the centre of gravity and the stability of the body. For instance, one student responded, *the lower the center of gravity the less* *the stability.* This was not a correct response. Some of the students provided irrelevant responses. For instance, one student wrote *it is important to keep the centre of gravity of motor bus as low as possible because the motor-bus contains high weigh may cause damage of the car*. This was not a correct response and make no sense.

Moreover, the students in this category failed to apply the concepts, theories and principles of force in equilibrium to determine the weight of metre rule. They failed to identify the materials that may be used to determine the weight of the metre rule. One of the students wrote *Stable equilibrium, unstable equilibrium and Neutral Equilibrium* as materials to determine the weight of the metre rule. This was not a correct answer. This student was supposed to realize that stable equilibrium, unstable equilibrium and neutral equilibrium are states of equilibrium and not materials used to determine the weight of the metre rule. In part (b) (ii), most of the students provided the wrong experimental setup and sketch. One student provided a sketch of the spring balance. Indeed, spring balance is used to determine the weight of the substance. However, as per question demand, the students were supposed to apply the concepts, theories and principles related to the force in equilibrium to determine the weight of metre rule. In Extract 8.1 shows a sample of incorrect responses in Question 8.

8. (a) Why is it important to keep the centre of gravity of a motor-bus as low as possible? **(2 marks)**

It is important to keep the centre of gravity of motor-bus as low as possible because the motor-bus contain high weight may cause damage of the car.

(b) Your Physics teacher has assigned you to determine the weight of a meter rule using the concept of forces in equilibrium.

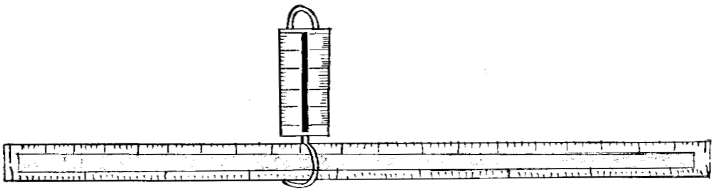
(i) Name three types of materials which should be used in the task given. **(3 marks)**

i, Apparent weight

ii, Real weight

iii. Upthrust weight

(ii) With a aid of a diagram, explain how you will determine the weight of the meter rule. **(5 marks)**



The weight of ~~an~~ a meter ruler can be determined through the upper numbers which have length of 5 each distance and the numbers which have the length of 15 each distance.

Extract 8.1: A sample of the incorrect responses in Question 8

Extract 8.1 shows a sample of students who poorly performed this question. The responses of this student make no sense as per question demand.

On the contrary, a few students scored high (6.5-10.0), suggesting they had enough knowledge and skill on the topic of forces in Equilibrium. They were able to provide the relationship between gravity and the stability of the bus. Moreover, they demonstrated their mastery skills in applying concepts, theories and principles of forces in equilibrium in real-life situations. These students effectively outlined materials that could be used to determine the weight of a meter rule. They proposed that standard masses, a knife edge, and cotton thread/string as the materials needed to determine the weight of the meter rule. They provided a correct sketch that can be used to determine the weight of the metre rule. Further, they provided the correct procedure for the proposed experimental setup. This is an indication that they had enough experimental skill in this concept. Extract 8.2 shows a sample of correct responses to Question 8.

8. (a) Why is it important to keep the centre of gravity of a motor-bus as low as possible? **(2 marks)**

• It is important to keep the contre of gravity of a motor-bus as low as possible so as to increase the stability of the motorbus and prevent the motor bus from over turning resulting into accidents. This helps in order to ensure the safety of the motor bus.

(b) Your Physics teacher has assigned you to determine the weight of a meter rule using the concept of forces in equilibrium.

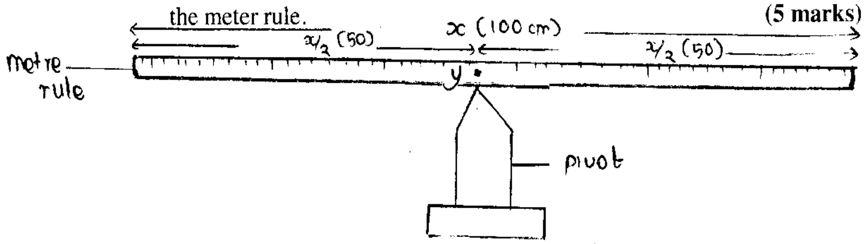
(i) Name three types of materials which should be used in the task given. **(3 marks)**

i) Pivot / knife edge

ii) Metre rule

iii) Mass (load)

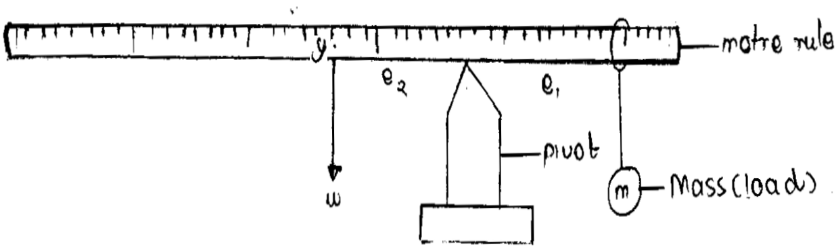
(ii) With a aid of a diagram, explain how you will determine the weight of the meter rule. **(5 marks)**



To determine the weight of the meter rule:

i) First of all, determine the length of the metre rule (x); it is 100 cm or 1m since it is a metre rule

ii) Determine the contre of gravity 'y' of the meter rule. In this case, place the metre rule on the pivot and adjust until when it balances at that point 'y'.



iii) Then, tie a mass (load) on the metre rule by using a string and adjust the metre rule to ensure that it maintains it's state of balance

iv) Record the length of the mass (load) from fulcrum and record it as e_1 and that of weight of metre rule from fulcrum and record it as e_2 then calculate weight of the metre rule by following the condition that

Σ of clockwise moment = Σ of anticlockwise moment

where $w \times e_2 = e_1 \times m$ or, $w = \frac{e_1 \times m}{e_2}$

From there, you will get the weight of your metre rule.

Extract 8.2: A sample of correct responses in Question 8

In Extract 8.2, a student demonstrated a strong understanding of stable equilibrium and the process of determining the weight of the metre rule. As a result, the student was able to provide the correct answers.

2.2.7 Question 9: Sustainable Energy Sources

In part (a), students were asked to describe the meaning of geothermal energy sources and outline the steps involved in generating electricity from geothermal energy. In part (b), students were required to identify three disadvantages of wind energy.

A total of 794,493 (100%) students attempted the question out of which 714,530 (89.93%) scored from 0.0 to 2.5 marks, 69,735 (8.78%) scored from 3.0 to 6.0 marks and 10,228 (1.29%) scored from 6.5 to 10.0 marks. The general performance was weak since the majority of them, 714,530 (89.94%) scored from 0.0 to 2.5 marks. Figure 9 denotes the performance of students in Question 9.

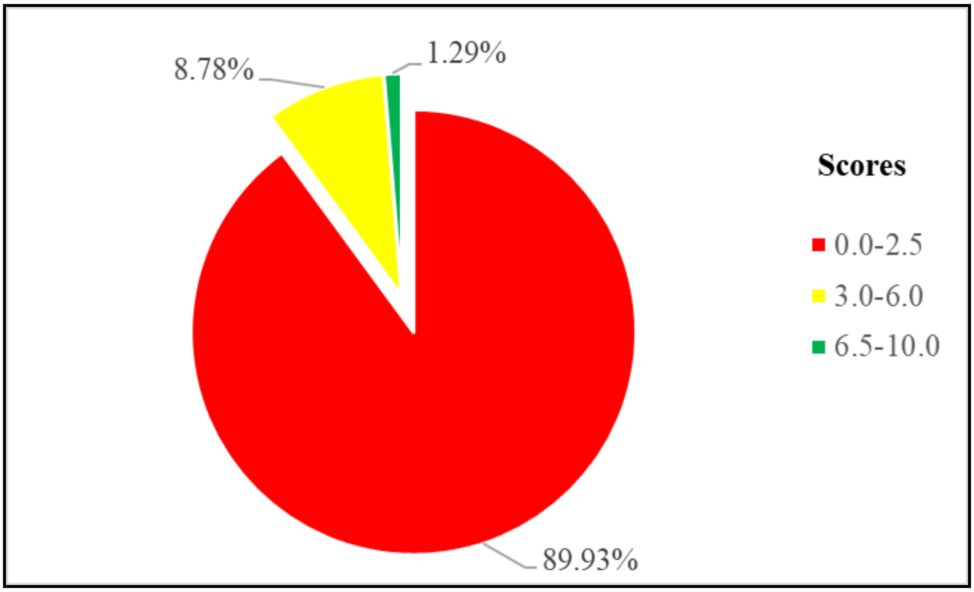


Figure 9: *Students' Performance in Question 9*

The performance of the students on this question was weak as the majority (89.94%) scored low marks, ranging from 0.0 to 2.5. Most students provided irrelevant answers. For example, in part (a) (i), some defined geothermal energy as *a source of energy that is clean and safe for the environment* Indeed, geothermal energy sources are renewable and sustainable energy sources. However, the students were supposed to describe the meaning of geothermal energy sources. Others incorrectly described it as *energy generated from waterfalls*. This was an incorrect response. These students were supposed to realize that geothermal energy is the heat produced by the flow of heat from beneath the Earth's surface.

In part (a) (ii), students who failed to provide correct answers. This suggests that they lacked adequate knowledge and skills on the electricity production by geothermal energy sources. For example, some of the students provided irrelevant responses. For instance, one student wrote *"connect a pipe to the source of geothermal energy, collect heat from underground, cool down the heat, and convert it to electricity, then the electricity is produced. This was a wrong response. It makes no sense in a physics context*." These students seemed to understand the concept of geothermal energy as a source but lacked sufficient knowledge about how it can be exploited. This student was supposed to state that the energy from the Earth's interior heats underground water. The heated water then generates steam. The steam carries this energy, which is converted into mechanical energy by a turbine. The turbine rotates a shaft connected to an electrical generator. Finally, the rotating shaft turns the generator, producing electricity.

In part (b), most of the students provided irrelevant responses. For example, a few students stated that *wind can dry our clothes, wind can give you fresh air, and wind can protect our lives*. Some students wrote, *wind pulls down trees, wind pulls down crops, the wind is used to cook food, the wind pulls down houses*. These answers described the hazardous effects of wind. This student was supposed to provide the disadvantage of wind energy sources.

These students were supposed to realize that wind is sustainable energy source with the following disadvantages:

(a). Wind speed and direction at a given area are not constant over the year. Thus, energy production varies too and it is not reliable.
(b). Wind turbines are noisy and can spoil the landscape.
(c). Large windy sites are required for large scale production
(d). A wind farm affects local wildlife. For example, birds can be killed by flying in rotating wind turbines.
(e). The manufacture and implementation of wind farms is costly.

Extract 9.1 is a sample of incorrect responses from Question 9.

9. (a) (i) What do you understand by the term geothermal as a source of energy.

(3 marks)

geothermal is the source of energy is the source of energ which it have started to been used with people'and its produced by using solar.

(ii) Outline four steps in which electricity is produced from geothermal energy. **(4 marks)**

- geothermal energy are produced by using presence of water; are the energy which are produced by using presence of water in order to produce more light.
- geothermal energy are the energy which produced by using solar; This energy to do work up to the presence of solar due to the sun.
- geothermal energy are produced by the presence of wind energy; This energy are the energy which can be produced to the presence of wind
- geothermal energy are the energy which can be produced by the presence of Biogas; This energy can be produced by using Biogas.

(b) In three points, give the disadvantages of wind energy. **(3 marks)**

i) It can cause the distraction of the environment.

ii) It can cause death to the people.

iii) It can cause bad smell to the environment.

energy can be produced by using Biogas.

Extract 9.1: A sample of the incorrect responses in Question 9

On the contrary, students who responded correctly demonstrated good understanding of the meaning of geothermal energy. They were also able to list four steps involved in harnessing geothermal energy. In part (b), these students correctly outlined the disadvantages of wind energy. Extract 9.2 is a sample of correct responses from Question 9.

9. (a) (i) What do you understand by the term geothermal as a source of energy. **(3 marks)**

Geothermal energy is the energy which is derived from the hot molten material which is found deep in the earth. Sometimes it can come up to the land surface in form of geysers, springs or volcano.

(ii) Outline four steps in which electricity is produced from geothermal energy. **(4 marks)**

- Drill a hole in the ground until to the underground reservoir of heat
- Connect pipes through the hole until to where the reservoir is so as to access the steam.
- Allow the steam to rise through the pipes until to a higher area where it can be accessed easily.
- Direct the steam to the turbines which will in turn drive the generators and thus producing electricity

(b) In three points, give the disadvantages of wind energy. **(3 marks)**

i. It is not reliable since not at all times there is a strong wind which will drive the turbines.
ii. It requires a large land area for establishment of a wind farm large enough to harness a lot of electricity.
iii. It can lead to death of local wild animals for instance birds when they pass or fly onto the moving turbines

Extract 9.2: A sample of the correct responses to Question 9.

2.3. Section C: Structured Question

Section C was a structured question based on the topic of current electricity. It consisted of three parts: (a), (b), and (c), weighing a total of fifteen (15) marks.

2.3.1 Question 10: Current Electricity

The question was based on the topic of current electricity and consisted of three sub-items: (a), (b), and (c). The question read:

"Suppose you are the leader of a Physics laboratory and your teacher asks you to prepare the electrical components and instruments for an experiment to determine the relationship between voltage and current:

(a) List five electrical components that will be used in this experiment.

(b) Draw a simple electric circuit suitable for the experiment.

(c) Using the circuit drawn in part (b), state the criteria for connecting the ammeter and voltmeter in the circuit."

A total of 794,493 (100%) students attempted the question out of which 520,729 (65.54%) scored from 0.0 to 4.0 marks, 179,193 (22.55%) scored from 4.5 to 9.5 marks and 94,571 (11.91%) scored from 10.0 to 15.0 marks. The general performance was average since 273,764 (34.46%) scored from 4.5 to 10.0 marks. Figure 10 denotes the performance of students in Question 10.

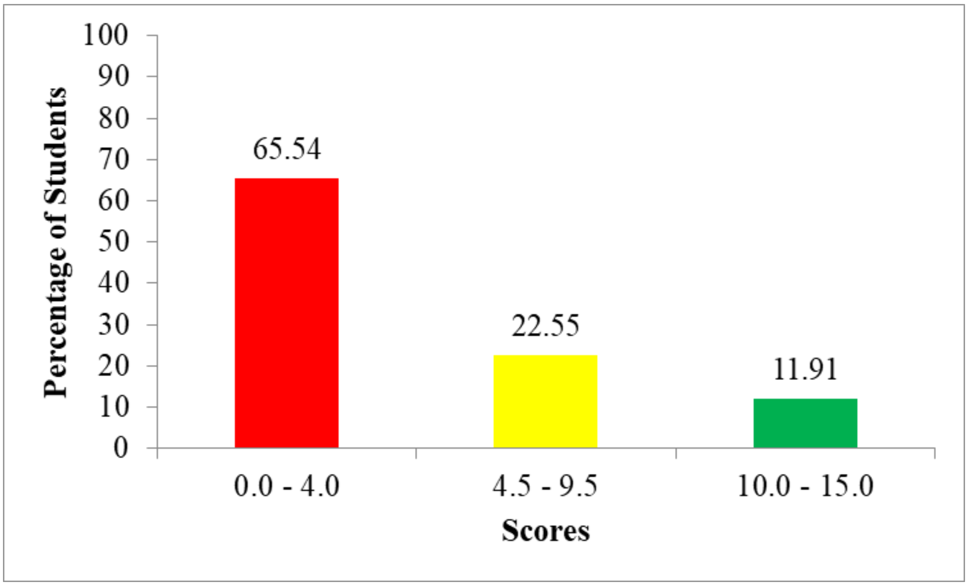


Figure 10: *Students' Performance in Question 10*

The analysis shows that students who scored low marks failed to respond to this question correctly. For example, in part (a), some students wrote r*esistance*, *current*, and *voltage*. These students were supposed to know that voltage and current are not electrical components. These are physical quantities. Some of the students provided irrelevant responses. For instance, one student wrote *water supply, gas system, drainage system, and electricity system*. This was not a correct response and it makes no sense as per question demands. In part (b), the students in this category failed to demonstrate their mastery skills of basic experimental skills, particularly in the current electricity. The design and sketch of a wrong electric circuit for verifying Ohm's law. They failed to connect electrical components in the circuit correctly. For instance, one student connected an ammeter and voltmeter in series. It is impossible to use that circuit to verify Ohm's law.

Some of the students failed to respond to part (c) of this question incorrectly. One student responded to this item by stating Ohm's law. This was a wrong response and it makes no sense as per the question context. One student wrote *the ammeter and voltmeter are connected in the circuit by using a connecting wire*. Indeed, both voltmeter and ammeter are connected with wire in the electric circuit. The student was expected to know that a voltmeter is connected in parallel with a resistor or device to measure the potential difference across it, while an ammeter is connected in series to measure the total current flowing in the circuit. However, this response indicates that the students lacked sufficient knowledge and understanding of the working principles of voltmeters and ammeters. One student incorrectly stated that *a voltmeter is used to reduce the energy of electricity and that an ammeter is used to add energy to electricity if it is too small*. This was a wrong response. Extract 10.1 is an example of an incorrect answer to question 10.

10. Suppose you are a Physics laboratory leader and you are asked by your teacher to prepare the electrical components and instruments for an experiment to determine the relationship between voltage and current:

(a) List down five electrical components which will be used in this experiment. **(5 marks)**

(i) Do not make noise in the laboratory

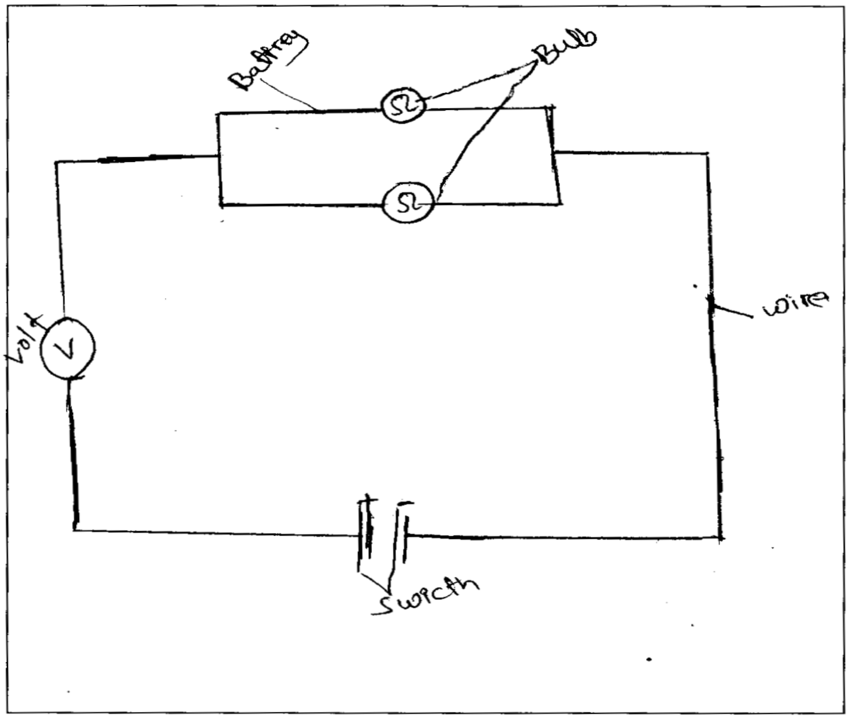
(ii) Do not inter in the laboratory without pumishion.

(iii) Do not Eat In the laborarory

(iv) Do not ~~drang~~ drincing in the laboratory

(v) Do not kerrilless In the laboratory

(b) Draw a simple electric circuit which will be suitable for that experiment. **(5 marks)**



(c) Using the simple electric circuit drawn in 10 (b), state the criteria used to connect the ammeter and voltmeter electrical components in the circuit. **(5 marks)**

wire
bulb
bettrie
swich
voltt

Extract 10.1: A sample of incorrect response in question 10

Further analysis reveals that some students were able to correctly tackle the question.

Students who provided correct responses demonstrated good understanding of various concepts related to current electricity. For example, in part (a), most students successfully listed the circuit components required for an experiment to determine the relationship between voltage and current. They were able to recall the circuit components used to verify Ohm's law.

In part (b), students demonstrated their ability to apply concepts, theories and principles related to current electricity to design and draw a simple circuit to verify Ohm's law. Through a sketch, they correctly connected each component in a manner that allowed for the practical functionality of the circuit.

In part (c), students showed an understanding of the proper setup for ammeters and voltmeters in an electric circuit. They demonstrated knowledge of how to connect the ammeter in series and the voltmeter in parallel, ensuring that the functionality of both instruments was not hindered and that no principles were violated. Extract 10.2 is a sample of a correct response to question 10.

10. Suppose you are a Physics laboratory leader and you are asked by your teacher to prepare the electrical components and instruments for an experiment to determine the relationship between voltage and current:

(a) List down five electrical components which will be used in this experiment. **(5 marks)**

(i) Resistor

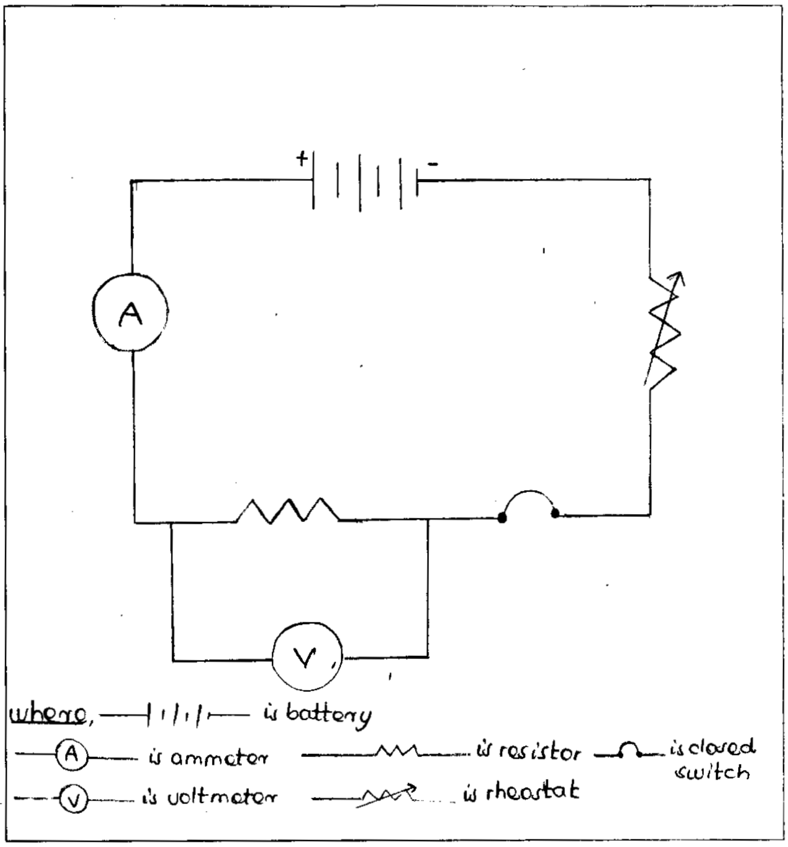
(ii) Rheostat

(iii) Ammeter

(iv) Voltmeter

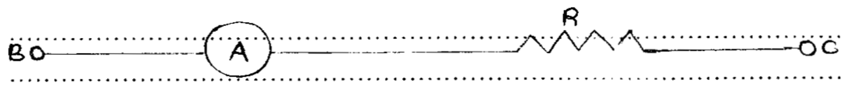
(v) Cell or Battery

(b) Draw a simple electric circuit which will be suitable for that experiment. **(5 marks)**



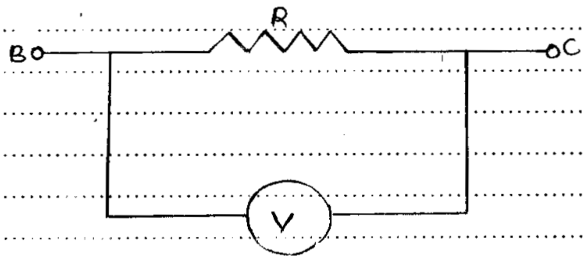
(c) Using the simple electric circuit drawn in 10 (b), state the criteria used to connect the ammeter and voltmeter electrical components in the circuit. (5 marks)

i. How to connect an ammeter
- An ammeter is a device to measure current in a circuit
- An ammeter is connected in series with any other electrical component like bulb, resistor because it has low resistance



where A = Ammeter $\overline{BC}$ = Wire (Connecting wire)
R = Resistor.

ii. How to connect a voltmeter
- A voltmeter is a device which is used to measure a potential difference across a point in a circuit
- A voltmeter is connected in parallel to any electrical component such as bulb and resistor since it has a high resistance



where V = Voltmeter
R = Resistor
$\overline{BC}$ = Wire (Connecting wire)

Extract 10.2: A sample of correct responses in question 10

Extract 10.2 indicates that the student demonstrated adequate knowledge of the electrical components and instruments required in the verification of Ohm's law. The student was also able to correctly sketch the electric circuit, illustrating the proper connections of the ammeter and voltmeter in the circuit to verify Ohm's law.

3.0 ANALYSIS OF THE STUDENTS' PERFORMANCE IN EACH TOPIC

3.1 The Analysis of Students' Performance in each Topic in 2024

The analysis of the 2024 Physics assessment for Form Two students highlights several key findings. While no single topic demonstrated consistently strong performance, the overall performance in Question 1, which assessed various topics, was notably good, with a rate of 74.73%. However, Questions 7 and 10, focusing on *Simple Machines* and *Current Electricity*, showed relatively lower performance, with averages of 38.55% and 34.46%, respectively. Additionally, six topics—*Motion in a Straight Line, Temperature, Magnetism, Sustainable Energy Sources, Forces in Equilibrium, and Newton's Laws of Motion* revealed weak performance, ranging from 2.97% to 29.44%.

The weak performance was attributed to several factors, including students' difficulty in interpreting and identifying the task of the questions, challenges in solving numerical computations, and issues with English language proficiency and drawing skills. Furthermore, many students experienced difficulties in differentiating closely related terms and applying correct Physics terminologies in their responses.

These findings emphasize the need for targeted improvements in students' understanding of core concepts, their ability to apply critical thinking to solve problems, and their mastery of the appropriate terminologies. A more focused approach to teaching and assessment could help address these challenges, as further detailed in Appendix I.

3.2 Comparison of Students' Performance Between the Years 2023 and 2024 in Terms of Topics

The analysis of the topics assessed in 2024, compared to 2023, reveals some minor fluctuations in performance across various topics. While some topics showed improvement, others experienced a decline. For example, a multiple-choice question with ten items covering different topics assessed in Question 1 demonstrated good performance in 2024, with a score of 74.73%. In contrast, the performance in 2023 was average, at 62.92%. This indicates a significant improvement of 11.81% compared to the previous year.

Another significant improvement was observed in the topics of Simple Machines and Current Electricity, where students' performance increased by 14.75% and 24.89%, respectively, in 2024. However, in 2024, the performance of students in the topic of Magnetism decreased by 18.96%, showing a more substantial decline compared to 2023. Though there was a slight increase in students' performance in the topics of Motion in a Straight Line, Temperature, and Forces in Equilibrium in 2024, their overall performance remained weak. Similarly, a slight decrease in performance in the year 2024, was observed in the topics of Sustainable Energy Sources and Newton's Laws of Motion, with scores decreasing by 7.41% and 2.52%, respectively. Appendix II provides a summary of such a comparison.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The general performance on the Physics assessment was weak, with an overall performance of 23.29%. The analysis of students' performance revealed that, students faced significant challenges when attempting the questions. Based on the data and the analysis of the students' scripts, it was observed that inadequate knowledge of the subject matter was the primary reason for the weak performance showed by most students. The analysis identified the following factors contributing to this performance:

Insufficient knowledge and skills in the concepts, theories, and principles of physics related to the subject matter. Due to this, students either failed to provide correct responses or gave irrelevant answers that did not align with the context of the subject matter. Furthermore, most students applied inappropriate formulas when attempting to explain various physics phenomena.

Poor reasoning skills was also a challenge, as most of the students struggled to integrate physics concepts, theories, and principles with real-life scenarios. For instance, many students failed to conceptualize a situation in which a person falls in the direction of motion of a slow-moving car, which they were supposed to relate to the law of inertia.

Insufficient manipulation and computational skills was also observed in students who scored low marks. These students showed limited competence in both applying appropriate formulas and performing the necessary calculations efficiently. As a result, while some students were able to accurately substitute data into the formula, they struggled to correctly execute the final calculation.

Another key factor contributing to weak performance was a lack of language proficiency necessary to effectively present responses. Many students made grammatical errors in their responses, and in some cases, failed to provide detailed information relevant to the demands of the question.

It can be generalized that most students lacked 21^{st} - century skills such as critical thinking, creativity, problem-solving, and communication skills. These factors collectively contributed to the weak performance of the students.

4.2 Recommendations

Based on the analysis of the students' item responses, the following recommendations are made to improve performance in Physics, particularly, on topics where students showed weak performance, in future assessments. Thus, teachers are urged to:

(a) use materials such as heavy loads, bottles, cards, and coins to encourage discussion about the behaviour of objects when there is a sudden change in their state of motion. Additionally, they should organize demonstrations to show that action and reaction forces are related but do not cancel each other out, as they act on different bodies. This can be done using materials like stiff spiral springs, blocks of wood, tables, and retort stands.

(b) guide students in groups to brainstorm about geothermal energy as a source of power, using a diagram of a geothermal plant and online resources. They should then lead discussions on how geothermal energy can be converted into electricity, utilizing materials such as manila paper, scissors, glue, marker pens, a website, and a geothermal plant diagram. Additionally, they should organize an educational visit to a location where a windmill is used, allowing students to study the limitations of applying wind energy in daily life.

(c) lead discussions using solid objects of various shapes and models of buses or lorries to illustrate how to apply conditions for the stability of different objects. Additionally, they should use a variety of masses, a knife edge, and a wooden bar to guide students in conducting experiments to verify the principle of moments and determine the weight of a meter rule or wooden bar.

(d) use materials such as water, heaters, balloons, and liquid-in-glass thermometers to help students identify measurable physical quantities that change with temperature and apply different temperature scales to record the temperatures of various objects. They should also guide students in identifying a suitable liquid to use as a thermometric liquid. Additionally, they should use a question-and-answer approach to help students discuss the limitations and precautions associated with using a clinical thermometer.

(e) guide students in peer groups to identify different types of magnets based on their shapes, such as U-shaped, bar, cylindrical, horseshoe, and field magnets. They should also lead students in experimenting to study the pattern of magnetic field lines around a bar magnet, using materials and instruments like bar magnets, iron fillings, plain paper, pencils, and a compass needle.

(f) encourage students to use the think-pair-share approach to explore the motion of bodies thrown vertically upwards and falling bodies. Using materials such as stones and balls, students should determine the height and time it takes for the bodies to travel from the ground to the top or from the top to the ground.

(g) encourage the use of the English language when discussing various physics concepts in classroom and during extracurricular activities. They should also encourage students to read a variety of books to enhance their critical thinking and improve their English proficiency.

(h) continue teaching and practicing computation skills that are required in solving different questions involving calculations.

(i) emphasizing experimentation, demonstrations, and drawing activities is essential for helping students develop drawing competence across various topics.

Appendix I: The Performance of Students in Each Question

S/N	Topic	Question Number	% of Students who Scored an Average of 30% or Above	Remarks
1	Introduction to Physics, Introduction to Laboratory Practice, Measurement, Force, Archimedes' Principle and the Law of Floatation, Structure and Properties of Matter, Pressure, Work, Energy and Power, Light, and Static Electricity	1	74.73	Good
2	Simple Machines	7	38.55	Average
3	Current Electricity	10	34.46	Average
4	Motion in a Straight Line	2&6	29.44	Weak
5	Temperature	4	24.52	Weak
6	Magnetism	3	15.1	Weak
7	Sustainable Energy Sources	9	10.06	Weak
8	Forces in Equilibrium	8	9.12	Weak
9	Newton's Laws of Motion	5	2.97	Weak

Appendix II: Comparison of Students' Performance between 2023 and 2024 in terms of Topics

S/N	Topic	FTNA 2024			FTNA 2023		
		Question number	% of Students who Scored an Average of 30% or Above	Remarks	Question number	% of Students who Scored an Average of 30% or Above	Remarks
1.	Introduction to Physics, Introduction to Laboratory Practice, Measurement, Force, Archimedes' Principle and the Law of Floatation, Structure and Properties of Matter, Pressure, Work, Energy and Power, Light, and Static Electricity	1	74.73	Good	1	62.92	Good
2.	Simple Machines	7	38.55	Average	7	23.80	Weak
3.	Current Electricity	10	34.46	Average	10	9.57	Weak
4.	Motion in a Straight Line	2&6	29.44	Weak	6	8.94	Weak
5.	Temperature	4	24.52	Weak	4	1.23	Weak
6.	Magnetism	3	15.10	Weak	3	34.06	Average
7.	Sustainable Energy Sources	9	10.06	Weak	9	17.47	Weak
8.	Forces in Equilibrium	8	9.12	Weak	8	2.18	Weak
9.	Newton's Laws of Motion	5	2.97	Weak	5	5.49	Weak