THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENT'S ITEMS RESPONSE ANALYSIS REPORT ON THE FORM TWO NATIONAL ASSESSMENT (FTNA), 2025

ENGINEERING SCIENCE (VOCATIONAL STREAM)

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035 ENGINEERING SCIENCE (VOCATIONAL STREAM)

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

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FOREWORD

This report presents Student's Item Response Analysis (SIRA) on the Form Two National Assessment (FTNA) on the Engineering Science subject for the Vocational Stream, which was conducted in 2025. It offers feedback to students, teachers, parents and other education stakeholders to help track students' progress and identify areas that require improvement.

The goal of the Form Two National Assessment (FTNA) is to monitor students' progress throughout their learning and to provide continuous feedback that helps students improve their academic performance. In addition, it supports teachers and other educational stakeholders in improving the quality of teaching and learning processes and in making informed administrative decisions.

This report aims to enhance understanding of the possible reasons underlying student's performance in the Engineering Science subject for the Vocational Stream. The report highlights factors that contributed significantly to good performance in certain questions, including the ability to identify the requirements of the questions, competency in performing arithmetical calculations and adequate knowledge of relevant laws, principles and formulae in Engineering Science.

In contrast, students who performed poorly faced several challenges, such as insufficient knowledge and skills in the assessed competencies, weak mathematical skills, inability to interpret tasks and illustrate required drawing skills and poor proficiency in English language.

The National Examinations Council of Tanzania (NECTA) believes that, this report will be useful to teachers, parents and other educational stakeholders, as the assessment findings can inform better decisions on how to improve the quality of teaching and learning, thereby supporting the achievement of instructional objectives in future assessments.

The Council appreciates the efforts of all those who, in one way or another, contributed to the preparation of this report.

Prof. Said Ally Mohammed
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report provides useful information on student's performance in the Form Two National Assessment (FTNA) in the Engineering Science subject. The assessment was set in accordance with the 2024 Engineering Science syllabus and the revised assessment format of 2025. It assessed the competencies attained by students after completing two years of study in ordinary secondary school.

The assessment paper was divided into three sections: A, B and C. Section A consisted of two objective questions in the form of multiple-choice and matching items, carrying a total of 15 marks. Section B comprised of seven short answer questions, carrying a total of 70 marks. Section C contained one structured question worth 15 marks. All questions in all sections were compulsory.

A total of 1,392 (100%) students sat for the Engineering Science subject. The analysis indicates that, the overall performance in the Engineering Science subject for the Vocational Stream in 2025 was good, with 937 (67.31%) students passing the assessment and 455 (32.69%) students failing the assessment.

Student's performance in this report is categorized into three levels; weak, average and good corresponding to score ranges of 0-29, 30-64 and 65-100 percent, respectively. The results are presented using figures and tables with a colour-coded scheme, where red indicates weak performance, yellow represents average performance and green denotes good performance. Figure 1 illustrates the performance by grade of the 1,392 students who sat for the Engineering Science assessment in 2025.

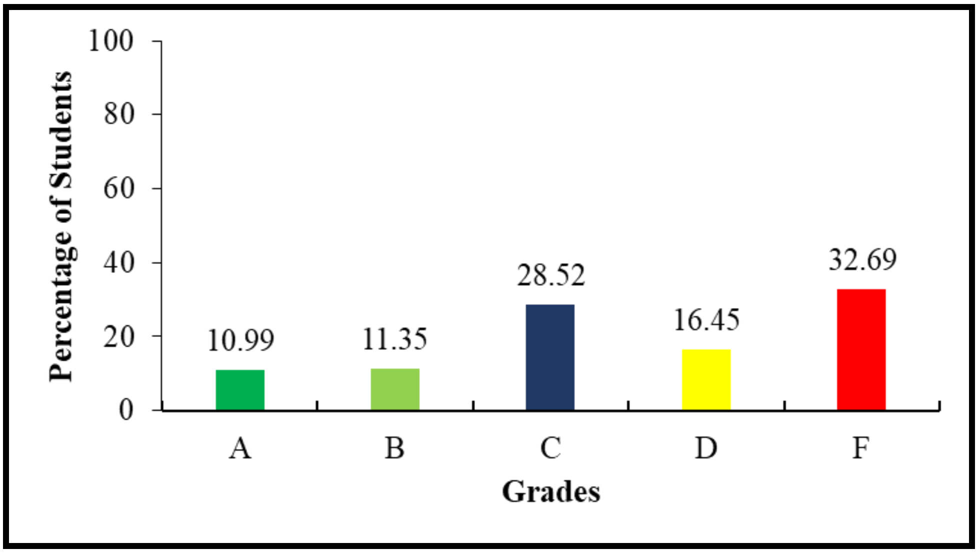


Figure 1: *The grade wise performance of students who sat for Engineering Science in 2025*

2.0 ANALYSIS OF STUDENTS' RESPONSES TO EACH QUESTION

The report offers an overview of student's performance on each question. The analysis covers question types, their requirements, the specific competencies they are based on and how students responded.

2.2 SECTION A: OBJECTIVE QUESTIONS

This section comprised of two objective questions. A multiple-choice question with ten (10) items, each carried 1 mark, making a total of ten (10) marks and matching items question with five items each item worth 1 mark, making a total of 5 marks. The whole section had 15 marks.

2.1.1 Question 1: Multiple Choice Items

This question had 10 items, (i) - (x). Students were required to choose the most correct answer among the given alternatives and write its letter in the box provided. The items were set from ten (10) specific competencies which are: *Fluid Mechanics, Introduction to Engineering Science, Mechanical Drives, Linear Motion, Measurements of physical quantities, Thermal Energy, Work, energy and power, Pressure, Force, Mechanical Properties of Matter.*

A total of 1,392 (100%) students attempted the question. The analysis indicates that 123 (8.84%) students scored from 0 to 2 marks, 957 (68.75%) students scored from 3 to 6 marks and 312 (22.41%) students scored from 7 to 10 marks. These scores indicate that student's performance in this question was good, as 1,269 (91.16%) of the students scored above the pass mark. Figure 2 shows student's performance in this question.

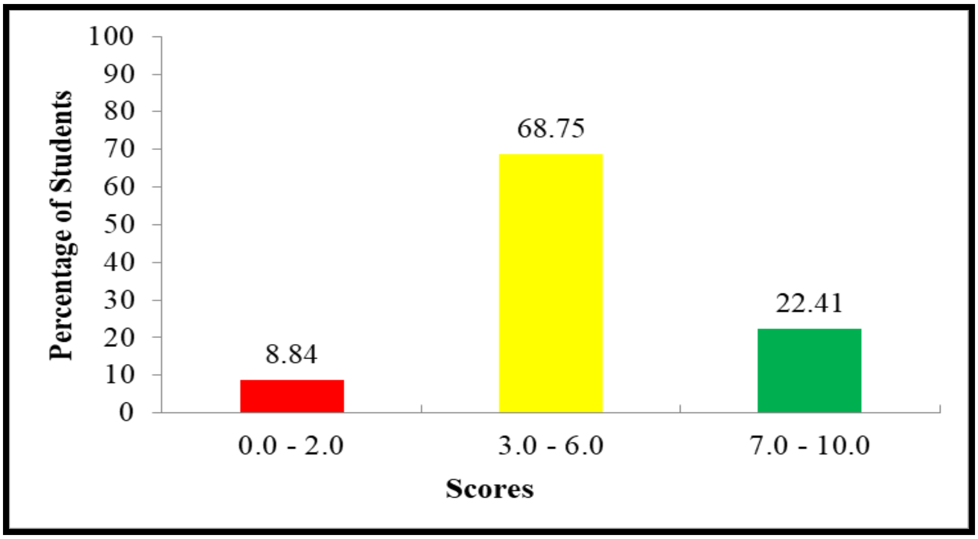


Figure 2: *The Student's Performance in Question 1*

The analysis reveals that the general performance in this question was good, as 1,269 (91.16%) of the students scored above the pass mark. This indicates that the students had adequate knowledge on the tested subject matter. On the other hand, some students who scored lower marks (0 - 2), failed to understand the concepts assessed. The analysis of each item is as follows:

Item (i) was constructed from the specific competency *Fluid Mechanics*. The question was intended to assess student's ability to apply the concepts of density and the law of flotation to describe the conditions under which a body floats on water. The question was as follows:

Why does a ship floats in water despite its size?

A *The density of ship is less than that of water*

B *The density of ship is equal to the density of water*

C *The average density of ship is equal to the density of water*

D *The average density of ship is less than the density of water*

The correct answer was alternative *D, The average density of ship is less than the density of water*. The students who chose alternative D, had adequate knowledge of applications of density and the law of floatation. They understood that although the materials of the ship (like steel) are denser than water, the air spaces within the ship reduce its overall average density. Students who chose an alternative *A, The density of ship is less than that of water,* failed to understand the intended question. They recognized that density affects flotation but failed to consider that it is the average density of the ship. Students who chose an alternative *B, The density of ship is equal to the density of water,* had inadequate knowledge on the law of flotation. They misunderstood that neutral buoyancy occurs when densities are equal, which does not result in the ship floating fully on the surface. Students who chose an alternative *C, The average density of ship is equal to the density of water,* had insufficient knowledge on the law of flotation, as floating requires the average density of the ship to be less than, not equal to the density of water.

Item (ii) was composed from the specific competency *Introduction to Engineering Science and* it assessed the ability to analyze the concepts related to engineering science. The question was as follows:

Which statement is true about engineering science?
A *It uses scientific knowledge to operate*
B *It is the mother of science*
C *It formulates its laws and principles to operate*
D *It is the grass root of science*

The correct answer was alternative *A, It uses scientific knowledge to operate*. The students who chose this option understood that, engineering science applies existing scientific knowledge and principles to design, construct and operate machines, structures and systems to solve practical problems. Students who chose alternative *B, It is the mother of science,* had insufficient knowledge on the relationship between science and engineering. Science is the source of knowledge, while engineering applies that knowledge, therefore, engineering science is not the mother of science. Students who chose alternative *C, It formulates its laws and principles to operate,* failed to understand the intended question. They had insufficient knowledge on distinction between scientific discovery and its application in engineering. Students who chose alternative *D, It is the grassroots of science,* failed to relate that science provides the foundational knowledge and principles that engineering applies in practical contexts, not the other way around.

Item (iii) was formulated from the specific competency of *Mechanical Drives* and it assessed student's ability to apply the formula to determine the velocity ratio of a simple gear system. The question was as follows:

A simple gear system has 120 teeth of driven gear A and 30 teeth of driver gear B mashed together. What is the velocity ratio of the gear system?

A	*4*	*B*	*90*	*C*	*150*	*D*	*3600*

The correct answer was alternative *A, 4.* Students who chose this option were able to understand clearly the relationship between numbers of teeth and velocity ratio. They had adequate knowledge on velocity ratio which determined by the ratio of teeth on the driven gear to the driver gear. Those who chose incorrect alternative *B,* C and *D* had inadequate knowledge on application of simple gear system. They failed to apply a correct formula for velocity ratio.

Item (iv) was constructed from the specific competency of *Linear Motion* and it assessed student's ability to interpret the velocity-time graph. The question was:

What does the area under the velocity time graph represents?

A	*Acceleration*	*C*	*Displacement*
B	*Uniform velocity*	*D*	*Average velocity*

The correct answer was alternative *C, Displacement.* Student who chose correct answer knew that, the area under the velocity-time graph represents displacement. They had adequate knowledge on multiplying velocity by time gives the distance covered in a straight line. Students who chose alternative *A, Acceleration,* lacked a clear understanding of the distinction between the slope and the area under a velocity–time graph displayed a misconception, confusing the slope of the graph which represents acceleration with the area under the graph. Students who chose alternative *B, Uniform velocity,* failed to differentiate a slope and area under the velocity-time graph. Students who chose alternative *D, Average velocity,* failed to understand the demand of the question. They exhibited limited understanding, confusing displacement with average velocity, which is the slope or ratio of displacement to time, not the area.

Item (v) was developed from the specific competency of *Fluid Mechanics* and assessed student's ability to compare densities of two liquids in relation to the conditions required for floatation. The question was as follows:

Two liquids P and Q having densities of 0.72 g/cm^3 and 0.9 g/cm^3 respectively. Giving a reason, which one will float?

A P because it is less denser than Q
B P because it is higher denser than Q
C Q because it is higher denser than P
D Q because it is less denser than P

The correct response was alternative *A*, *P because it is less denser than Q*. Students who chose this option had adequate knowledge on the concept of density comparison which enable them to determine the liquid that float. They had adequate knowledge on the conditions for flotation comparing the densities of the liquids. Those who chose incorrect alternative *B*, C and *D* failed to apply concept of density and law of floatation to analyze the state of two mixed liquids.

Item (vi) was constructed from the specific competency of *Thermal Energy*. It aimed to measure student's competency to convert temperature from thermodynamic to Celsius scale. The question was as follows:

During measurement of temperature of metal, a thermometer reads 423K. What is the value when it is expressed in Celsius scale?

A 696 ^{0}C *B* 455 ^{0}C *C* 391 ^{0}C *D* 150 ^{0}C

The correct answer was alternative *D, 150 ^{0}C*. Students who chose this option understood the conversion formula T(°C) = T(K) − 273 and obtained 150°C. They had adequate knowledge on relationship between the Kelvin and Celsius scales. Those who chose alternative *A*, *B* and *C* had inadequate knowledge on concept of absolute zero temperature (273K).

Item (vii) was constructed from the specific competency of Work, *energy and power*. It aimed to measure student's competency to analyze the necessary conditions for the work to be done. The question was as follows:

A woman carried a bucket of water weighs 200 N and walked for 15 m. How much work is done by the woman?

A 3000 J *B* 215 J *C 185 J* *D 0 J*

The correct answer was alternative D, *0 J*. Students who chose correct answer understood that, the work is zero when the force is perpendicular to displacement, even if effort is applied. They had understood on definition of work in Engineering science as $W = F \times d \times \cos\theta$. On the other hand, they realized that, the direction of the movement of the woman was perpendicular to the weight of the bucket. Those who chose wrong alternative *A*, *B* and *C*, failed to understand that, multiplying any force by distance always gives work, without considering the angle between the force and displacement.

Item (viii) was set from the specific competency of *Fluid Mechanics* and it measured student's ability to analyze and compare pressure of fluid at different diameters of a horizontal pipe. The question was as follows:

The student installed horizontal pipes as shown in the Figure below. Which of the following is true about pressure gauge readings in each section?

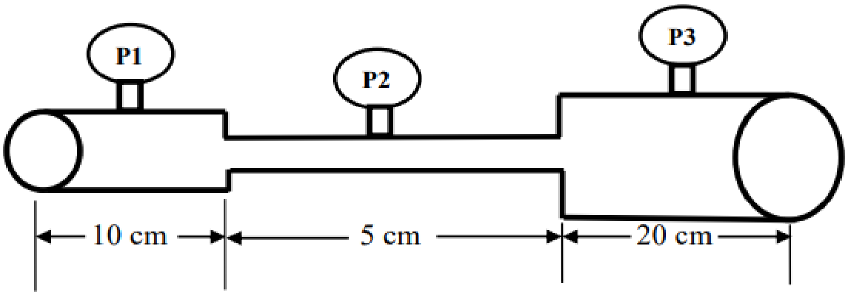


Figure 1

A	$P_3>P_1>P_2$	*C*	$P_2>P_1>P_3$
B	$P_1>P_3>P_2$	*D*	$P_2>P_3>P_1$

The correct response was alternative *A*, $P_3>P_1>P_2$. Students who chose this alternative had adequate knowledge on the relationship between pressure, velocity and pipe diameter in a flowing fluid. They identified that in a horizontal pipe with varying diameters, the pressure is highest at the widest section and lowest at the narrowest section. They applied Bernoulli's principle, recognizing that pressure decreases as velocity increases. Those who chose incorrect options *B*, *C* and *D* lacked knowledge on fluid mechanics, specifically the part related to variation of pressure with cross-sectional area.

Item (ix) was set from the specific competence, *Forces* and it measured student's ability to describe and analyze the types of forces. The question was as follows:

The students were instructed to clamp retort stand base on the workbench using the G clamp. Which force is exerted on the G clamp jaws?

A	*Torsional force*	*C*	*Stretching force*
B	*Compression force*	*D*	*Restoring force*

The correct answer was alternative *B, Compression force.* Students who chose the correct answer had adequate knowledge on the types of forces and their applications. They recognized that clamping involves compression. Students who chose alternative *A, Torsional force,* failed to interpret the twisting motion of the screw with the force exerted by the jaws. Students who chose alternative *C, Stretching force*, had inadequate knowledge associating clamping with pulling forces rather than pushing forces. Students who chose alternative *D, Restoring force,* lacked clarity by confusing elastic restoring forces with the mechanical forces applied by tools.

Item (x) was set from the specific competency *Mechanical Properties of Matter* and it measured student's ability to apply and evaluate the properties of matter in reality. The question was as follows:

A villager put a salt on a snail. After few hours all salt on the snail dissolved. Which mechanism appropriately describe this process?

A	*Osmosis*	*C*	*Diffusion*
B	*Capillarity*	*D*	*Surface tension*

The correct answer was alternative *A, Osmosis.* Students who chose this alternative knew that the process involved is osmosis, where water moves out of the snail's body through a semi-permeable membrane into the surrounding salt, causing the salt to dissolve. Students who chose alternative *B, Capillarity,* lacked enough knowledge related to Osmosis. They failed to understand that capillarity involves movement of fluid through small openings. Those who chose *C*, *Diffusion*, failed to identify the role of a semi-permeable membrane. Although both diffusion and osmosis involve particle movement down a concentration gradient, diffusion does not require a membrane, whereas osmosis occurs only through a semi-permeable membrane. Students who chose alternative *D, Surface tension*, lacked understanding of both osmosis and surface tension, as well as difficulty in applying these concepts in biological contexts.

2.1.2 Question 2: Matching Items

Question two (2) was composed from the specific competency of *Basic Analogue Electronics.* It was intended to assess student's ability to explore the concepts of electronic components and their applications. The question required students to match the descriptions about the uses of the devices in **List A** with their corresponding names in **List B** by writing the letter of the correct response below the item number in the box provided. The question was as follows:

List A	***List B***
(i) A device used to store electric charge.	*A Transistor*
(ii) A device used in voltage regulation.	*B Zener diode*
(iii) A device used as rectifier and switching regulator.	*C Photodiode*
	D Light emitting diode
(iv) A device used to amplify electrical signal.	*E Laser diode*
	F Schottky diode
(v) A device used in fire, smoke detector, cameras and photo sensors.	*G Diode*
	H Resistor

The question was attempted by 1,392 check the whole document (100%) students; where by 672 (48.28%) scored from 0 to 1 mark, 692 (49.71%) students scored from 2 to 3 marks and 28 (2.01%) scored from 4 to 5 marks. The performance on this question was generally average as 720 (51.72%) of the students scored above the pass mark. Figure 3 shows student's performance in this question.

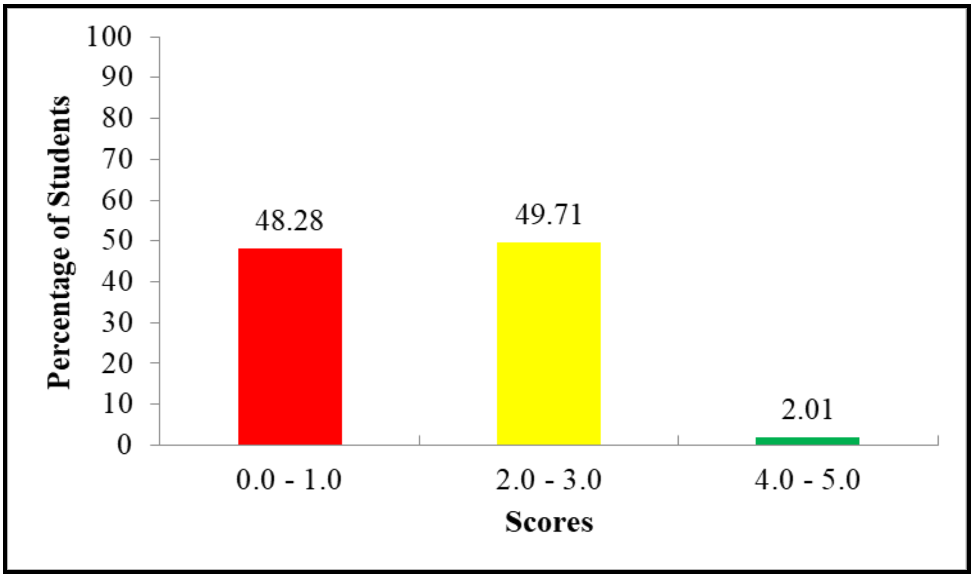


Figure 3: *The Student's Performance in Question 2*

The analysis of the student's responses in each item is as follows:
In item (i), the students were required to identify the correct name of an electronic component that matches the description *A, device used to store electric charge.* The correct response was alternative *G, Diode*. Some students were able to choose the correct answer. It is important to note that a diode does not store electrical charge like a capacitor, but it can temporarily store it due to the presence of its junction capacitance. Some of the students chose alternative *C, Photodiode,* which was an incorrect response. These students were supposed to realize that it is operating in a reverse bias. Thus, it is always minimizing the junction capacitance for fast responding stimulus. The charge storage is very minimal compared to a standard diode. Some of the students chose alternative *F, Schottky diode.* This was an incorrect response. These students failed to realize that a Schottky diode is a metal-semiconductor junction. In this device, the junction capacitance is very narrow for fast switching. Thus, it stores no electric charges.

The analysis also revealed that some of the students selected an alternative *B, Zener diode*. This was an incorrect alternative. The students in this category were supposed to know that this type of diode is designed to operate in reverse breakdown. Thus, charge storage is less significant. It is important to note that a Zener diode can store charge when forward-biased.

There were students who chose alternative *H, Resistor*, which was an incorrect response. Those students had the misconception that a resistor stores charge because it opposes the flow of charges. They were supposed to know that a resistor does not accumulate electric charge but resists its flow. Some of them selected an alternative *A, transistor*. This was an incorrect alternative. Indeed, a transistor can temporarily store electric charge depending on its type and mode of operation. In a saturation mode, it can store electric charges as it acts as a closed switch. For instance, it can accumulate temporarily electric charge in the base before moving to the collector when it is forward biased. It can be said that it is possible for a transistor to store charges under saturation mode. In this context, alternative *G, diode,* was the most correct alternative.

In item (ii), the students were required to identify the correct name of an electronic component that matches the description *A device used in voltage regulation.* The correct response was alternative *B, Zener diode*. Students who chose the correct answer were able to understand that a Zener diode consists of a *p-n* junction designed to conduct in a reverse direction when a certain specified voltage is reached. Some students who chose the incorrect alternative *H, Resistor,* lacked adequate knowledge of voltage regulation, as they attempted to apply Ohm's law, which explains the variation of current with voltage due to resistance, rather than recognizing that voltage regulation is achieved using specialized components such as Zener diodes. Those who chose incorrect alternative *A, Transistor,* failed to understand that voltage regulation is to maintain voltage even if the current changes and so they thought that to regulate is to amplify and this is done by transistor. Those who chose wrong option *F, Schottky diode,* were misled that the Schottky diode provides a small forward voltage drop. Those who chose wrong options *C, D* and *E,* failed to differentiate the types of diodes regarding to their appropriate applications.

In item (iii) the students were required to identify the correct response that matches the statement *A device used as a rectifier and switching regulator.* The correct answer was alternative *F, Schottky diode.* Students who chose the correct answer managed to properly understand the application of the Schottky diode. Moreover, they were able to distinguish between voltage regulator and switching regulator. Few students who chose wrong option *H, Resistor,* failed to recognize that resistor is never used as rectifier, resistor opposes the flow of electric current. It can be assumed that these students confused the facts that increasing resistance in the circuit may led to switch off the flow of the current. Those who chose the incorrect alternative A, *Transistor,* failed to understand that rectifier is a diode, while transistor is an amplifier. It is possible to conclude that these students were misled with the word switchin*g*. Some of the students chose incorrect an option *B, Zener diode*. Those who chose this option failed to distinguish the application of Zener diode and Schottky diode. Students who chose other incorrect options *C, D, E* and *G*, lacked knowledge related to types of diode and their applications and hence they ended up guessing.

In item (iv), the students were required to identify the correct response that matches the statement *A device used to amplify electrical signal*. The correct answer was alternative *A, Transistor.* Students who chose the correct answer had proper understanding about the application of transistor as an amplifier. Those who chose wrong alternative *H, Resistor,* lacked knowledge on the specific competency of Basic Analogue Electronics, specifically on the applications of electronic components. Those who chose other options *B, D, E, F* and *G*, failed to distinguish transistor from other active components.

In item (v) the students were required to identify the correct response that matches the statement *A device used in fire, smoke detector, cameras and photo sensors.* The correct answer was alternative *C, Photodiode*. Most students chose the correct answer. This suggest that the students had enough understanding on the application of photodiode. Some of them selected option *D, Light emitting diode.* This was an incorrect response. Some of students chose incorrect responses *B, E, F* and *G*. These students were supposed to know that not all diodes are designed to detect smoke. A photodiode is used in a smoke detector because it is designed to detect light. Some students chose an alternative *A, Transistor.*

These students were supposed to realize that a transistor does not detect light, thus, it cannot directly be used as a smoke detector. Some students chose incorrect response *H, Resistor,* lacked enough knowledge on the concepts related to electronics components and their applications. Some of the students failed to match all the descriptions about the uses of the devices in list A with corresponding names in list B. Extract 2.1 is a sample of incorrect response of a student who scored 0 mark to question 2.

Answers

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

Extract 2.1: A sample of incorrect responses to Question 2

In Extract 2.1, a student failed to match all the devices in List B to their corresponding descriptions in List A due to conceptual gaps, guessing from names and misunderstanding of technical terms. However, some of the students managed to score all 5 marks in this question. Extract 2.2 is a sample of correct responses of a student who scored 05 marks to question 2.

Answers

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

Extract 2.2: A sample of correct responses to Question 2

In Extract 2.2, a student managed to correctly match the descriptions about the uses of the devices in List A with their corresponding names in List B because he/she had a clear understanding of the functions of the devices, familiar with the technical terms and did not rely on guessing from the device names.

2.3 SECTION B: SHORT ANSWER QUESTIONS

This section comprised of seven (7) short answer questions, which were set from specific competencies of *Thermal Expansion, Linear Motion, Measurements, Electricity, Introduction to Engineering Science, Mechanical Properties of Matter and Forces.* Each question carried ten (10) marks, making seventy (70) marks. The pass mark for these questions is 3 marks. The student response analysis of each question is as follows:

2.1.3 Question 3: Thermal Expansion

This question was composed from the specific competency of Thermal Expansion. The question had two parts, namely part (a) and (b). Part (a) was conceptual and structured to assess the ability of students to analyze and apply the concepts and principles related to thermal expansion to solve real-life problems. Part (b) of this question was numerical based problem. The students were supposed to apply mathematical skills to determine the needed physical quantity. The question was as follows:

A metal worker is required to fit an iron ring around a wooden cart wheel. If iron ring is slightly smaller in diameter than the wheel;

(a) How can the metal worker fit the iron ring on the wheel?

(b) If the diameter of the iron ring is 1.00 m at room temperature of 25 ^{o}C and needs to expand by 0.002 m to fit the wheel, calculate the temperature that the metal worker must heat the ring if the linear expansivity of iron =$12\times10^{-6}/^{o}$C.

This question was attempted by 1392 (100%) students; where by 810 (58.19%) scored from 0 to 2.5 marks, 288 (20.69%) scored from 3 to 6 marks and 294 (21.12%) scored from 6.5 to 10 marks. The performance on this question was generally average as 582 (41.81%) of the students scored above the pass mark. Figure 4 shows student's performance in this question.

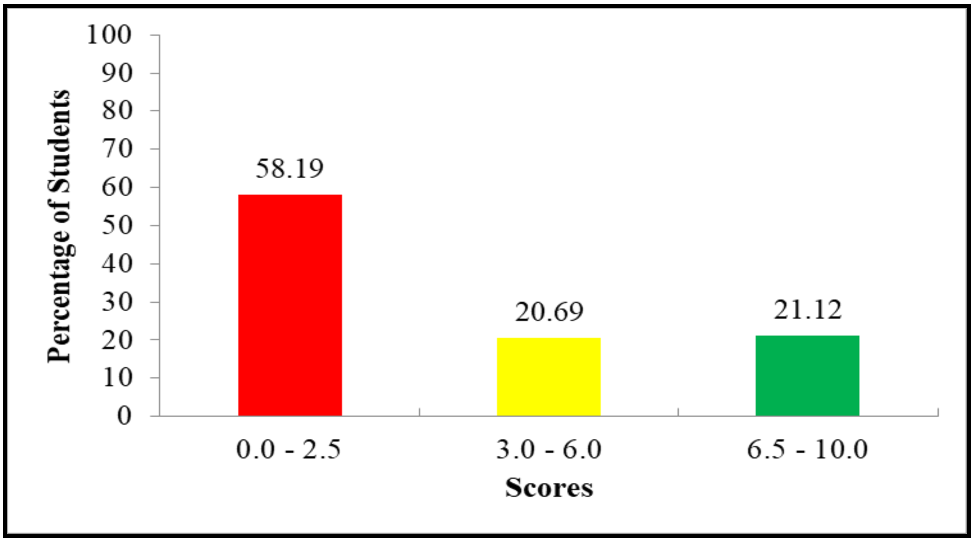


***Figure 4**: The Student's Performance in Question 3*

The statistical analysis reveals that some of the students scored lower marks (0-2.5). The students who scored low marks had insufficient knowledge and skills related to the specific competency of thermal expansion. They failed to apply the correct formula to determine the temperature needed for a ring to fit in a wheel. The student wrote $\alpha = \frac{\Delta l}{T_2 - T_1}$. This formula is dimensionally incorrect and make no sense in engineering science context.

Extract 3.1 is a sample of the student's incorrect response to question 3.

Soln

Dato

Diamoter of Iron ring: 1.00m

Temperature$_1$ = 25°C

To Expand : 0.002m

Temperature$_2$ = ?

Linear expansivity of Iron: 12×10^{-6}/°C.

From; Temperature:

$$\gamma = \frac{\Delta L}{(T_2 - T_1)}$$

$$\Rightarrow 0 = \frac{\Delta 25°C}{(T_2 - 25°C)}$$

$$\Rightarrow 0 = \frac{50°C}{T_2 - 25°C}$$

Temperature needed to expand iron ring is 30 °C.

Extract 3.1: A sample of incorrect responses to Question 3

In Extract 3.1, a student had inadequate knowledge on thermal expansion and failed to identify the appropriate formula of linear expansion and applied it incorrectly.

The students who scored average marks (3-6) were generally able to recall relevant formulas and recognize key principles such as the effect of forces or gravity on motion. However, they lacked consistency and detailed explanation.

Some of students who scored above average marks (6.5-10), were able to provide correct responses for part (a) and (b) of the question. They had adequate knowledge on the concepts and principles of thermal expansion. Moreover, these students were able to apply correct formula and computed the value of temperature needed to fit an iron ring. Extract 3.2 is a sample of the student's correct responses to question 3.

The metal worker must heat the iron ring so that it can expand and fit on the wheel.

Solution:

Data given: $d = 1M$

$\theta_1 = 25°C$

$d_2 = 1m + 0.002M = 1.002M$

$\alpha = 12 \times 10^{-6}/°C$

$\theta_2 = ?$

from: $\alpha = \dfrac{d_2 - d_1}{d_1(\theta_2 - \theta_1)}$

$12 \times 10^{-6}/°C = \dfrac{1.002m - 1M}{1M(\theta_2 - 25°C)}$

$\dfrac{12 \times 10^{-6}/°C}{1} = \dfrac{0.002M}{1M\theta_2 - 25°CM}$

$12 \times 10^{-6}/°C\,(1M\theta_2 - 25°CM) = 0.002M$

$0.000012/°C\,(1M\theta_2 - 25°CM) = 0.002M$

$0.000012M\theta_2 - 0.0003°CM = 0.002M$

$\dfrac{-0.0002988}{-0.0002988} = \dfrac{0.002M°C}{-0.0002988M} = -6.693440428°C$

$\therefore \dfrac{23}{10{,}000} = \dfrac{3}{250{,}000} = 10{,}000 \times 3 = 250{,}000 \times 23$

$\dfrac{\cancel{30{,}000}\,\theta_2}{30{,}000} = \dfrac{5750000°C}{30{,}000} = \dfrac{575}{3}$

$\therefore$ The temperature that the metal worker must heat the ~~rig~~ ring is 191.6667 °C.

Extract 3.2: A sample of correct responses to Question 3

In Extract 3.2, a student managed to provide correct description on how to expand the iron ring through heating so as to fit on the wheel. This student was able to provide the correct and relevant formula of linear expansivity and apply it to calculate the final temperature needed to expand the iron ring by 0.002 m.

2.1.4 Question 4: Linear Motion

This question was developed from the specific competency of *Linear Motion*. The question was designed to assess student's ability to analyze and describe the physical parameters related to motion under the influence of gravitational acceleration. The students were required to understand the effect of gravity on a vertically projected object. They were expected to apply correct mathematical equations to determine the speed, time and maximum height attained by the rocket after it was projected upward from the Earth's surface. The question was as follows:

Scientist launched a satellite to the space station above the earth surface. The rocket carrying the satellite ascended vertically upward with a velocity of 3600 km/hr.

(a) What will be the speed of the rocket when it landed at the space station?

(b) Did the speed of the rocket decreases before it is landed at the space? Give reason for your answer.

(c) Calculate the time the rocket spent to reach the space station.

(d) How far is the space station from the earth surface?

The question was attempted by 1,392 (100%) students; where by 1.099 (78.95%) scored from 0 to 2.5 marks, 165 (11.85%) students scored from 3 to 6 marks and 128 (9.20%) scored from 6.5 to 10 marks. The general performance was poor as 1,099 (78.95%) of the students scored below the required pass mark. Figure 5 shows student's performance in this question.

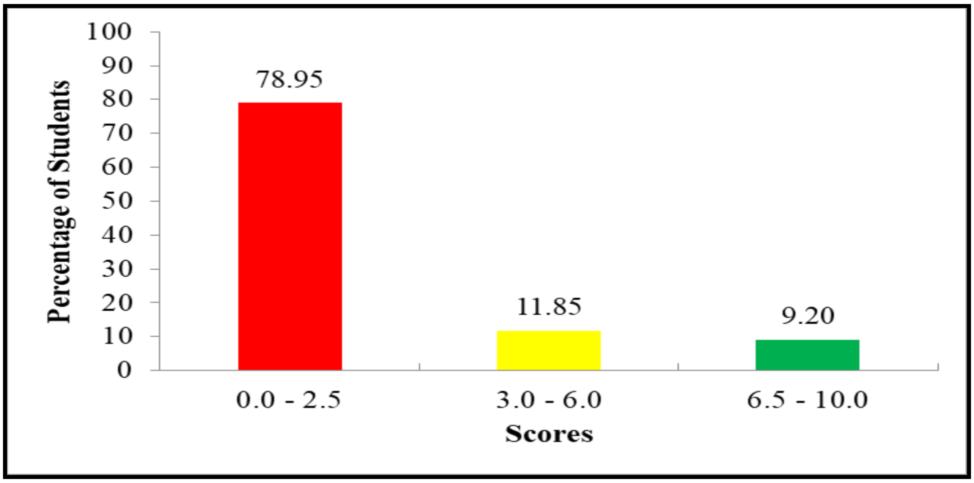


Figure 5: *The Student's Performance in Question 4*

Analysis reveals that the majority of the students scored lower marks (0-2.5). This indicates that the students had insufficient knowledge and skills related to the motion under gravity. In part (a), most students failed to recognize that when the rocket moves vertically upward, it experiences a downward (negative) acceleration due to gravity. As a result, its speed decreases continuously and eventually becomes zero when it reaches space.

Extract 4.1 is a sample of the student's incorrect responses to question 4.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

If $V = \frac{D}{T} = \frac{3600\ \text{Km}}{1\ \text{hr}}$ ∴ Speed of the rocket will be 3600 Km/hre

~~Note~~ because the rocket will decrease the the Speed in order for to to stay \a Space Station

If 1Km = 1000 m
3600 = ?m
$= \frac{3600\ \text{Km} \times 1000\text{m}}{1\ \text{Km}}$
= 3600000 m
and
1 hr = 60 min
and
1 m = 60Sec
3600

$$\text{Speed} = \frac{\text{distance}}{\text{Time}}$$

$$\text{Speed} = \frac{3600000}{3600}$$

Speed = 100 m / Sec

∴ this time to reach the Space Station is 100 m/s

~~3600~~ The Space station from the earth surface is 3600 Km

Extract 4.1: A sample of incorrect responses to Question 4

In Extract 4:1, a student provided an irrelevant description of the motion of the rocket. In part (a), they did not correctly identify that the rocket's speed would change due to acceleration or gravitational effects and gave unrelated answer. In part (b), the student failed to explain the decrease in the rocket's speed, indicating insufficient knowledge of the forces acting on the rocket. In parts (c) and (d), the student failed to apply kinematic formulas correctly and made unit conversion errors, resulting in incorrect or missing answers. On the other hand, the students who scored average marks (3-6) were generally able to recall relevant formulas and recognized that gravity affects the motion of the rocket, but they showed difficulties in applying these concepts accurately and consistently.

However, students who scored above average marks (6.5-10) had adequate knowledge of motion under gravity and problem-solving skills. Extract 4.2 is a sample of the student's correct response to question 4.

The velocity OR a speed when it landed at the space station = O, because for a vertically upward projected body the final velocity, V = O

YES, The speed of the rocket decreased before it landed because it is projected vertically upwards and it is opposing the force at gravity.

Solution:

Data given: Initial velocity, $u = 1000$ m/s – from 3600 km/hr

Final velocity, $v = 0$ m/s – from 0.04 g

Constants: Force of gravity, $g = 10$ m/s²

For a body projected upward: $v = u - gt$

We get: $t = \frac{V - u}{-g}$

$t = \frac{(0 - 1000) \text{ m/s}}{-(10 \text{ m/s}^2)}$

$t = \frac{-1000 \text{ m/s}}{-10 \text{ m/s}^2}$

$t = 100$ seconds

∴ The time spent by the rocket to reach the station, $t = 100$ seconds

Solution:

Data given: Initial Velocity, $u = 1000$ m/s

Final Velocity, $v = 0$ m/s

Time spent, $t = 100$ s

Constants: Force of gravity, $g = 10$ m/s²

For a vertically upward projected body: $h = ut - \frac{1}{2} g t^2$

$h = (1000 \times 100) - \frac{1}{2} \times 10 \times 100^2$

$h = (100\,000 - 50\,000)$ m

$h = 50\,000$ m

∴ The distance from the earth to the space station that is above, $h = 50\,000$ m

Extract 4.2: A sample of correct responses to Question 4

In Extract 4.2, a student correctly managed to analyze the concept on effect of acceleration due to gravity under the upward vertical motion of a moving rocket before it lands in space. Additionally, the student managed to recall and use appropriate questions of uniformly accelerated motion to compute time, speed and height attained by the rocket from the earth's surface to space.

2.1.5 Question 5: Measurement

The question intended to assess student's ability to analyse and apply the relevant formula to determine the density and relative density of an irregular stone. The question was as follows:

Form two students performed an experiment to determine the density and relative density of an irregular stone. The students used measuring cylinder, beam balance and water to perform the experiment and obtained the following readings:

(i) Initial reading of measuring cylinder (V_1) = $40\ cm^3$

(ii) Final reading of measuring cylinder (V_2) = $60\ cm^3$

(iii) Mass of irregular stone (m) = 100 g

(a) Determine the density of stone as per experiment done.

(b) Determine the relative density of stone given that the density of water = $1\ g/cm^3$

This question was attempted by 1392 (100%) students; where by 475 (34.12%) scored from 0 to 2.5 marks, 179 (12.86%) students scored from 3 to 6 marks and 738 (53.02%) scored from 6.5 to 10 marks. The overall performance on this question was good as 917 (65.88%) of the students scored above pass mark. Figure 6 shows student's performance in this question.

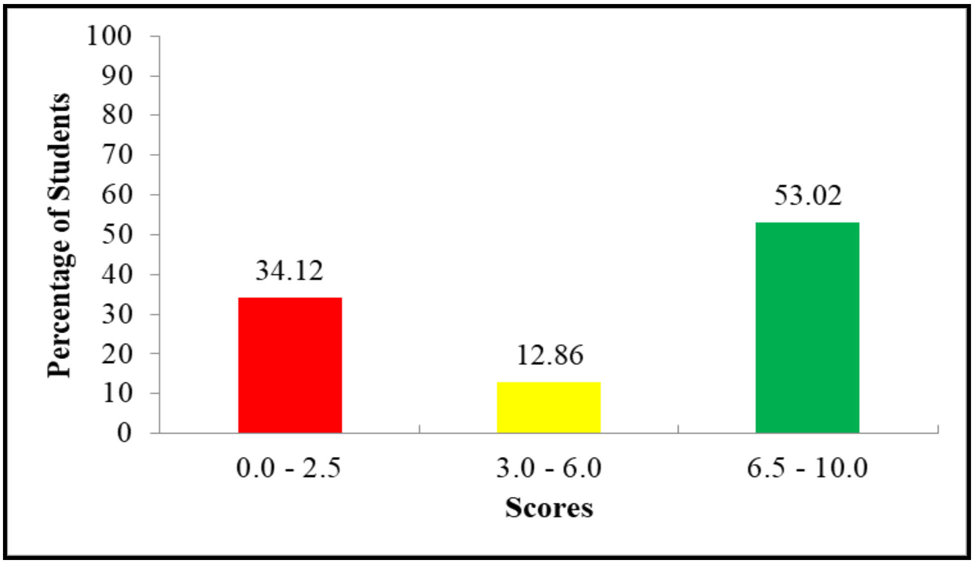


Figure 6: *The Students Performance in Question 5*

The students who scored below the pass mark (0-2.5) failed to analyze and organize the given data in the question as well as to recall and use the correct formula to calculate the density and relative density of an irregular stone as required. Extract 5.1 is a sample of student's incorrect response to question 5.

Soln

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}_1 + \text{Volume}_2}$$

$$\text{Density} = \frac{100g}{40cm^3 + 60cm^3}$$

$$\text{Density} = \frac{100g}{100cm^3}$$

$$\text{Density} = 1g/cm^3$$

$\therefore$ Density $= 1g/cm^3$

$$\text{Relative density} = \frac{\text{Mass of the Substance}}{\text{Volume of the Substance}}$$

$$\text{Relative density} = \frac{100g}{100cm^3}$$

$$\text{Relative density} = \frac{1g/cm^3}{1g/cm^3}$$

$$\text{Relative density} = \underline{\underline{1}}$$

Extract 5.1: A sample of incorrect responses to Question 5

Extract 5.1 shows responses from a student who failed to organize the given data from the question to calculate the density and relative density of an irregular stone as required. The student added the initial and final readings of volume instead of subtracting the reading of the initial volume from that of the final volume.

On the other hand, the students who scored average marks (3-6) were able to calculate the volume of the stone correctly using water displacement and identify the correct formula of density. However, some made calculation errors or did not clearly explain the steps involved.

The students who scored above average marks (6.5-10) had adequate knowledge on the specific competency of measurements, specifically on the concept of density and relative density. They provided relevant responses to most parts of the question, determined accurately the volume of the irregular stone using the displacement method and calculated density and relative density using the given density of water. Extract 5.2 is a sample of the student's correct responses to question 5.

Data given.

$(V_1) = 40 cm^3$

$(V_2) = 60 cm^3$

$(M) = 100 g$

From, Density $= \frac{Mass}{Volume.}$

$\rho = \frac{M}{V_2 - V_1} = \rho = \frac{100 g}{60cm^3 - 40cm^3}$

$\rho = \frac{100g}{20cm^3} = 5g/cm^3$

$\therefore$ The Density of stone is $5 g/cm^3$

ρ of water $= 1 g/cm^3.$

From,

Relative density $= \frac{\rho_s}{\rho_w}$

$R.D = \frac{5 g/cm^3}{1 g/cm^3.} = 5.$

$\therefore$ Relative density of stone is 5.

Extract 5.2: A sample of correct responses to Question 5

Extract 5.2 shows responses from a student who managed to determine the volume of an irregular stone and correctly used it to determine the density of an irregular stone and its relative density. Also, the student managed to analyze the data from the question and correctly applied the relevant formula; *density* = $\frac{mass}{v2-v1}$ and *R.D* = $\frac{density\ of\ a\ substance}{density\ of\ equal\ volume\ of\ water}$ to calculate the required density of an irregular stone in part 5(a) and its relative density in part 5(b), respectively.

2.1.6 Question 6: Electricity

The question aimed to assess student's ability to analyze and identify the electrical components by their symbols and how to properly assemble them to design a simple electrical circuit. The question was as follows:

(a) You are provided with the following electrical components: cell, resistor, an ammeter, switch and variable resistor to construct a simple electric circuit. Sketch these symbols as will be used in the circuit.

(b) *Design a simple electrical circuit using the symbols in (a) to verify ohm's law.*

(c) *State ohm's law as verified in (b).*

A total of 1,392 (100%) students attempted this question; where by 341 (24.5%) scored from 0 to 2.5 marks, 387 (27.8%) students scored from 3 to 6 marks and 664 (47.7%) scored from 6.5 to 10 marks. The performance on this question was good as 1,051 (75.5%) of the students scored above the pass mark. Figure 7 shows student's performance in this question.

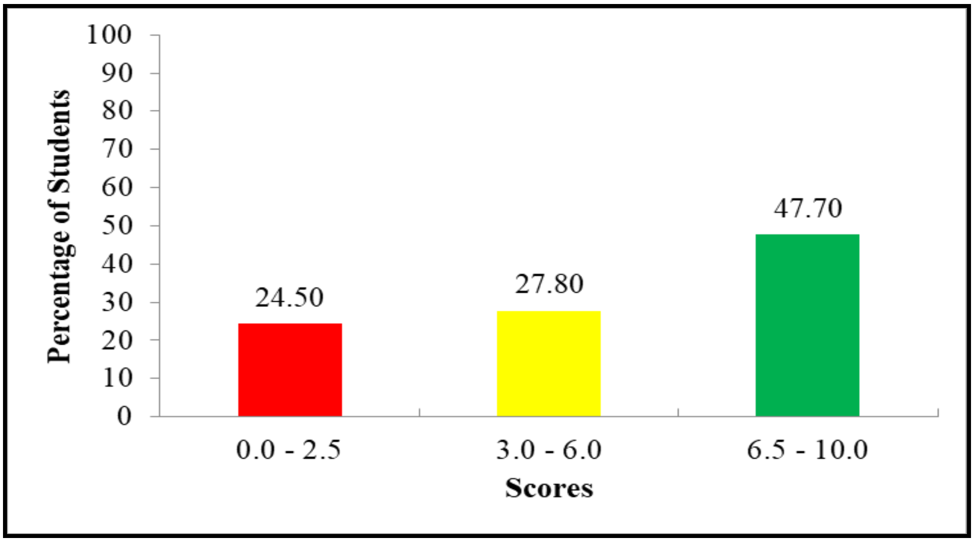
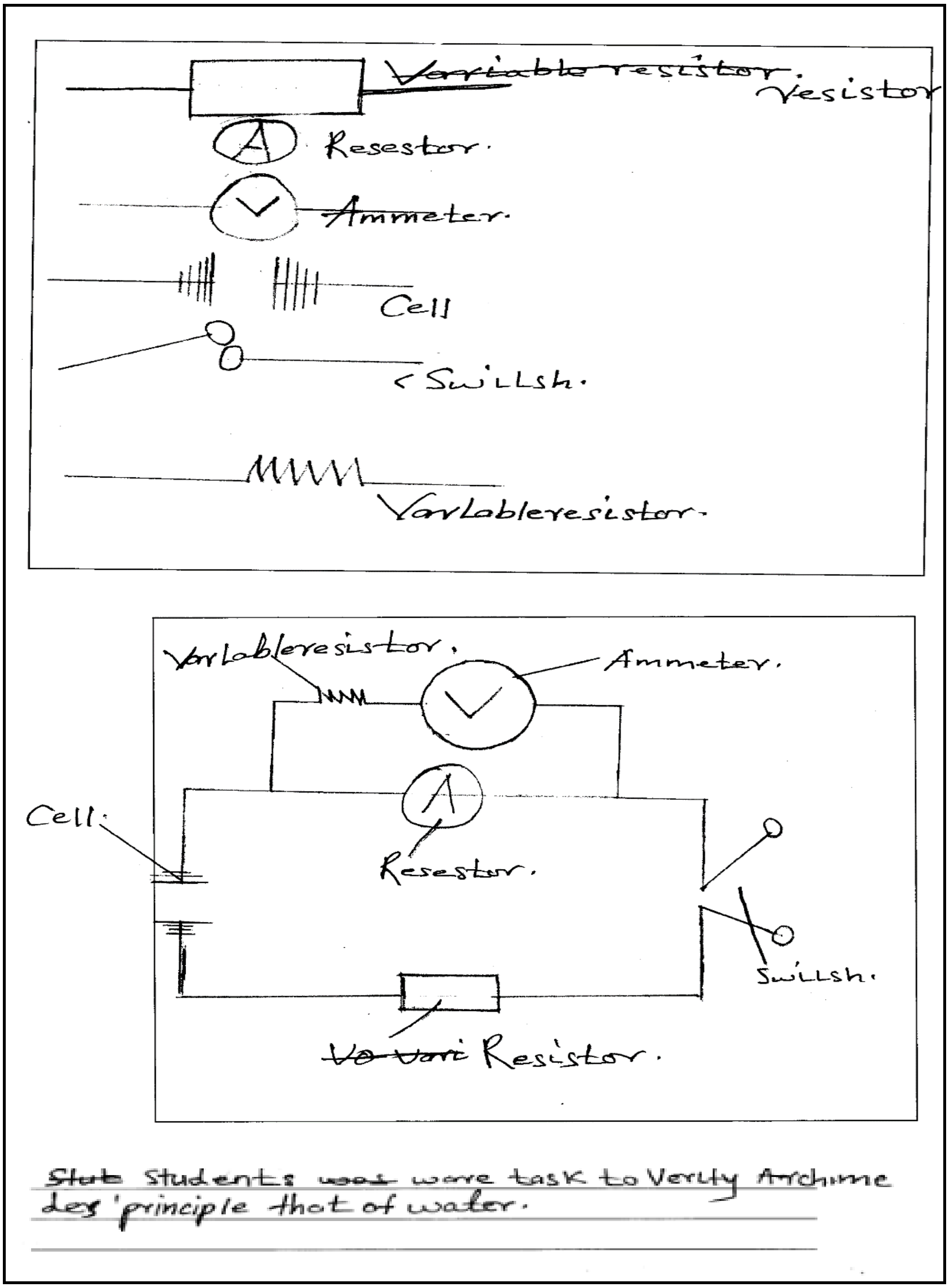


Figure 7: *The Students Performance in Question 6*

The students who scored low marks (0-2.5) in part (a) failed to identify the correct symbols for the given electrical components. Moreover, some of these students interchanged the names and symbols of the electrical components that they managed to provide. Furthermore, in part (b) they failed to design a simple electrical circuit as they connected the electrical components randomly to the wrong positions. Most of these students lacked knowledge on how to connect the ammeter and voltmeter with respect to other electrical components in the circuit. Extract 6.1 is a sample of student's incorrect responses to question 6.

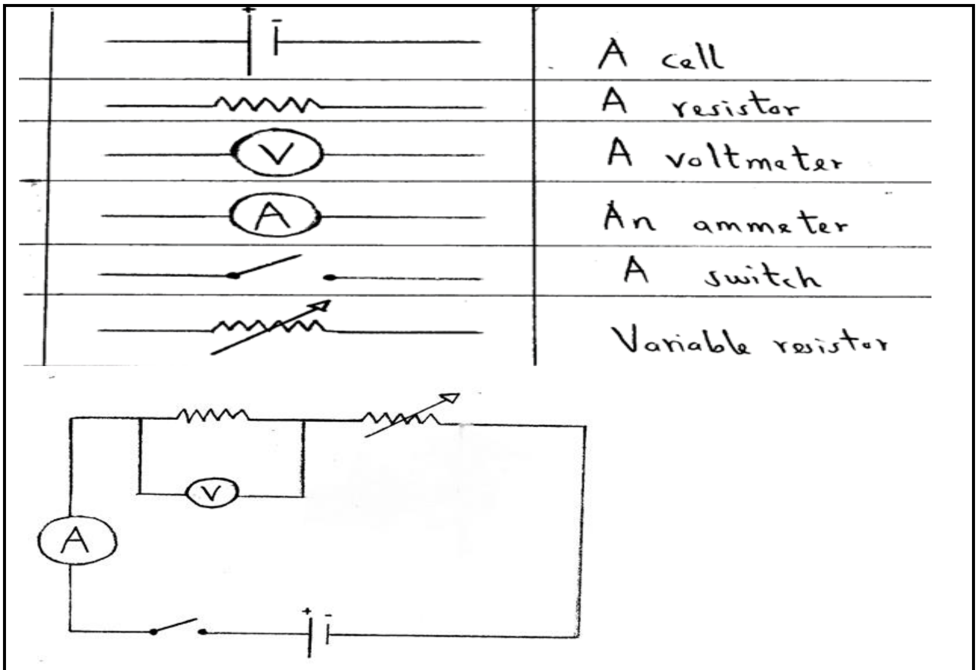


Extract 6.1: A sample of incorrect responses to Question 6

In Extract 6.1, students failed to identify electrical components and symbols and were unable to assemble them correctly to design a simple electrical circuit.

Students who scored average marks (3 - 6) were able to sketch some correct circuit symbols and design a basic circuit arrangement. However, errors were noted in symbol labeling, circuit connections and explanations of the role of the variable resistor.

However, students who scored above the average marks (6.5 - 10) accurately sketched standard circuit symbols, correctly designed a series circuit suitable for verifying Ohm's law and clearly stated the law using correct scientific terminology. Extract 6.2 is a sample of student's correct responses to question 6.



The ohm's law states that "The current flowing through a conductor is directly proportional to the voltage (Potential Difference) and inversely proportional to the resistance when temperature and pressure is kept constant in a given circuit".

Extract 6.2: A sample of correct responses to Question 6

In Extract 6.2, a student managed to apply the relevant knowledge on circuit symbols, circuit construction and Ohm's law.

2.1.7 Question 7: Fluid Mechanics

The question intended to assess student's competency in Fluid Mechanics, particularly on the application of Archimedes' Principles to determine the apparent loss in weight of the body, the volume of liquid displaced and the relative density of the body. The question was as follows:

Form two students were given a task to verify Archimedes' principle. They obtain the following results;
(i) Weight of the body in air (W_1) = 20 N
(ii) Weight of the body when totally immersed in water (W_2) = 15 N.

By using the results obtained, find the following:
(a) The apparent loss in weight of the body.
(b) The volume of liquid displaced.
(c) The relative density of the body.

The question was attempted by 1,392 (100%) students; in which 726 (52.16%) scored from 0 to 2.5 marks, 307 (22.05%) students scored from 3 to 6 marks and 359 (25.79%) scored from 6.5 to 10 marks. The performance on this question was average as 666 (47.84%) of the students scored above the pass mark. Figure 8 shows student's performance in this question.

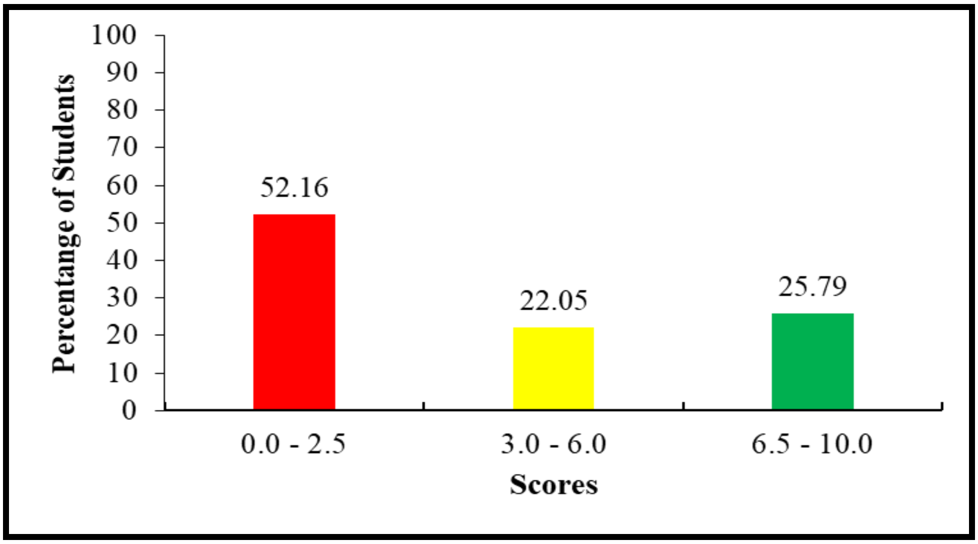


Figure 8: *The Student's Performance in Question 7*

Students who scored below pass marks (0-2) had insufficient knowledge on the specific competency of fluid mechanics, especially on the concepts related to apparent loss in weight and application of Archimedes' principle to determine the relative density of the solid body. Extract 7.1 is a sample of student's incorrect responses to question 7.

Data given:
W of air = 20 N (W_1)
W of water = 15N (W_2)
D of water = 1000 kg/m³

Solution.
$\Rightarrow$ Apparent loss I in weight = $\frac{(W_1 - W_2)}{D \text{ of water}}$

$= \frac{5N}{1000kg/m^3} = 200 kg/m^3$

$= 200kg/m^3$

∴ Therefore the apparent loss in weight of the body is 200 Nt kg/m³.

Data analysis
W of air = 20N (W_1)
W of water = 15N (W_2)
D of water = 1000kg/m³

Solution.
$AW = \frac{W_1 + W_2}{D \text{ of water}}$

$= \frac{55N}{1000kg/m^3}$

$= 28.57 kg/m^3$

∴ Therefore the volume of liquid displaced is 28.57 kg/m³.

Extract 7.1: A sample of incorrect responses to Question 7

In Extract 7.1, a student failed to organize the weight of the body in air and weight of the body in liquid to compute the apparent loss in weight of the body. The student poorly organized the three quantities as $\frac{apparent\ loss}{weight\ of\ body\ in\ liquid}$ = *weight of the body in* air, which is wrong.

A few students who scored average marks (3-6) were able to calculate the apparent loss in weight correctly but experienced difficulties when determining the volume of liquid displaced, particularly in substituting values into the formula. Some students correctly found the relative density but did not clearly explain the steps involved.

On the other hand, the students who scored above the average marks (6.5 - 10) were able to calculate correctly the apparent loss in weight, determined the volume of liquid displaced using appropriate formula and obtained the correct relative density. Extract 7.2 is a sample of student's correct responses to question 7.

Data given;

Weight of body in air (W_1) = 20 N

Weight of body when totally immersed in water (W_2) = 15 N.

Apparent loss in weight = ?

From;

Apparent loss in weight = $W_1 - W_2$

= 20 N − 15 N

= 5 N.

∴ The apparent loss in weight of the body is 5 N.

Data given;

Weight of body in air (W_1) = 20 N

Weight of body when totally immersed in water (W_2) = 15 N

Apparent loss in weight = 5 N

Volume of liquid displaced = ?

From;

Upthrust = $\text{Volume}_{\text{object}} \times \text{Density}_{\text{water}} \times \text{Gravity}$.

But;

Upthrust = Apparent loss in weight

Volume of liquid displaced = Volume of object immersed.

Then,

Upthrust = 5 N

Recall

$U = V_0 \times \rho_l \times g$

$5N = V_0 \times 1000 kg/m^3 \times 10 N/kg$

$\frac{5N}{10000 Nm^3} = \frac{10000 Nm^3 V_0}{10000 Nm^3}$

$V_0 = 5 \times 10^{-4} m^3$

Recall; V_0 = V. liquid displaced

∴ The volume of liquid displaced is $5 \times 10^{-4} m^3$

Extract 7.2: A sample of correct responses to Question 7

In Extract 7.2, a student had a proper understanding on concepts of Archimedes' principle as per the instructions of the question and determination of mathematical skills to recall and apply the correct formula to calculate both the apparent loss in weight of the body and volume of liquid displaced.

2.1.8 Question 8: Mechanical Properties of Matter

The question intended to assess student's ability to apply the concepts of forces on solid materials to determine stress, strain and Young's Modulus of elasticity. The question was as follows:

The handbrake cable initial has a length of 2 m and cross section area of 20 mm^2. Calculate the following:

(a) The stress in the cable when the driver applied a force of 800 N to the handbrake.

(b) The strain in the cable when it is extended by 0.4 mm.

(c) Modulus of elasticity for cable material.

This question was attempted by 1,392 (100%) students; where by 786 (56.47%) scored from 0 to 2.5 marks, 378 (27.15%) students scored from 3 to 6 marks and 228 (16.38%) scored from 6.5 to 10 marks. The performance on this question was average as 606 (43.53%) of the students scored above the pass mark. Figure 9 shows student's performance in this question.

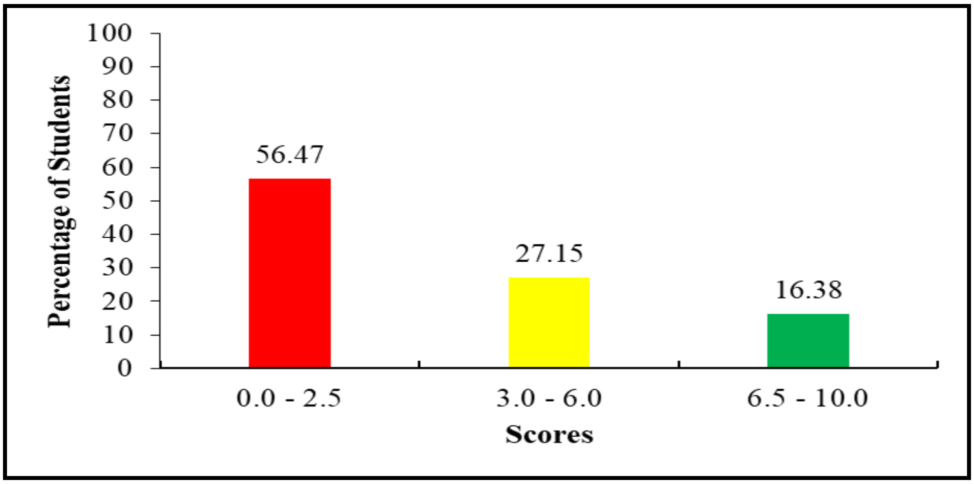


Figure 9: *The Students Performance in Question 8*

Those students who scored below the pass mark (0-2.5) lacked knowledge on the concepts of forces applied to solids, specifically the stress, strain and Young's Modulus. In part (a), one student wrote and use incorrect formula for stress, the student wrote stress = force × area, instead of $stress = \frac{force}{area}$, hence failed to correctly compute the correct values of stress, strain and Young's modulus for cable material. Extract 8.1 is a sample of student's incorrect responses to question 8.

(a) Data given.

800N force.

Cable length = 2m.

Cross sectional area = 20mm²

Stress = ?

Stress = Force x Area.

= 20mm² x 800N

= 400Nmm² ~~= 50Nm²~~ 0.02Nm²

∴ the stress is equal to 0.02Nm²

(b) Data given.

8 ~~Force~~ extension = 0.4mm.

Cable length = 2m.

Cable Area = 0.02Nm²

force = 800N.

Strain = Force x length extension.

800N x (2m + 0.4mm)

$800N \times \left(\frac{1}{2500}m + 2m\right)$ ~~0.32Nm~~ $= \frac{40008\ Nm}{25}$

∴ The strain in the cable is ~~0.32Nm~~

1600.32Nm.

Data given.

(c) extension = 0.4mm.

Cable length = 2m

Cross sectional Area = $20mm^2$

Force = 800 N.

$800N = \cancel{0.4mm}\ 1/2500m.$

$1N = x$

$800\cancel{N}x = 1\cancel{N} \times \frac{1}{2500m}$, $x = 2000000m.$

Extract 8.1: A sample of incorrect responses to Question 8

In Extract 8.1, a student applied incorrect formula to calculate the stress, strain and modulus of elasticity.

However, the students who scored average marks (3-6) were able to recall the correct formula for stress and strain. Others computed stress and strain correctly but were unable to determine the modulus of elasticity due to errors in substitution or incomplete calculations.

A few students who scored above average marks (6.5-10) managed to properly recall, organize and apply the concepts of forces on solid materials to determine stress, strain and Young's Modulus of elasticity. Extract 8.2 is a sample of student's correct responses to question 8.

(a) data given from a question

Inital Length = 2m.

Area = 20mm²

force applied = 800N

extension = 0.4mm.

Stress = required.

from; - $\text{Stress} = \frac{\text{force applied}}{\text{Area}}$

$\text{Stress} = \frac{800 N}{20mm^2}$

but $20 mm^2 = 2 \times 10^{-5} m$.

$\text{Stress} = \frac{800 N}{2 \times 10^{-5} m^2}$

$\text{Stress} = 40000000 N/m^2$

(b) from, $\text{Strain} = \frac{\text{extension}}{\text{original Length}}$.

$\text{Strain} = \frac{0.4mm}{2m}$.

Recall, $0.4mm = 4 \times 10^{-4} m$.

$\text{Strain} = \frac{\cancel{0}\ 4 \times 10^{-4} m}{2 m}$.

$\text{Strain} = \left(\frac{4 \times 10^{-4}}{2}\right) m/m$

$\text{Strain} = \left(\frac{4 \times 10^{-4}}{2}\right) \times 1$

$= 2 \times 10^{-4} \times 1$

$\text{Strain} = 2 \times 10^{-4}$

(c) $\text{Young Modulus} = \frac{\text{Stress}}{\text{Strain}}$

Recall, $\text{Stress} = 40000000 N/m^2$

$\text{Strain} = 2 \times 10^{-4}$.

then; $= \frac{40000000 N/m^2}{2 \times 10^{-4}}$

$\text{Young modulus} = 2 \times 10^{+11} N/m^2$

$\therefore$ $\text{Young modulus} = 2 \times 10^{11} N/m^2$

Extract 8.2: A sample of correct responses to Question 8

In Extract 8.2, a student correctly converted units, accurately applied the formula on stress and strain and successfully calculated the modulus of elasticity to compute the solutions well-organized and logically presented.

2.1.9 Question 9: Forces

The question intended to assess student's knowledge on different ways to minimize friction between surfaces in contact, explain the application of friction in walking and identify the effects of forces. The question was as follows:

(a) When soapy water is spill on tiles floor, the walking become more difficult. Why is it so?

(b) A student was riding a bicycle to school. After 10 minutes collided to a car which was on a wrong parking. After collision student fell down and the bicycle was severely damaged. Identify four effects of force which are likely to occur on that accident

The question was attempted by 1,392 (100%) students; where by 658 (47.27%) scored from 0 to 2.5 marks, 482 (34.63%) scored from 3 to 6 marks and 252 (18.10%) scored from 6.5 to 10 marks. The performance on this question was average as 734 (52.73%) of the students scored above the pass mark. Figure 10 shows student's performance in this question.

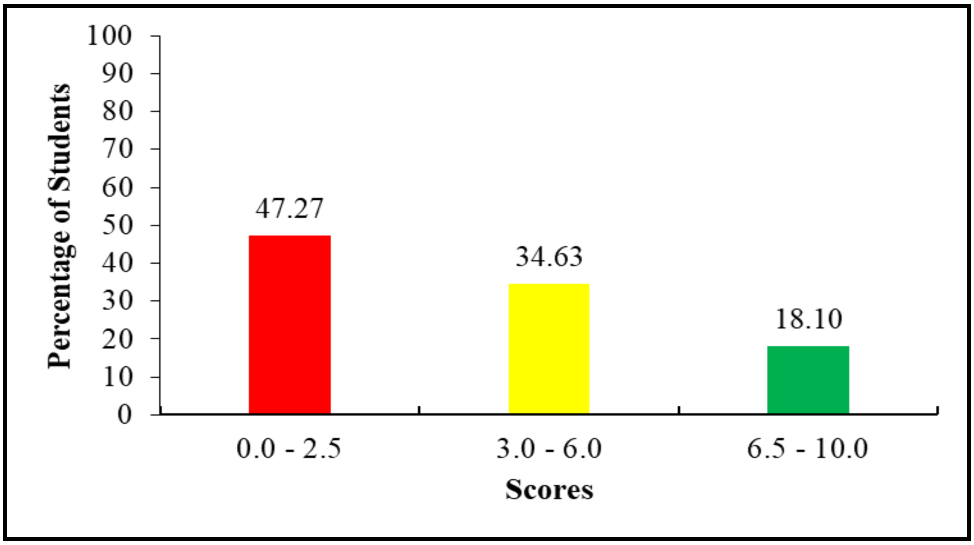


Figure 10: *The Students Performance in Question 9*

Those students who scored below the pass mark (0-2.5) provided incorrect responses to part (a) and were unable to identify the effects of forces on various parts (b). Moreover, they lacked knowledge of forces, particularly the advantages and disadvantages of the friction force. Extract 9.1 is the sample of the incorrect responses of a student to question 9.

< Because when soapy water is spill on tiles floor it lower or decrease the gravitational force ∫ so it can cause slips or an object to be unequilibrium because when you Lower the ~~center of~~ gravity you make an object to be unstable.

(i) : It causes the loss of recruiting placement and the cost to buy or repair the new thing like a bicycle

(ii) : It cause damage, injury when you collide a big a huge stationary body like a student

(iii) : It causes conflict among student and driver because the driver parking a car in a ~~wrop~~ wrong place.

(iv) : Trouble with the laws, If you can apply more force and you going faster speed you can be in a trouble with the law so force it can produce Troubling with the law

Extract 9.1: A sample of incorrect responses to Question 9

In Extract 9.1, a student provided incorrect descriptions of the advantages and disadvantages of friction as per the question instruction. The student identified that a decrease in gravitational force was not correct.

Students who scored average marks (3-6) identified some correct effects of force, such as a change in motion or deformation, but lacked clarity or completeness on explanations.

Some students scored above average marks (6.5-10), had adequate knowledge on friction and the effects of force. They clearly explained how soapy water reduces friction and accurately identified relevant effects of force during the accident. Extract 9.2 is the sample of a correct response of a student to question 9.

Walking become difficult because, soapy water reduce friction force between you and the floor.

(i) The motion of a student stopped

(ii) The shape of the bicycle was changed; It means that the bicycle was very damaged.

(iii) ~~If two object~~ The state of ~~a~~ student with his/her bicycle changed, thus the student was moving ~~to~~ so she/he stopped

(iv) By the reference to newton's third law of motion (To every action there is an equal and opposite reaction) the student after collision felt down because of the reaction force

Extract 9.2: A sample of correct responses to Question 9

In Extract 9.2, a student understood methods to minimize friction and its disadvantages between surfaces in contact, recognizing that walking is impossible without friction. The student also analyzed and identified the effects of forces in a collision between a bicycle rider and a parked car.

2.4 SECTION C: STRUCTURED QUESTION

This section had one (1) structured essay question, set from the specific competency of simple machines. The total marks allotted to this question were fifteen (15) marks.

2.1.10 Question 10: Simple Machine

The question intended to assess the ability of students to determine the velocity ratio, mechanical advantage and efficiency of the machine, specifically the inclined plane. The question was as follows:

An inclined plane was used to raise a load of 8000 N through a vertical height of 1.0 m by applying a force of 500 N. if the distance moved by the effort was 40 m, calculate the following:

(a) Velocity ratio

(b) Mechanical advantage

(c) Efficiency of the inclined plane.

The question was attempted by 1,392 (100%) students; where by 364 (26.15%) scored from 0 to 4.5 marks, 206 (14.80%) students scored from 5 to 9 marks and 822 (59.05%) scored from 9.5 to 15 marks. The general performance of students was good as 1,028 (73.85%) of them scored above the pass mark. Figure 11 shows student's performance in this question.

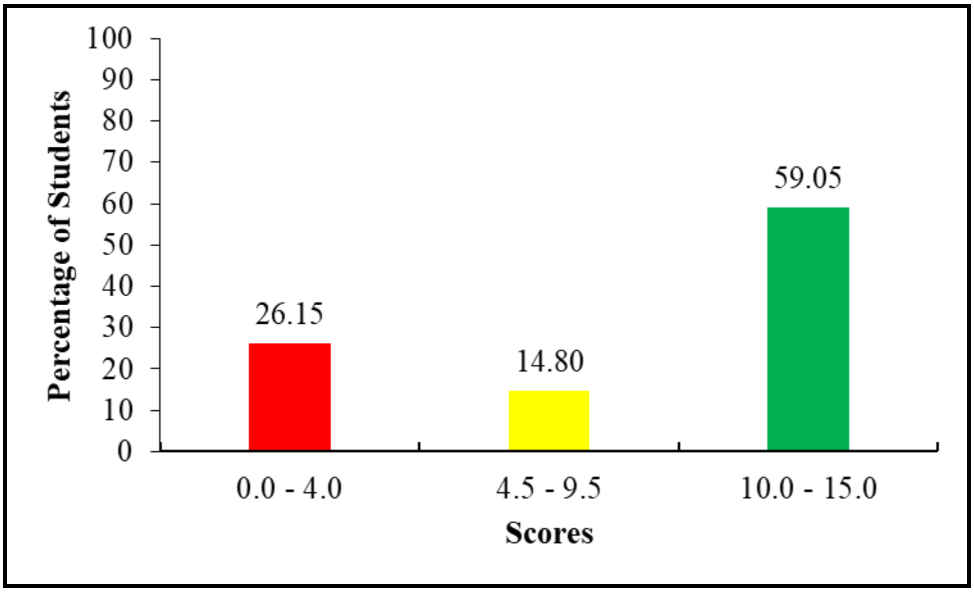


Figure 11: *The Student's Performance in Question 10*

The students who scored below the pass mark (0-4) had insufficient knowledge of simple machines. They failed to determine both velocity ratio (V.R), mechanical advantage (M.A) and the efficiency of the inclined plane. Extract 10.1 is a sample of the student's incorrect responses to question 10.

Soln

M.V.R = $\frac{\text{Destistance moved by load}}{\text{Destance moved by effort}}$

M.V.R = $\frac{8000N}{500N}$

V.R = 16

M.A = $\frac{\text{effort}}{\text{load}}$

M.A = $\frac{40N}{1.0N}$

M.A = 40

efficiency = $\frac{M.A}{V.R} \times 100$

e = $\frac{40}{16} \times 100$

efficiency = 250

Extract 10.1: A sample of incorrect responses to Question 10

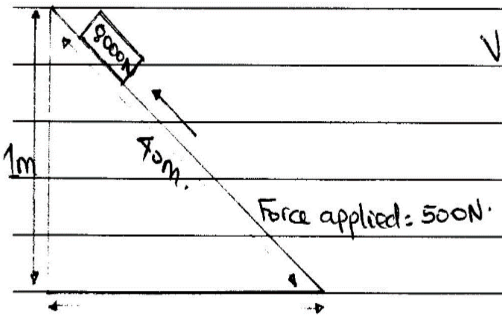
In Extract 10.1, the student interchanged the formula and wrote $V.R = \frac{distance\ moved\ by\ load}{distance\ moved\ by\ effort}$ instead of $V.R = \frac{distance\ moved\ by\ effort}{distance\ moved\ by\ load}$. In addition, the student misinterpreted the formula by substituting the value of the load in the place of distance moved by the load and the value of effort in the distance moved by effort. The student also interchanged the formula for mechanical advantage by writing M.A=$\frac{effort}{load}$ instead of

M.A= $\frac{load}{effort}$ and subsequently misinterpreted the variables. Furthermore, the student interchanged the values of M.A and V.R in the efficiency formula and substituted $\frac{40}{16}$ x 100 instead of $\frac{16}{40}$ x 100%.

However, some students who scored average marks (4.5–9.5) correctly calculated either the velocity ratio or the mechanical advantage but made errors in determining efficiency and did not express it as a percentage.

Students who scored above average marks (10-15) had adequate understanding. They applied the formula correctly, interpreted variables accurately and presented logically structured solutions with correct final answers. Extract 10.2 is a sample of correct responses to question 10.

Velocity Ratio $= \dfrac{\text{Effort distance}}{\text{load distance}}$.



Velocity Ratio $= \dfrac{\text{Slant height}}{\text{Vertical height}}$.

$= 40m / 1m$

$= 40.$

∴ The velocity Ratio is 40.

Mechanical Advantage $= \dfrac{\text{Load}}{\text{Effort}}$.

$= \dfrac{8000N}{500N}$

$= 16$

∴ the Mechanical Advantage $= 16$

Efficiency $= \dfrac{MA}{VR} \times 100\%$.

$= \dfrac{16}{40} \times 100\%$

$= 2/5 \times 100\%$

$= 40\%$.

∴ the efficiency of an inclined plane is 40%

Extract 10.2: A sample of correct responses to Question 10

In Extract 10.2, the student identified properly the distance moved by the effort and the distance moved by the load. They identified that the load moves a distance equal to the vertical height of the inclined plane, while the effort moves a distance equal to the length of the plane. Moreover, the student recalled and applied correctly the formula to calculate the velocity ratio, the mechanical advantage of a simple machine and finally determined the formula to calculate the efficiency of the inclined plane as required.

3.0 ANALYSIS OF STUDENTS' PERFORMANCE IN EACH COMPETENCY

The Engineering Science subject on FTNA 2025 (Vocational Stream) assessed the following specific competencies: *Fluid Mechanics, Introduction to Engineering Science, Mechanical Drives, Linear Motion, Density and Relative Density, Thermal Energy, Work, Energy and Power, Pressure, Forces, Mechanical Properties of Matter, Thermal Expansion, Electricity and Magnetism, Measurement and Simple Machines.* Analysis of student's performance shows that the highest achievement was in Electricity (75.50%), Simple Machines (73.85%) and Measurement (65.88%), which were assessed in questions 6, 10 and 5, respectively. Specific competencies where students had average performance include Forces (52.73%), Basic Analogue Electronics (51.72%), Fluid Mechanics (47.84%), Mechanical Properties of Matter (43.53%) and Thermal Expansion (41.81%).

Students performed poorly in Linear Motion (21.05%), scoring below the pass mark. In some questions, students provided incorrect responses and were unable to apply the correct formula in calculations, insufficient subject knowledge and inadequate drawing skills. A detailed summary of student's performance for each specific competency is provided in the Appendix.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The student's performance in the Form Two National Assessment (FTNA) 2025 on Engineering Science subject was generally good, as 937 (67.31%) students passed. This outcome suggests that most students mastered the content, applied appropriate skills and successfully used mathematical expressions to solve competence-based problems. Furthermore, the students demonstrated adequate knowledge to interpret drawings. However, 455 (32.69%) students attained below pass mark, indicating gaps in understanding and limited mastery of key concepts and skills within the subject. This group experienced difficulties in applying knowledge accurately and consistently during problem-solving tasks.

4.2 Recommendations

To improve performance in Engineering Science subject, the report proposes the following recommendations

(a) Recommendations to the Students

(i) Students should focus more on conceptual understanding of fundamental principles such as density, buoyancy, friction, elasticity and simple machines to reduce rote learning and improve conceptual clarity.

(ii) Students should practice to step by step on problem-solving strategies, particularly in questions involving calculations, to enhance accuracy and logical reasoning.

(iii) Students should practice on the correct use of units, symbols and scientific notation.

(b) Recommendations to the Teachers

(i) Teachers should integrate real-life examples and practical applications when teaching theoretical concepts to improve relevance and student's engagement.

(ii) Teachers should strengthen student's understanding of scientific terminology and symbols through consistent practice exercises.

(iii) Teachers should encourage peer learning and collaborative tasks, allowing students to explain concepts to one another.

(iv) Teachers should provide structured revision sessions and guided practice before assessments.

Appendix

Student's Performance Question-Wise in Engineering Science Subject

S/N	Specific Competency	Question Number	Percentage of Students who Scored 30% or More	Remarks
1	Fluid Mechanics, Introduction to Engineering Science, Mechanical Drives, Linear Motion, Density and Relative Density, Thermal Energy, Work, Energy and Power, Pressure, Forces and Mechanical Properties of Matter.	1	91.16	Good
2	Electricity and Magnetism	6	75.5	Good
3	Simple Machines	10	73.85	Good
4	Measurement	5	65.88	Good
5	Forces	9	52.73	Average
6	Basic Analogue Electronics	2	51.72	Average
7	Fluid Mechanics	7	47.84	Average
8	Mechanical Properties of Matter	8	43.53	Average
9	Thermal Expansion	3	41.81	Average
10	Linear Motion	4	21.05	Weak