THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEMS RESPONSE ANALYSIS REPORT FOR THE FORM TWO NATIONAL ASSESSMENT (FTNA) 2018

035 ENGINEERING SCIENCE

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FOREWORD

The Engineering Science Item Responses Analysis report on the performance of the students in the Form Two National Assessment (FTNA) 2018 was written in order to provide feedback to students, teachers, parents, policy makers and the public in general about the performance of the students and the challenges they faced in attempting questions. The report has attempted to expose a number of factors that seemed to be the source of the students' poor performance in the subject.

The Form Two National Assessment marks the end of two years of Ordinary Level Secondary Education. It is a formative evaluation of which its effectiveness shows the achievement of the education system in general and the education delivery system in particular. Essentially, the students' responses to the assessment questions are foremost pointers of what the education system was able or unable to offer to the students in their two years of early stage of Ordinary Level Secondary Education.

The report highlights the factors that affected the students'performance in the questions. Such factors include failure to understand the task of the question, lack of knowledge on the concepts related to the subject and inability to manipulate basic calculations. The feedback provided will help the educational administrators, school managers, teachers, students and other stakeholders to identify proper measures to be taken in order to improve the FTNA students' performance in future.

The National Examinations Council of Tanzania will highly appreciate comments and suggestions from teachers, students, education quality assurers, curriculum developers and the public in general, that can be used in improving students' performance in the future examinations.

Finally, the Council would like to thank the examination officers and others who participated in analysing the data used in this report, typesetting the document and reviewing the report.

Dr Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report analyses students' performance in Engineering Science Subject for the Form Two National Assessment (FTNA) in 2018. The analysis focus on highlighting the strengths and weaknesses observed on the students' answers in order to provide a general overview regarding students' performance.

The Engineering Science paper consisted of two (2) sections namely, A and B with a total of 10 questions. Sections A had 3 questions and section B had 7 questions. The students were required to answer all questions in all sections. Section A carried 30 marks and B carried 70 marks.

A total of 1612 students sat for FTNA 2018 in Engineering Science paper whereby 876 (54.3%) students passed while 736 (45.7%) failed. In 2017, the number of the students who sat for Engineering Science paper was 1513, of which 665 (44%) students passed while 848 (56%) failed. This implies that the students' performance in this subject has increased by 10.3 percent. The comparison of the students' performance in Engineering Science in the FTNA 2018 and 2017 is presented on the Figure 13 (Appendix II).

The analysis starts by presenting the requirements of each question, students' strengths and weaknesses in their responses and percentage of students in each group of scores accompanied with a bar chat. Finally, it provides the conclusion, graphs for; performance for individual question, percentage of students' overall performance and the comparison of the students' performance between 2018 and 2017, recommendations and an attachment which contains the percentages of the students who scored 30 marks or above in each question.

The performance of students in this analysis was categorized in the following ranges: 0 to 29 as weak, 30 to 64 as average, and 65 to 100 as good. Generally, the performance in FTNA 2018 was average. The overall performance of this subject is presented in Figure 1.

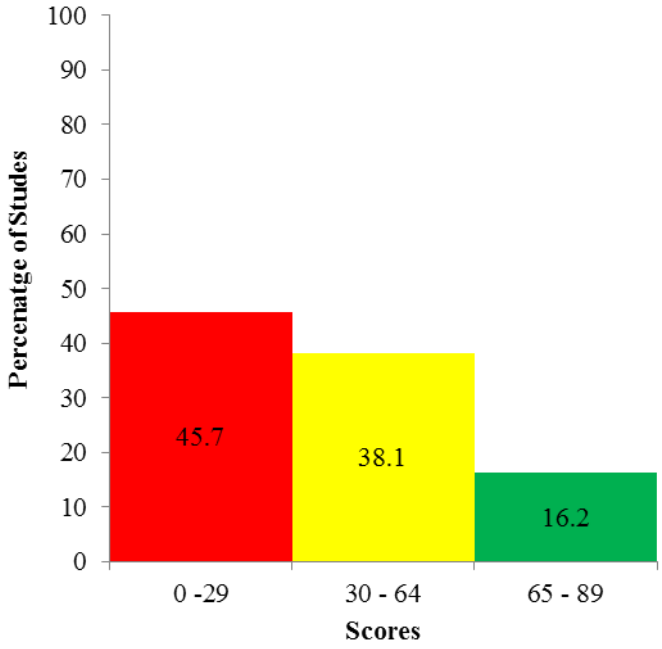


Figure 1

2.0 ANALYSIS OF ITEM RESPONSES IN EACH QUESTION

2.1 SECTION A: *Objective and Short Answer Questions*

2.2.1 Question 1: Multiple Choice

In this question, students were required to choose the correct answer from the given alternatives. The question consisted of ten (10) items (i) – (x) which were drawn from various topics within the form one and two syllabus.

This question was attempted by 1612 (100%) students, out of which 18.0 percent scored below 3 marks, 63.3 percent scored from 3 to 6 marks, and 18.7 percent scored from 7 to 10 marks. The performance of the students in this question is presented in Figure 2.

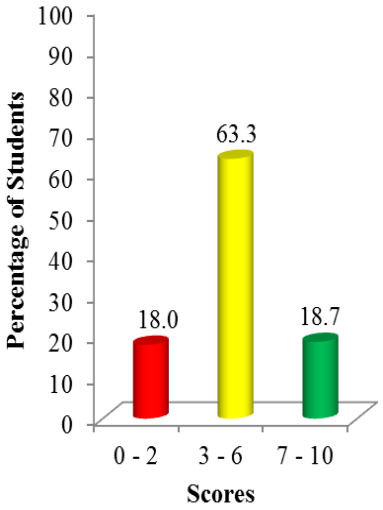


Figure 2

The majority of the students failed to choose the correct responses in item (iv) and (vii).

The item (iv) question was;

(vi) What is the velocity ratio of the pulley and Tackle system which supports the bottom blocks by two ropes?

A Four
B Three
C Two
D Six

Most of the students chose alternative 'A: Four' instead of the correct one 'C: Two'. They were required to demonstrate their skills by applying the knowledge of pulley and tackle system. In attempting this item, the importance of using diagram was necessary. The students failed to correlate between the number of ropes and pulleys in the system. They were supposed to understand that, the number of pulleys or strings in the pulley and tackle system is equal to the velocity ratio. This phenomenon could also be verified by drawing the pulley and tackle system which supports the bottom blocks by two ropes. Through sketching, the system, could reveal the number of pulleys used hence identifying the velocity ratio. It seemed that they chose 'A: Four' because they confused that the bottom blocks supported by two ropes could be two and two blocks on the upper hence making a total of four pulley and therefore four velocity ratio.

Item (vii) question was;

(vii) If the surface of one body is moving over another surface of a body which is in contact, the resistance is set up

A parallel to the motion
B perpendicular to motion
C normal to motion
D opposite to motion

Most of the students chose alternative 'A: 'Parallel to motion' instead of the correct one 'D: 'opposite to motion'. Since there are two forces which are resistance set up between surfaces (friction force 'F_f') and applied Force 'F'. The students confused to choose 'A' instead of 'D' because the two forces are collinear.

These students had insufficient knowledge to sketch and use the diagram to identify the concept of direction of resistance set up as illustrated on the diagram 1. Diagram 1 exposes the two forces, whereby they are both parallel to motion but the friction force (resistance set up) is opposite to motion and applied force is in the same direction to motion

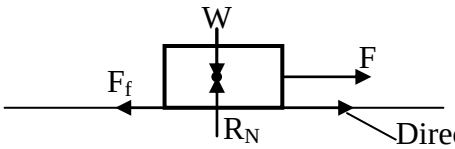


Diagram 1

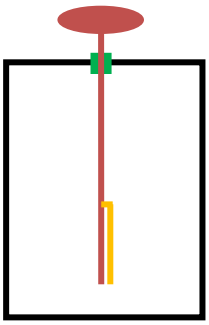
Despite selection the incorrect alternative in items (iv) and (vii), majority of the students were able to select the correct responses in items (iii), (ix) and (x).

The item (iii) question was;

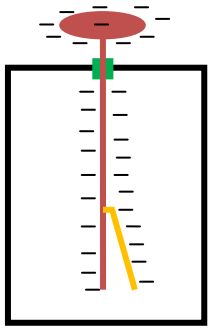
The gold leaf electroscope is an instrument used to tell if an object is

A charged
B neutral
C a coil
D a magnet

The students were able to remember the function of the gold leaf electroscope. They were familiar with the sub-topic of static electricity. They imagined the picture of the gold leaf electroscope before and after being charged Diagram 2 (a) and (b).



Uncharged gold leaf electroscope
(a)



Charged gold leaf electroscope
(b)

Diagram 2

They had the concept that, the gold leaf electroscope is used to detect whether the object is charged or not charged. They were also aware that, inorder the gold leaf electroscope to detect the charge, the charged object must be wiped across the cap of electroscope. The charge (if any) flows over the conducting copper and gold, thus the gold leaf rises as it becomes repelled by having the same charge as the copper. (see Diagram 2 (b).)

The item (ix) question was;

Shadows are formed when some rays of light impact to;
A *translucent object*
B *transparent object*
C *opaque object*
D *eclipse object.*

The students were familiar with the topic of Optics. They were aware that light rays travels in a straight lines and opaque materials doesn't allow light rays to pass through while other materials allow light to pass through partially or totally. They remembered that, opaque material causes shadow on the opposite side when the light rays impact on the surface on other side.

They were aware that, shadow is formed when an opaque object blocks the path of a beam of light thereby causing the ray not to illuminate the background surroundings of the opaque object. This dark area behind the

opaque object is known as shadow. Shadow is formed due to blockage of light.

The item (x) question was;

Which of following are the two forces acting on a book which is resting on a smooth flat table?

A Weight and reaction
B Weight and friction
C Reaction and friction
D Upthrust and friction

The students chose the correct alternative 'A: Weight and reaction' because they were aware that object resting on a flat table consists of only two forces which are the weight of the object and the reaction force given back by the table to maintain the object to be in equilibrium.

They didn't choose other alternative as correct answer because they had the concept that, friction force exist only if the object is just about to move and that, the upthrust occurs only in fluid as the object sinks or floats in liquid or atmosphere. Diagram 3 shows an object resting on table with two force W 'weight of the object' and R_N 'reaction force' of the table. Selections of correct answers for other items were average.

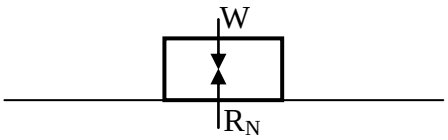


Diagram 3

2.2.2 Question 2: True or False

This was the best performed question as 98.6 percent of students scored 3 marks or above. The question was derived from different topics and consisted of ten (10) items (i) - (x) in which students were required to write TRUE if the statement was correct or FALSE if the statement was not correct.

This question was attempted by 1612 (100%) students, out of which 1.4 percent scored from 0 to 2 marks with 0.1 percent being those who scored a 0 mark, 38.3 percent scored from 3 to 6 marks and 60.3 percent scored from 7 to 10 marks. The graphical presentation of the groups of scores with

respective percentage of students who did this question is summarized in Figure 3.

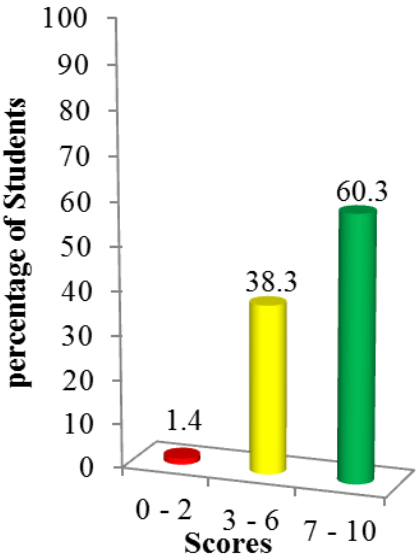


Figure 3

Some of the students 121 (7.5%) were able to write the correct responses in all items and hence scored all 10 marks in this question. They were familiar with concepts from different topics such as Energy, Work and Power, Sound, Force, Fluid Mechanics, Turning forces, Electricity and Magnetism, Heat, Measurement, Friction Force and Linear Motion. Although some students scored all marks, there were those who scored from 7 to 9 marks while others scored from 3 to 6 marks. The items in which most of these students (who scored from 3 to 9 marks) failed to fill in the correct response of True or False were (v) and (vi).

The item (v) question was;

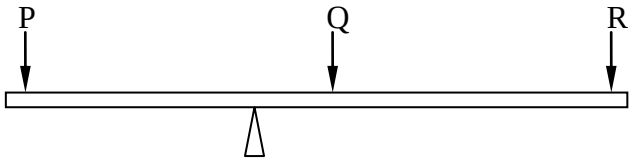


Figure 1

One of the conditions for the body Figure 1 to be in equilibrium is that, the sum of clockwise moment must be not equal to the sum of the ant clockwise moment ……..

Most of the students wrote the wrong answer as "True' instead of "False". They were not aware with the principle of moment which states that "the sum of clockwise moments about a point is equal to the sum of the anticlockwise moments". They failed to verify that, for the diagram figure 1 to be in equilibrium, the product of the sum of force 'Q' and the (the distance from force 'Q' to fulcrum) plus the product of force 'R' and (distance from Force 'R' to Fulcrum) could be equal to the product of force 'P' and (the distance from force 'P' to Fulcrum).They were supposed to know that for Figure 1 to be maintained in equilibrium, the clockwise and anticlockwise moments about the fulcrum should balance each other, so that the resulting moment about the fulcrum could be zero.

The item (vi) question was;

The resistance of a metal conductor increases with temperature……

The correct answer was True. Most of students wrote False, they were not aware that the increase in temperature on a conductor increases resistance of a conductor due to that, when the temperature of metallic conductor increases, it causes the increase in amplitude of vibration of metallic atoms which in turn causes some extra resistance in a path of free electrons, thus causing the increase of the resistance of a conductor. Extract 2.1 is a sample of a good response from one student.

2. For each of the following statements, write **True** if the statement is correct or **False** if the statement is not correct.

(i) Energy can be changed from one kind to another but amount of energy stay the same
....True:.....

(ii) Sound waves are reflected well from hard and flat surfaces such as wall or cliff....True.....

(iii) The force that a bar magnet exerts on the iron nail is called repulsive force
.....False.....

(iv) Relative density of an object is the ratio of its density to the density of an equal volume of water. .....True.....

(v) One of the conditions for the body in Figure 1 to be in equilibrium is that, the sum of clockwise moment must not be equal to the sum of the anti - clockwise moment False
.....

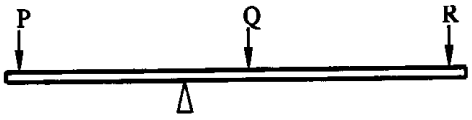


Figure 1

(vi) The resistance of a metal conductor increases with temperature .....True.....

(vii) The boiling point of water is not affected by the impurities dissolved in the water.
.....False.....

(viii) Measurement is simply defined as the process of assigning numbers to observations
.....True.....

(ix) Dynamic friction is the friction between two surfaces which are trying to move but are not yet moving....False.....

(x) The distance travelled by the body is the same as the area under velocity time graph
....True.....

Extract 2.1 shows a sample of response from one of the students who managed to answer all parts of the question correctly.

The students who scored 0 mark failed to identify the correct and incorrect statements in all items (i) –(x) that's why they wrote *TRUE* for incorrect statement and *FALSE* for correct statement. These students misinterpreted the given statements that is why they failed to identify the true and the false statement. For example one student failed to write the required response in item (i) to (v) by writing wrong 'True statement and False statements' and in item (vi) to (x) wrote irrelevant responses with regard to the requirements of the question as shown in Extract 2.2.

2. For each of the following statements, write **True** if the statement is correct or **False** if the statement is not correct.

(i) Energy can be changed from one kind to another but amount of energy stay the same
F FALSE

(ii) Sound waves are reflected well from hard and flat surfaces such as wall or cliff. F FALSE

(iii) The force that a bar magnet exerts on the iron nail is called repulsive force
T TRUE

(iv) Relative density of an object is the ratio of its density to the density of an equal volume of water. F FALSE

(v) One of the conditions for the body in Figure 1 to be in equilibrium is that, the sum of clockwise moment must not be equal to the sum of the anti - clockwise moment .....
T TRUE

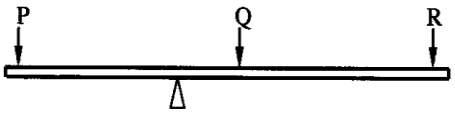


Figure 1

(vi) The resistance of a metal conductor increases with temperature ..... vector quantity

(vii) The boiling point of water is not affected by the impurities dissolved in the water.
neutral

(viii) Measurement is simply defined as the process of assigning numbers to observations
people which

(ix) Dynamic friction is the friction between two surfaces which are trying to move but are not yet moving. Basic quentity

(x) The distance travelled by the body is the same as the area under velocity time graph
opposite motion

Extract 2.2 shows a poor response from one of the students who wrote wrong 'true statement' and 'false statements' and in some items wrote irrelevant responses with regard to the requirements of the question.

2.2.3 Question 3: Filling in the Blanks

This question consisted of ten (10) short answer questions (i) – (x) which required the students to fill in the blanks provided.

The question was attempted by 98.1 percent of the students, out of which 73.9 percent of the students scored from 0 to 2.5 marks, 32.7 percent scored 0 mark, 25.5 percent scored from 3 to 6 marks and 0.6 percent scored either 7 or 8 marks. The graphical presentation of the groups of scores with respective percentage of students who did this question is summarised in Figure 4.

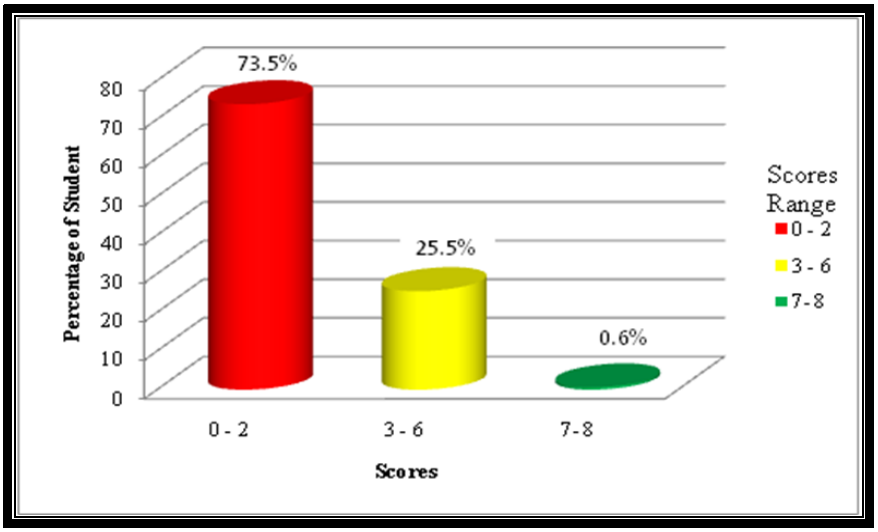


Figure 4

The students performed very poor in this question. A few percent of the students (26.1%) scored 3 marks and above. The majority of students 73.9% failed to fill in the correct responses in almost all items except one or two items. The items in this question were derived from different topics of Engineering Science. Most of the students failed to fill in the correct response due to lack of general knowledge in engineering science. Most of the students if not all failed to fill in the correct responses in items (i) , (ii), and (viii) . Extract 3.1 is a sample of poor response.

3. Fill in the blank spaces by writing the correct answer:

(i) The two equal forces 'F' acting on the rod in Figure 2 subject the rod into

acceleration

Figure 2

(ii) The arrangement of pulleys in the pulley and tackle pulley system with velocity ratio of five are .....

(iii) The unit of luminous intensity is known as .....Steel.....

(iv) When a bus is travelling with a constant velocity its acceleration is

...Zero.....

(v) The SI unit of potential difference is the same as the SI unit of ....Voltmeter Lumens

(vi) The light is the energy which travels only in ....Sun.....

(vii) Among air, vacuum, steel and water, sound travels fastest in ..Steel Line.....

(viii) When copper and steel rods of the same dimensions are heated to a certain temperature, their temperature raise in each rod differs due to ...Linear....motion.....

(ix) If the object is allowed to fall freely from rest to the ground, its potential energy just before it strike the ground is equal....to...ground.....

(x) An object weighs more at the North and South poles than at the....Compass.....

Extract 3.1 shows a sample of response from one of the students who failed to fill in the correct responses in all items of the question.

The item (i) question was;

The two equal forces 'F' acting on the rod in Figure 2 subjects the rod into ……..

Figure 2

Students were required to identify the type of force acting on rod Figure 2 in the question paper. Most of them provided irrelevant response, they failed to study the diagram and interpret the action of force 'F' in order to give relevant answer. They were not aware of the concepts that, when two forces act on an object in opposite direction, cause the object to be subjected to compression. They lacked the knowledge on the sub-topic of types of forces.

Some of the students left this item blank. Others confused the subtopic of types of forces with the topic of turning forces. Instead of stating the type of force subjected to the rod given to figure 2 in the question paper, they stated the principle of moment. Others gave irrelevant responses such as *dynamic friction, hard surface, ammeter, dimension and parallel to motion.*

The item (ii) question was;

The arrangement of pulleys in the pulley and tackle pulley systems with velocity ratio of five are ……

The question required the student to apply the knowledge of pulley and tackle pulley system to sketch the diagram of pulley and tackle pulley system with velocity ratio of five in order to identify the arrangement of the pulleys which has two parts, that is, upper fixed pulley and the lower fixed pulley. They failed to identify by sketching the pulley that, when the system has a velocity ratio of five, the system consists of five pulleys. The arrangement of all odd number of pulleys in the pulley and tackle system is that, the number of pulleys in upper fixed pulley is greater than those fixed on the lower side. Therefore the pulley and tackle pulley system with velocity ratio of five consists of five pulleys of which three pulleys are fixed on the upper side while the remaining two pulleys are fixed on the lower side of pulley and tackle pulley system.

Some of the students provided wrong responses as they stated the number of pulleys without considering the velocity ratio of the system. Others gave

irrelevant responses such as *level, parallel to the motion, inclined pulleys, efficiency of the machine and block by five ropes.*

The item (viii) question was:

When copper and steel rods of the same dimensions are heated to a certain temperature their temperature raise in each rod differs due to ……

The question required the student to remember the properties of material of copper and steel when subjected to heat. They should have the concepts of the rate of energy needed by these materials to rise the temperature from one point to another.
Every material consumes its own heat when heated in order to rise a temperature to a certain point. They were supposed to understand that, heat consumption differs from one material to another, when the material of 1 kg is heated to rise 1 degree Celsius. The amount of heat consumed for every material is known as specific heat capacity of the material.

Therefore, the specific heat capacity for the material is the amount of heat energy required to rise the temperature of a unit mass of the substance by unit rise in temperature.

Most of the students confused the sub-topic of specific heat capacity with the sub-topic of linear expansion of solid materials. Instead of stating the specific heat capacity as the cause of difference of temperature rise when copper and steel rod are heated, they wrongly stated that, the coefficient of linear expansivity, heat capacity, expansion, increase in temperature is the cause of the difference of the temperature rise when these material are heated. Others provided irrelevant response such as *linear motion, vacuum, velocity time graph, translucent, the resistance.*

Other items were moderately filled in with the correct responses by 26.1% of the students. Only three students scored 8 marks on this question while 7 students scored 7 marks. There were no students who were able to fill correctly in all blanks, thus no student scored 9 or 10 marks from this question. Extract 3.2 is a sample of poor response.

(iii) The unit of luminous intensity is known as .....Candela.....

(iv) When a bus is travelling with a constant velocity its acceleration is .....Zero.....

(v) The SI unit of potential difference is the same as the SI unit of electromotive force

(vi) The light is the energy which travels only in ...a straight line.....

(vii) Among air, vacuum, steel and water, sound travels fastest in .....steel.....

(viii) When copper and steel rods of the same dimensions are heated to a certain temperature, their temperature raise in each rod differs due to ..specific heat capacity.

(ix) If the object is allowed to fall freely from rest to the ground, its potential energy just before it strike the ground is equal.....

(x) An object weighs more at the North and South poles than at the...Equator.....

Extract 3.2 shows a sample of good responses of some items from the script of one student who was able to fill in correctly.

2.2 SECTION B: Structured Questions

2.2.1 Question 4: Linear Motion

This question consisted of four parts (a), (b), (c) and (d). It was drawn from the topic of Linear Motion. The question demanded students to (a) define the terms as applied in the study of linear motion (i) inertia and (ii) speed, (b) write down the three motion of a body thrown vertically upward, and part (c) demanded the students to find momentum after 6 seconds of a bus of mass 5000kg moving from rest with constant acceleration of 2 m/s^2;

The question was attempted by 99.0 percent of the students out of which 63.5 percent scored from 0 to 2.5 marks out of which (30.9%) scored 0 mark, 20 percent scored from 3 to 6 marks and 16.5 percent scored from 6.5 to 10 marks. The general performance of the students on this question was average. The graphical presentation of the groups of scores with respective percentage of students of this question is summarised in Figure 5.

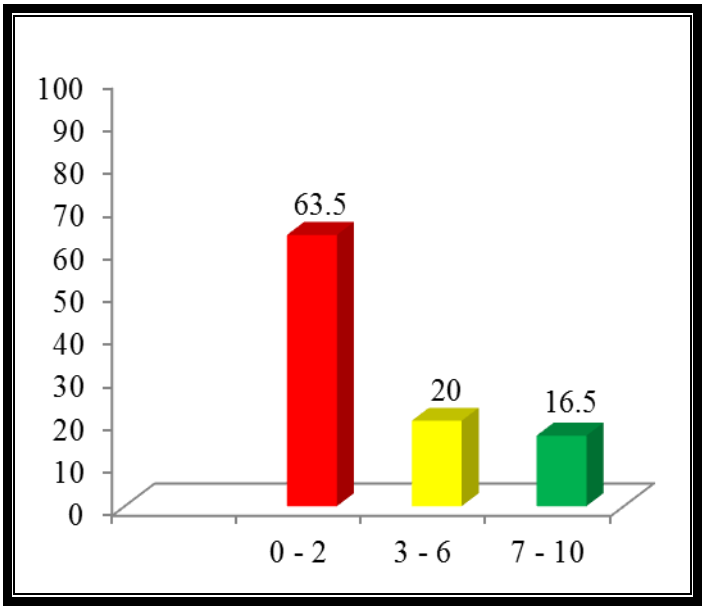
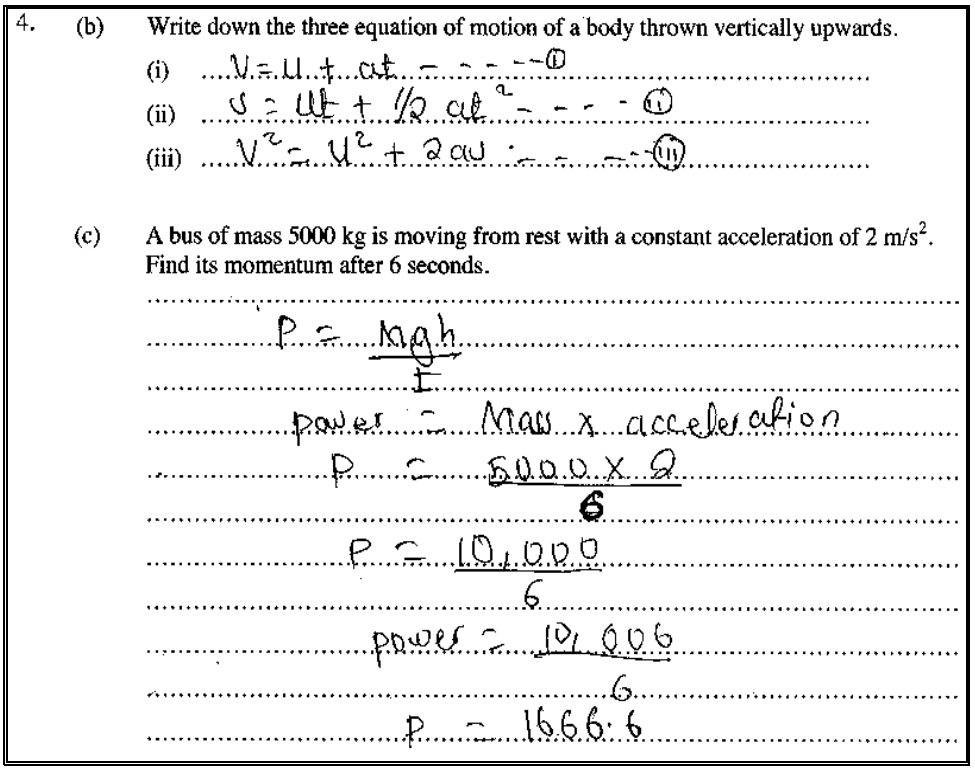


Figure 5

The students who scored a 0 mark failed to provide correct answers for questions in part (a) (i) define the term inertia and (ii) speed. They were not able to remember the definition of inertia and speed. They did not understand the concept of the inertia which is the resistance of a body to act due to an external force forcing a body to act in a certain way. In (ii) they failed to remember that, speed is the scalar quantity which has magnitude only and thus is defined as the distance travelled over certain period. Some of the students who did not answer this queston correctly confused the term speed with velocity. Instead of defining the term speed, they defined velocity. Others defined acceleration instead of speed. There were those who provided wrong definition, for example, one student defined speed as *the tendency of the body to start at rest and move with an object to another*. Another student defined speed as *the rate on which a velocity remains constant.* In part (b), they failed to list the three equations of motion when a body thrown vertically upward. Instead of writing the three equations of a body moving vertical upward, some of the students wrote the three equation of linear motion. They wrongly wrote $v = u + at$, $s = ut + \frac{1}{2}at^2$ and $v^2 = u^2 + 2as$ instead of writing $v = u-gt$, $h = ut - \frac{1}{2}gt^2$ and $v^2 = u^2 – 2gh$. From these students' responses, it reveals that, the students confused the equation for linear motion with the equation of the motion of a body moving vertically upward. In part (c) some of the students failed to remember the formula used to find the momentum of a bus with a given time, some others remembered the formula to find the momentum which is

"Momentum = Mass x Velocity", but they failed to find the velocity required so it could be substituted in the formula for finding momentum. The analysis reveals that this group of students lacked knowledge on the topic of Linear Motion. They were not aware that, inertia relates to Newton's first law of motion and the term speed differs from velocity in such a way that, velocity has both magnitude and direction while speed has magnitude only. Extract 4.1 shows a sample of a poor response in this question.


4. (b) Write down the three equation of motion of a body thrown vertically upwards.

(i) $V = u + at$ ---(i)

(ii) $s = ut + \frac{1}{2}at^2$ ---(ii)

(iii) $V^2 = u^2 + 2as$ ---(iii)

(c) A bus of mass 5000 kg is moving from rest with a constant acceleration of 2 m/s^2. Find its momentum after 6 seconds.

$P = \frac{mgh}{t}$

power = Mass x acceleration

$P = \frac{5000 \times 2}{6}$

$P = \frac{10,000}{6}$

power = 10,006 / 6

$P = 1666.6$

Extract 4.1 is a sample of a poor response taken from the script of a student who failed to attempt the question correctly.

For those who scored from 0.5 to 2.5 marks most of them were able to define speed but failed the other items, while others managed to write the formula v = u + at and failed the rest parts of the question. There were those who managed to define both inertia and speed in part (a) (i) and (ii) respectively and attempted some steps to score 0.5 marks on part (c) making a total of 2.5 marks. Others managed to attempt correctly part (c) only. A few students in this group who were able to write formula and hence scored some marks on part (b).

Some of the students who scored from 3 to 6 marks, were able either to attempt part (a) and some area in part (b) or attempted part (a) and (c) but failed to attempt part (b).
Some students among a group of those who scored from 6.5 to 10 marks managed to (a) define the term inertia in (i) and speed in (ii), and were able to write correctly the three equations of motion when body is thrown vertically upward. Others were able to write the three equations of vertically upward motion and managed to find the momentum of a bus correctly. Some of students among this group were able to attempt some areas of part (a) and (c) and wrote correctly the three equations of vertically upward motion in part (b) thus obtaining marks between 6.5 to 9.5. From the analysis it reveals that the failure of these students to score all 10 marks on this question was due to some failed to remember the definition of inertia and speed and others had misconception on the formula for the vertical upward motion while other didn't remember the formula for velocity and momentum. There were those who showed lack of concentration in manipulation of finding the momentum of a bus thus they obtained less than 10 marks.

For those who scored 10 marks managed to define all the terms inertia and speed in part (a) (i) and (ii) respectively, they further showed that, the speed of a body can be obtained by using the formula $Speed = \frac{Distance}{Time\ taken}$ they wrote all three correct formula for vertical upward motion in part (b) and were able to find correctly the momentum of a bus in part (c). These students showed mastery of the topic of linear motion. Extract 4.2 is the sample of response from the script of the student who was able to attempt the question correctly.

(a) Define the following terms as applied in the study of linear motion:

(i) Inertia

Is the tendency of a body to continue in motion or that at rest remain so, unless it is acted by external force.

(ii) Speed

Is the rate of change of distance

∴ speed = distance (d) / time taken (t).

(b) Write down the three equation of motion of a body thrown vertically upwards.

(i) $V = U - gt$

(ii) $H = ut - \frac{1}{2}gt^2$

(iii) $V^2 = u^2 - 2gh$.

(c) A bus of mass 5000 kg is moving from rest with a constant acceleration of 2 m/s^2. Find its momentum after 6 seconds.

Data given.

Mass of a bus = 5000 kg.

Acceleration (a) = $2\ m/s^2$

Initial velocity (u) = 0 m/s

final velocity (v) = ?

time (t) = 6s.

Soln.

From equation (1) of motion.

$V = u + at$.

$V = 0\ m/s + 2\ m/s^2 \times 6s$

$V = 12\ m/s$

∴ Momentum (P) = mass x velocity.

$P = m \times v$.

$P = 5000\ kg \times 12\ m/s$.

$P = 60\,000\ kg\ m/s$.

∴ The momentum after 6seconds = 60.000 kg m/s.

Extract 4.2 is a sample of a response from a script of the student who demonstrated accurate answers.

2.2.2 Question 5: Electricity and Magnetism

This question was set from the topic of Electricity and Magnetism. The question had three parts (a), (b) and (c) as follows;

(a) *Define the following terms;*
(i) Ammeter
(ii) Voltmeter

(b) List four factors that affect the resistance of a conductor

(c) (i) State the magnetic domain theory
(ii) Draw a sketch to show how a ferromagnetic material gets magnetized

The students' performance in this question was average. The question was attempted by 98.4 percent of the students, out of which 55.6 percent of the students scored from 0 to 2.5 marks 24.2% scored a 0 mark, 38.6 percent scored from 3 to 6 marks and 5.8 percent scored from 6.5 to 8 marks. The graphical presentation of the groups of scores with respective percentage of students who did this question is summarized in Figure 6.

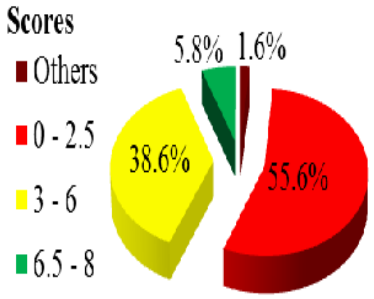


Figure 6

The poor responses of the students who scored 0 reveal that, they had insufficient knowledge on the topic of Electricity and Magnetism and that is why they failed to define Ammeter and Voltmeter in part (a). These students didn't understand that Ammeter is an instrument used to measure current while Voltmeter is an instrument used to measure potential different (p.d) between two points in an electric circuit. These instruments are found in an electric circuit. The ammeter is connected to series with electric circuit while voltmeter is connected to parallel with the electric circuit. These group of students failed even to apply the diagram to define the ammeter and voltmeter as it can be seen in diagram 4.

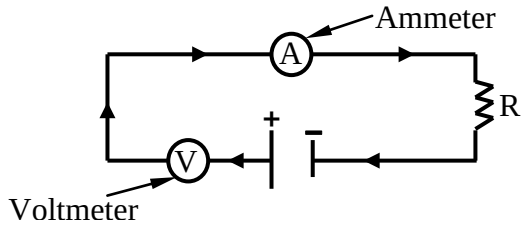


Diagram 4: An electric Circuit

They failed to list four factors that affect the resistance of a conductor in part (b) and were not able to state the magnetic domain theory as well as to draw a sketch to show how a ferromagnetic material gets magnetised in part C (i) and (ii) respectively. These students had no idea on the sub-topic of magnetism. They did not understand that magnetic domain is a group of atomic magnets pointing in the same direction and they were not able to remember that, 'magnetic domain theory' is the theory which emphasis on how a Ferromagnetic becomes magnetized in the direction of any applied magnetic field and this magnetization produces a magnetic pole in the ferromagnetic opposite to that pole which is nearest to it.

Those who scored from 0.5 to 2.5 marks were able either to define Ammeter and Voltmeter in part (a) or listed one or two factors that affect the resistance of a conductor in part (b). Others managed only to define Ammeter and listed one factor that affect the resistance hence scoring less than 3 marks on this question. They also failed to draw a sketch to showing how ferromagnetic material gets magnetised, thus they scored below average. These students demonstrated poor mastery of the subtopic of magnetism. Extract 5.1 shows a sample of poor responses.

5. (a) Define the following terms:

(i) Ammeter

Ilenal of the ararung Wahena jucter teramsey tluera huezatlung Walung watinounaline

(ii) Voltmeter

Isetheral of the areiwating Waliney ano thearani theung Wa Illerahing Waleung ecforelinet therang

(b) List four factors that affect the resistance of a conductor.

(i) Thera thera thera ngat erang Wahey therang

(ii) liang Waley therang Wahera ngaherati Walieng

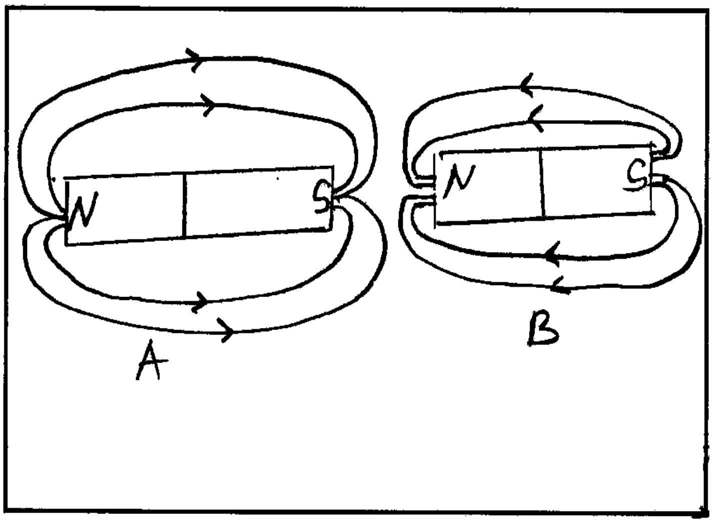
(iii, Tlera ngulung Water yate thgau yaranuty

(iv) Derafing therang Waliney therang

(c) (i) State the magnetic domain theory.

Thera thueraing domiean thorey Shentrali Mainenal of therang Waiting Ameraturai

(ii) Draw a sketch to show how a ferromagnetic material gets magnetized.



Extract 5.1: A sample of a response from the script of a student who failed to define Ammeter and Voltmeter and to list the four factors that affect the resistance of a conductor. Nevertheless he/she was unable to draw a sketch to show how ferromagnetic material gets magnetised.

The students who have scored averagely - (scored 3 to 6 marks) were analysed in this group that, they were able to define Ammeter and Voltmeter and listed one or two factors that affect the resistance of a conductor in part (b). Others failed to give definition in part (a) but managed to list all the factors in part (b) and stated wrong magnetic domain theory and drew irrelevant sketch to show how a ferromagnetic material gets magnetised in part (c). Others attempted part (a) correctly and were able to sketch the magnetisation drawing but either failed to substitute data into the formula or wrote wrong formula and therefore scored average marks in this question.

None of the students scored all 10 marks in this question. Some scored from 6.5 to 8 marks. Most of these students managed to give correct answer in part (a), (b) and (c) (ii). The analysis showed that there were others who managed to define Ammeter and Voltmeter in part (a) and listed three factors that affect the resistance of a conductor in part (b) and in part (c). They either stated the magnetic domain theory correctly or drew correctly the sketch to show how a ferromagnetic material gets magnetised and this is the reason why they scored between 6.5 and 8 marks. It is obvious that, these students demonstrated some knowledge on this subtopic of magnetism. They were able to give factors that affect the resistance of a conductor such as the nature of the material of the conductor and dimension of the conductor. Extract 5.2 shows the response of a good answer from one student.

5. (a) Define the following terms:

(i) Ammeter

Is an instrument that is Used to measure the electric current in the circuit

(ii) Voltmeter

Is an instrument that is Used to measure the amount of voltage in the circuit across points.

(b) List four factors that affect the resistance of a conductor.

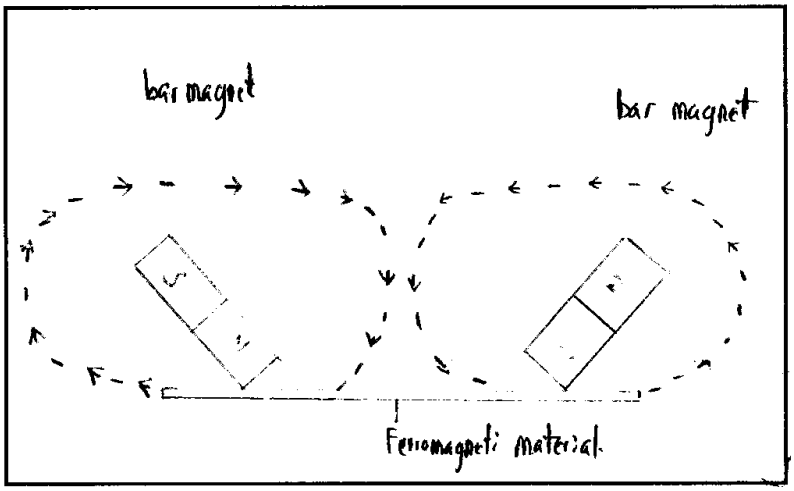
(i) Length of a conductor

(ii) Nature of a material Used to make the conductor.

(iii) Cross section area of a conductor.

(iv) Temperature of a conductor.

(ii) Draw a sketch to show how a ferromagnetic material gets magnetized.



Extract 5.2: A sample of some parts of a response from a script of a student who was able to; define Ammeter and Voltmeter, list four factors that affect the resistance of a conductor and draw a sketch to show how ferromagnetic material gets magnetised.

2.2.3 Question 6: Work, Energy and Power

Question 6 consisted of two parts, (a), (b) and (c).
The question was as follows:

(a) *Mention two forms of mechanical energy.*
(b) *Define the two forms of mechanical energy mentioned in 6 (a) above.*
(c) *A jack can lift 2000 kg vertically through a height of 6 m in 10 s. Find the following;*
    (i) Work done by a jack
    (ii) Power applied by a jack

The question was attempted by 98.5 percent of the students. Out of these 34.3 percent scored from 0 to 2.5 marks, 17.6 percent scored 0 mark, 23.6 percent scored from 3 to 6 marks, and 42.1 percent scored from 6.5 to 10 marks. The graphical presentation of the groups of scores with respective percentage of students of this question is summarised in Figure 7.

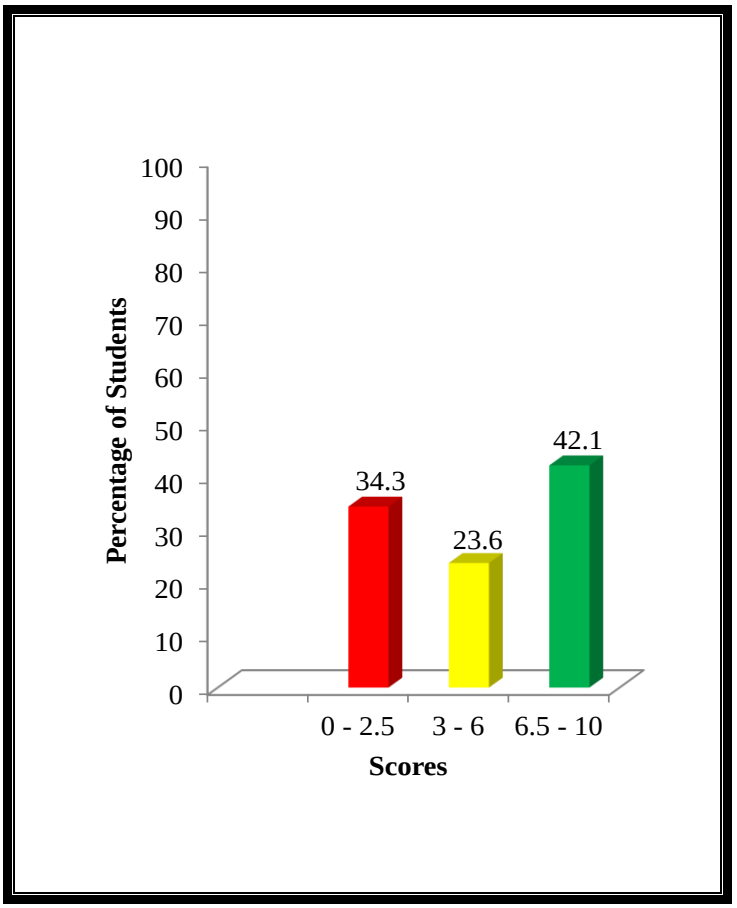
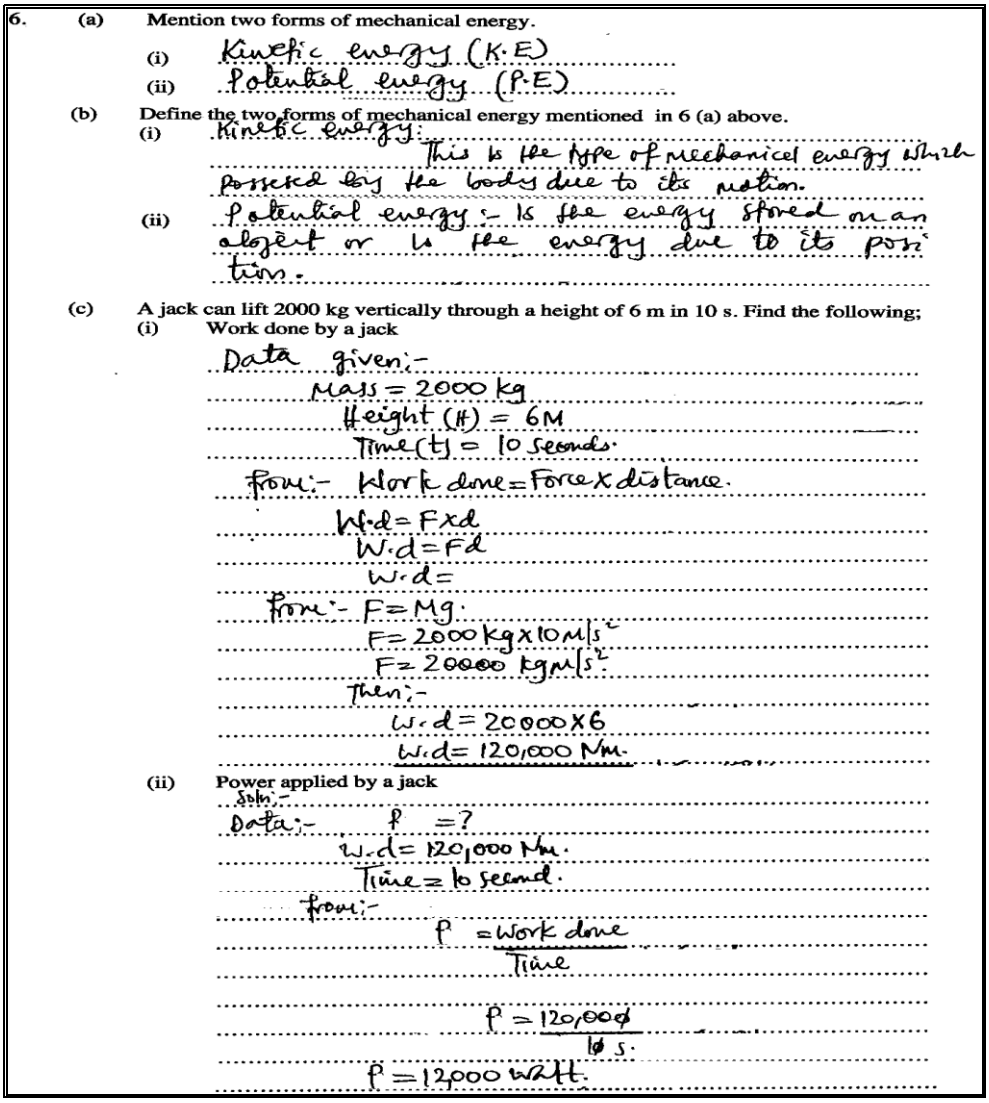


Figure 7

According to the analysis of this question, it shows that, it is one of the questions students performed well. The number of the students who scored 3 marks or above is 65.7 percent. Only 34.3 percent of the students failed the question by scoring less than 3 marks. Among the student who performed well in this question, are those who scored all 10 marks (18.5%). These students were able to mention the two forms of mechanical energy in part (a) and managed to define these forms of mechanical energy in part (b). They were able to find the work done by a jack and power applied by a jack in part (c). This group of students were familiar with topic of Work, Energy and Power as it was revealed by their responses whereby, they mentioned the correct forms of mechanical energy which are energy due to motion (Kinetic energy) and the stored energy (Potential energy). They used the correct formula for the work done by a jack which is, W = F x d and the power applied by a jack which is, $P = \frac{Work\ done}{Time\ taken}$. They were able to find force F = mg in order to find the work done. The analysis showed that, these groups of student were conversant with this topic. Extract 6.1 shows a sample of the good response.


6. (a) Mention two forms of mechanical energy.

(i) Kinetic energy (K.E)

(ii) Potential energy (P.E)

(b) Define the two forms of mechanical energy mentioned in 6 (a) above.

(i) Kinetic energy: This is the type of mechanical energy which possessed by the body due to its motion.

(ii) Potential energy:- Is the energy stored on an object or is the energy due to its position.

(c) A jack can lift 2000 kg vertically through a height of 6 m in 10 s. Find the following;

(i) Work done by a jack

Data given:-

Mass = 2000 kg

Height (H) = 6M

Time (t) = 10 seconds.

From:- Work done = Force x distance.

W.d = F x d

W.d = Fd

W.d =

From:- F = Mg.

F = 2000 kg x 10 m/s²

F = 20000 kgm/s²

Then:-

W.d = 20000 x 6

W.d = 120,000 Nm.

(ii) Power applied by a jack

Soln:-

Data:- P = ?

W.d = 120,000 Nm.

Time = 10 second.

From:-

P = Work done / Time

P = 120,000 / 10 s.

P = 12000 watt.

Extract 6.1: Good response from one of the students who managed to mention and define the two forms of mechanical energy. He/she was able to calculate the work done and power applied by jack.

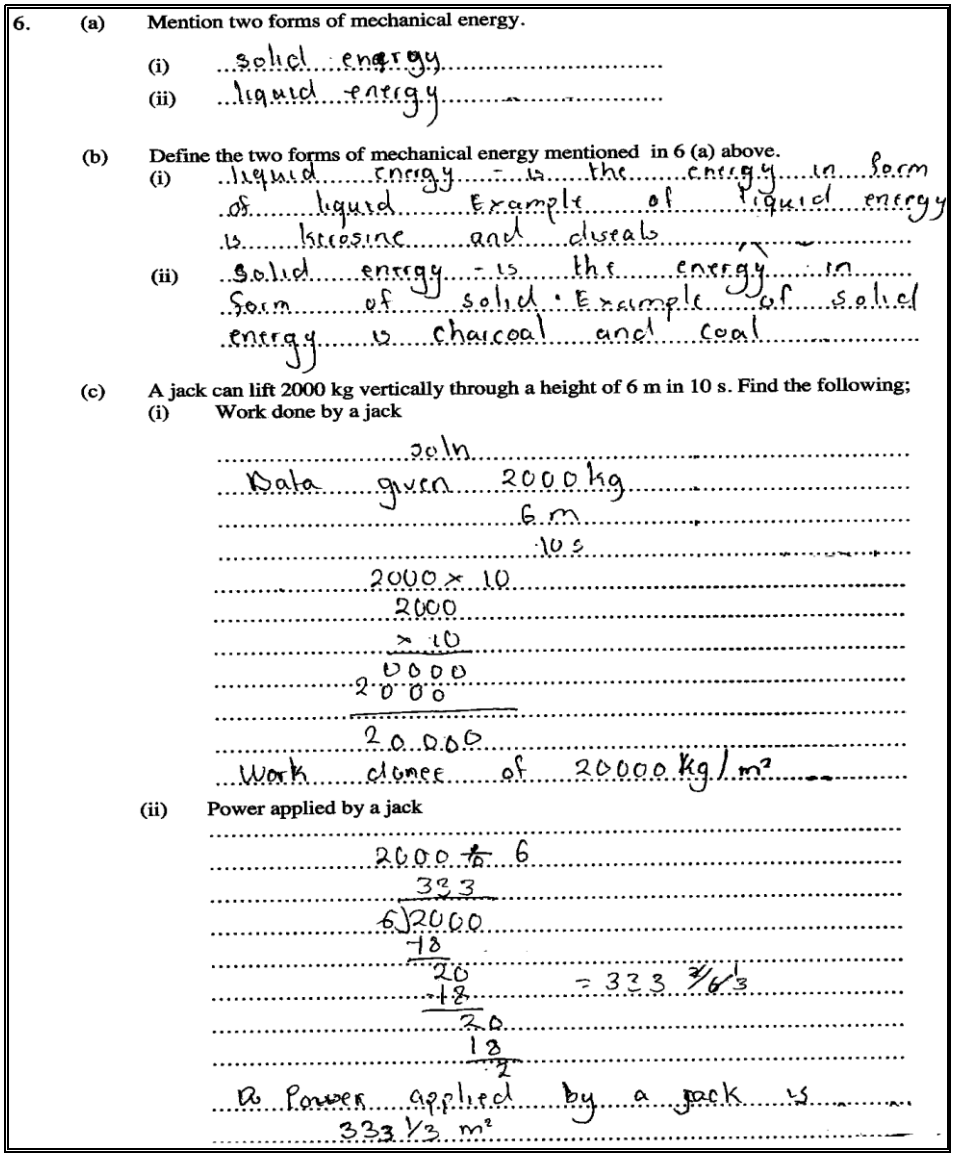
Some of the students who scored from 6.5 to 9.5 marks, were able to mention two forms of mechanical energy and defined only one form of mechanical energy and successfully did manipulation to find the work done and the power applied by the jack thus scored less than 10 marks. Others managed to attempt correctly almost all parts but either failed to define one form of energy or manipulated wrongly some steps for calculating the work done by a jack or power applied by a jack and therefore scored less than 10 marks. There were also those who managed to attempt part (a) and (b)

correctly and were only able to attempt part (c) (i) thus scoring between 6.5 and 9.5 marks.

Some of those who scored from 3 to 6 marks, mentioned the forms of mechanical energy and defined one of the forms of mechanical energy but failed the other part of the question. Others were able to write the formula W = F x d to find the Work done by a jack and $P = \frac{Work\ done}{Time Taken}$ to find Power applied by a jack, moreover they introduced the formula F = mg to convert the given mass into applied Force. Some managed to mention the two forms of mechanical energy and managed to define only one form of mechanical energy and failing to attempt the rest part of the question, thus they scored only 3 marks on this question.

`

The students who scored a 0 mark, failed to remember the forms of the mechanical energy, so they had no one to define in part (b). they failed to find the work done by the jack and the power applied by the jack in part (c). These students were not familiar with the topic of work, energy and power. Some of these students did not answer part (a) and (b) and they wrote irrelevant formula for the part (c). For example one student wrote the formula for work done as *work done = mass x acceleration*, and the formula for power as *Power = mass x acceleration x height*. From these wrong responses it shows that, the students were not conversant with the topic of Work, Energy and Power. Extract 6.2 shows a poor response taken from the script of one student.


6. (a) Mention two forms of mechanical energy.

(i) solid energy

(ii) liquid energy

(b) Define the two forms of mechanical energy mentioned in 6 (a) above.

(i) liquid energy - is the energy in form of liquid Example of liquid energy is kerosine and diseals

(ii) Solid energy - is the energy in form of solid. Example of solid energy is charcoal and coal

(c) A jack can lift 2000 kg vertically through a height of 6 m in 10 s. Find the following;

(i) Work done by a jack

20 Ih

Data given 2000 kg

6 m

10 s

2000 × 10

2000

× 10

0000

2000

20 000

Work donee of 20000 kg/m²

(ii) Power applied by a jack

2000 ÷ 6

333

6)2000

-18

20

-18 = 333 2/6 1/3

20

-18

2

A Power applied by a jack is

333 1/3 m²

Extract 6.2: A poor response from the student who wrongly answered this question.

2.2.4 Question 7: Optics

This question was drawn from the topic of optics (Light). It consisted of two parts (a) and (b). The question was as follows:

(a) With the aid of example, define the following terms;

(i) Opaque

(ii) Transparent

(iii) Translucent

(b) *A girl 1.40m tall is photographed 2.80m in front of the pin-hole camera. If the film is placed 10 cm behind the pin-hole, what will be the height of image formed on the film?*

The question was attempted by 93.9 percent of the students out of which 47.5 percent scored from 0 to 2.5 marks, with 35.3 percent scoring 0 mark. 37.4 percent scored from 3 to 6 marks and 15.1 percent scored from 6.5 to 10 marks. This was an average performance question. The graphical presentation of the groups of scores with respective percentage of students who did this question is summarised in Figure 8.

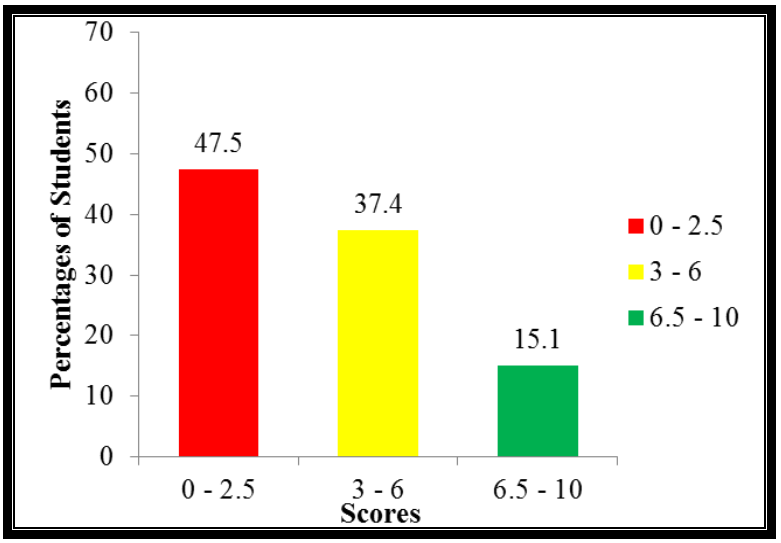


Figure 8

The students who scored 0 mark failed to define and give of examples (a) (i) opaque (ii) transparent (iii) translucent. In part (b) they failed to write and apply the formula to calculate the height of the image on the pin-hole camera.

These students did not know those opaque's are those materials which do not allow light to pass through. Examples of opaque materials are walls, books and wood. Transparent are those materials which allow all light to pass through. Examples of transparent materials are glass, slab and prism. Translucent are those materials which allow a small portion of light to pass through. Example of translucent is tinted glass. They did not remember the

formula in order to calculate the height of an image on the film. For example one of a poor responses from a student in this group was;

(a) *(i)* *opaque it allows air to pass through*
(ii) *Transparent it does not allow air to observe air*
(iii) *It does not allow air to pass through*

Another poor response in part (a) was;

(a) *(i)* *Opaque is the energy which does not travel in a straight line.*
(ii) *Transparent is the energy which travels in the magnitude and direction.*
(iii) *Translucent is the energy which travels in the magnitude only.*

In part (b) some of the students in this group wrote and substituted data on unknown formula and computation to obtain wrong answer as as follow;

(b) *soln*

$$\frac{1.40 \times 2.80}{10}$$

$$= 3920m$$

Extract 7.1: shows a sample of poor response from a script of the student.

7. (a) With the aid of example, define the following terms;

(i) Opaque

Opaque is where the light takes place.

(ii) Transparent

Transparent is where shadows are formed when some rays of light impact (.)

(iii) Translucent

Translucent is where shadows are not formed when some rays of light impact.

(b) A girl 1.40 m tall is photographed 2.80 m in front of the pin-hole camera. If the film is placed 10 cm behind the pin-hole, what will be the height of image formed on the film?

Data given

1.40 m tall

2.80 m

10 cm

1.40x2.80 / 10

3.92x100 / 10x100 = 392 / 1000

∴ Height of the image is 0.392 m is the answer.

Extract 7.1: A poor response from the student who wrongly answered this question.

A few of students who scored from 0.5 to 2.5 marks, wrote only examples of the opaque, transparent and translucent but either did not attempt the remaining questions or performed by using wrong formula. The other students either defined opaque, transparent or translucent but failed to attempt the remaining part of the question and therefore they failed to score 3 marks or more.

For those students who scored from 3 to 6 marks, were considered to have passed this question averagely. Some of them managed only to define the given terms, opaque, transparent and translucent but did not give example for those terms. Others defined and wrote the examples of the opaque, transparent and translucent. These attempted the question but failed to draw the diagram of pin-hole camera in order to get the concept on how to find the height of an image on the pin-hole camera and therefore did not perform the calculation of the remaining part (b) thus they scored averagely in this question. From this group of students, there were those who attempted only part (b). Despite that they did not attempt part (a). They showed mastery of the topic of optics in terms of calculation. These students were able to write the formula $\frac{height\ of\ image}{height\ of\ object} = \frac{distance\ of\ image\ from\ pin\text{–}hole}{distance\ of\ object\ from\ pin\text{–}hole}$ and, therefore they calculated the height of the image formed on the film and obtained the correct value and therefore they scored averagely on this question.

Some of the students who scored 6.5 to 10 marks managed to answer correctly in part (a) by writing with examples the definitions of opaque, transparent and translucent. In part (b) they were able to write formula to find the height of image formed on the film but either were not able to substitute the correct data into the formula or they did not concentrate as a result, they failed to calculate the correct value of the height of image. Others managed to draw a pin-hole camera with correct data and formula but confused to substitute the correct data in the formula due to failure to translate the data. They wrongly substituted the value of the 'distance of image from pin-hole' into the 'distance of object from pin-hole' and therefore ended up with wrong answer of height of an image formed on the film.

There was a group of students 65 (4%) who scored 10 marks in this question. The analysis showed that, this group had sufficient knowledge on optics. It was witnessed from their responses that, they wrote with examples the correct definition of opaque, transparent and translucent. They also wrote the correct formula for height of an image formed on the film. Although they wrote the formula in different way, all ended up with correct formula and succeeded to substitute the correct data and thus finally they came up with correct solution of the height of an image formed on the

film. For example, there were those who wrote the formula as $\frac{height\ of\ image}{height\ of\ object} = \frac{distance\ of\ image\ from\ pin\text{–}hole}{distance\ of\ object\ from\ pin\text{–}hole}$ and they summarised as $\frac{h_i}{h_o} = \frac{d_i}{d_o}$ and they made height of image (h_i) the subject of the formula to obtain the height of an image formed on the film. The formula became $h_i = \frac{d_i \times h_o}{d_o}$. Others wrote the formula in different way as $h_i d_o = h_o d_i$ and from this, they made (h_i) the subject of the formula thus they also obtain $h_i = \frac{d_i \times h_o}{d_o}$, whereby they used this formula to find the height of an image formed on the film. Others were able to show their given data in the diagram they drew which helped them to find height of an image in part (b) by using the following formula: $\frac{height\ of\ image}{height\ of\ object} = \frac{distance\ of\ image\ from\ pin\text{–}hole}{distance\ of\ object\ from\ pin\text{–}hole}$. Extract 7.2 shows a sample of a good response from the script of one student.

7. (a) With the aid of example, define the following terms;

(i) Opaque

These are materials which do not allow any light rays to pass through them. Example walls.

(ii) Transparent

These are materials which allow all of the light rays falling onto them to pass through. Example glass.

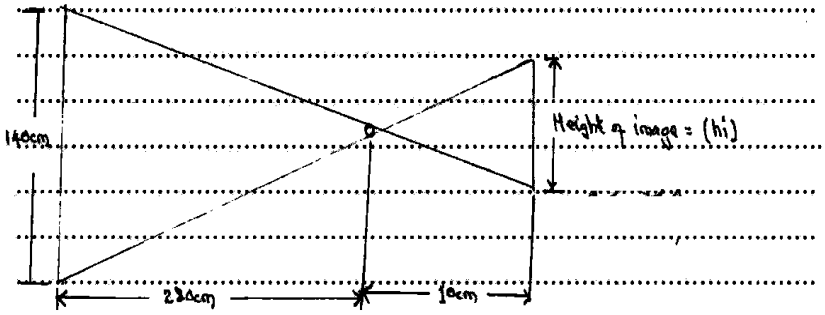
(iii) Translucent

These are materials which allow only part of light falling onto them to pass through. Example an oiled paper

(b) A girl 1.40 m tall is photographed 2.80 m in front of the pin-hole camera. If the film is placed 10 cm behind the pin-hole, what will be the height of image formed on the film?

Soln:

Let the diagram be.



From; the formula

Image height (hi) = Image distance (v)

Object height (ho) Object distance (u)

$\frac{hi}{140cm} = \frac{10cm}{280cm}$

$280cm\,hi = 140cm \times 10cm$

$hi = \frac{140cm \times 10cm}{280cm}$

$hi = 5cm$

∴ Image's height = 5 cm.

Extract 7.2: a good response from one of the students who managed to write with examples the correct definition of opaque, transparent and translucent.

2.2.5 Question 8: Simple Machine

This question was the topic of simple machine. It had two parts (a), and (b). The question was as follows:

(a) *Distinguish between 'work output' and ' work input' as applied in simple machines.*

(b) *A simple machine was used to raise a load of weight 3920 N through a height of 3.5 m by applying an effort of 980 N. If the distance moved by the effort was found to be 20 m, find the following:*

(i) *Mechanical advantage*

(ii) *Velocity ratio*

(iii) *Efficiency of the machine*

This question was attempted by 95.8 percent of the students out of which 28.4 percent scored from 0 to 2.5 marks, 16.8 percent scored 0 mark, 22.6 percent scored from 3 to 6 marks and 49 percent scored from 6.5 to 10 marks. This is one of the questions which was well performed. The graphical presentation of the groups of scores with respective percentage of students who did this question is summarised in Figure 9.

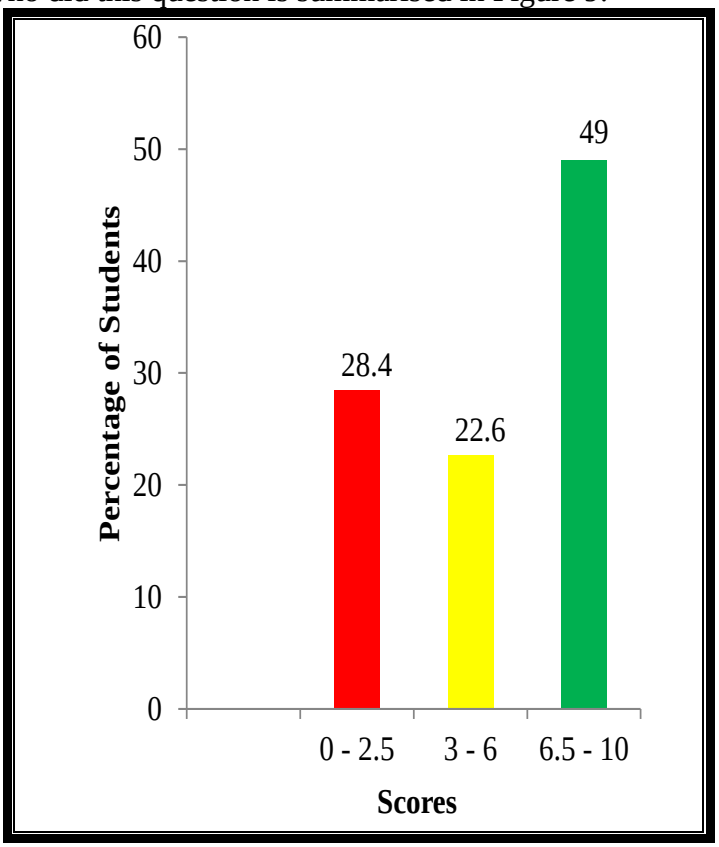


Figure 9

There were 223 (14.4%) students who scored all 10 marks. These students were able to answer all parts of the question. They managed to Distinguish between 'work output' and 'work input' as applied in simple machines. They identified the three formulae, Mechanical Advantage = $\frac{Load}{Effort}$, Velocity ratio = $\frac{Dis\tan ce\ moved\ by\ Effort}{Dis\tan ce\ moved\ by\ Load} or \frac{Effort\ Dis\tan ce}{Load\ Dis\tan ce}$ and the formula for efficiency of machine which is given by, Efficiency = $\frac{M.A}{V.R} x100\%$. The students managed to manipulate all steps which were involved in calculation to attain the correct answer as shown in Extract 8.1.

8. (a) Distinguish between 'work output' and 'work input' as applied in simple machines.

Work output is the work done by the load in simple machines while work input is the work done by the effort to a simple machine.

Work output = L x Ld

while

Work input = E x Ed.

(b) A simple machine was used to raise a load of weight 3920 N through a height of 3.5 m by applying an effort of 980 N. If the distance moved by the effort was found to be 20 m, find the folowing:

(i) Mechanical advantage

Solu.

Data.

Load L = 3920N

Load Height h = 3.5m

Effort E = 980N

Effort distance, Ed = 20m

Mechanical advantage = ?

From:

$M.A = \frac{Load}{Effort}$

$M.A = \frac{3920N}{980N}$

$M.A = 4$

∴ The mechanical advantage is 4.

(ii) Velocity ratio

Solu.

$V.R = \frac{Effort\ distance}{Load\ distance}$

$V.R = \frac{20m}{3.5m}$

$V.R = 5.714...$

∴ The velocity ratio is 5.71

(iii) Efficiency of the machine

From.

$Efficiency\ of\ Machine = \frac{M.A}{V.R} \times 100\%$

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

$\eta = \frac{4}{5.7} \times 100\%$

$\eta = 70.17\%$

Extract 8.1: A sample of responses from the student who distinguished between 'work output' and 'work input', and was able to calculate the Mechanical Advantage, Velocity ratio and efficiency of machine by applying the correct formulae.

This group of students managed to elaborate that work input is the work done by the force (effort) used to operate a simple machine and it is equal to the effort multiplied by the distance moved by the effort, and that work output is the work done by simple machine on load and it is equal to the load multiplied by distance moved by load, Also they applied the correct formula and was able to find the M.A, V.R and efficiency of the machine and were able to follow all manipulation steps without mingling and therefore they validated with correct responses of Mechanical Advantage, Velocity Ratio and Efficiency of the machine. From the analysis, it was revealed that these students were familiar with the topic of simple machine and therefore were able to understand the question demand and they remembered the required formulae and followed all calculation steps to achieve correct answers.

There is a group of students who scored from 6.5 to 9.5 marks. Among these students, there were those who managed to answer the whole question except messing up one or two steps of calculation thus obtaining 9 or 9.5 marks. Others were able to attempt the majority part of the question but did wrong some area and therefore they scored from 6.5 to 9 marks. For example one student was able to distinguish between 'work output' and 'work input' and calculated Mechanical Advantage, and Velocity Ratio but failed to compute efficiency of the machine. This student scored good marks but less than 10.

Some of the students who scored from 3 to 6 marks, were able only to distinguish between 'work output' and 'work input in part (a). Others wrote only all formulae for Mechanical Advantage, Velocity Ratio and efficiency of the machine but did not go through calculation and therefore they scored average marks. There were those who distinguished between 'work output' and 'work input in part (a) and calculated the Mechanical Advantage and wrote only the formula for Velocity Ratio without further computation and thus scored average marks. From the analysis of this question, it was found out that, some of this group of students missed the concentration on attempting this question. It was revealed that, they were able to distinguish between 'work output' and 'work input and yet wrote all the necessary formulae but were not keen enough to ensure they substitute the data to the respective formula and position. For example, one student who attempted part (a) and part (b) wrote the correct formula for Mechanical Advantage = $\frac{Load}{Effort} = \frac{L}{E}$, Velocity Ratio = $\frac{Distance\ moved\ by\ Effort}{Distance\ moved\ by\ Load} = \frac{D\ of\ E}{D\ of\ L}$ but he/she made mistake during the substitution process whereby instead of substituting the load 3920 into 'L' he/she wrongly substituted into 'E' and verse-vise. Also he/she did the same mistake to calculate the Velocity Ratio

and thereafter substituted the wrong solutions into the formula for efficiency of the machine and thereby ended up with wrong solution of efficiency of machine.

The analysis for this question sugests that the students who scored from 0.5 to 2.5 marks were not able to distinguish between 'work output' and 'work input. They only managed to define either between 'work output' or 'work input. Others wrote the formula for mechanical advantage and velocity ratio but did not do any calculation. There were those who wrote the definition of either 'work output' or 'work input and the formula for either mechanical advantage or velocity ratio but did not do any calculation and therefore they ended up with less than 3 marks. Others wrongly wrote the formulae. For example one of the students wrote for Mechanical Advantage as M.A = $\frac{Effort}{Load} = \frac{E}{L}$, Velocity Ratio as V.R = $\frac{Distance\ moved\ by\ Load}{Distance\ moved\ by\ Effort}$, such a student ended up with less than 3 marks on this question.

The students who scored 0 mark failed to give any correct answer in this question. They failed to distinguish between work output and work input in part (a) and in part (b) They were not able to write any correct formula in order to calculate mechanical advantage, velocity ratio and efficiency of the machine. The following were some of the poor students' responses;

(a) *Work out put it used a load and effort while work in put it is used machine to finished that job.*

(b) *(i)* *M.A = Effort × distance .*
F1=3920N× d13.5m
=1370Nm
F= 980N×d= 20=19600Nm

(ii) V.R=load/ effort =13720N/1960

(iv) Efficiency of machine is =19600Nm

Another student's poor response was

(a) *Workout put is the process whereby the simple machine do work in the output solution of work and work output is the process by the simple machine do work in the input work of the machine.*

From the students' responses it is revealed that those who scored of 0 mark did not have sufficient knowledge on the topic of simple machines. Extract 8.2 shows a sample of the response of the candidate who failed to provide relevant responses.

8. (a) Distinguish between 'work output' and 'work input' as applied in simple machines.

work out put	work in put
- work out put = work out put x work in out put - work in put x work out done - work done x work out put.	work in put = work in put x work out put - work out put - work in done - work in out put x work done.

(b) A simple machine was used to raise a load of weight 3920 N through a height of 3.5 m by applying an effort of 980 N. If the distance moved by the effort was found to be 20 m, find the folowing:

(i) Mechanical advantage

M·A = L = 3920 N
= H = 3·5 m
E = 980 N
? = 20 m

H = 3·5m x 20m
= 3·5m
x 20m
700
700m

M·A = L x H x 100%
= 3920N x 980N x 100%
100%
3920N x 98N = 384160N
10 3846
384160N = 38416N
10 1 700M

(ii) Velocity ratio

V·R = L x H
E
L = 3920
H = 3·5m

L = 3920 x 3·5m x 980
10m
137·200 x 98N
= 135·45600N

(iii) Efficiency of the machine

Effrieney of Machine = L = 3920N
H = 3·5m
E = 980N
? = 20m

DATA
L = 3920N
H = 3·5M
E = 980N
? = 20M

L = 3920N x 980N -
3·5m x 20m
= 3841600N = 9345 1/4 1
7·00m
= 9345 1/4N

Extract 8.2: A sample of responses from the student who was not able to distinguish between 'work output' and 'work input' and was not able to calculate the Mechanical Advantage, Velocity ratio and efficiency of machine by applying the correct formulae.

2.2.6 Question 9: Fluid Mechanics

Question 9 was on Fluid Mechanics. It consisted of two parts (a) and (b). The question was as follows:

(a) *(i)* *Differentiate between apparent weight of a body and up thrust as applied in fluids.*

(ii) *Why does a body weighs more in air than when immersed in a liquid?*

(b) *(i)* *State the Archimedes principle*

(ii) *A body weighs 30 N in air but when it is completely immersed in water the body weighs 12 N. Calculate the apparent loss in weight of the body and the volume of the water displaced.*

This question was attempted by 92.6 percent of students, out of which 61 percent scored from 0 to 2.5 marks, 26.3 percent scored 0 mark. 22.3 percent scored from 3 to 6 marks, and 16.7 percent scored from 6.5 to 10 marks. The graphical presentation of the groups of scores with respective percentage of students who did this question is summarised in Figure 10.

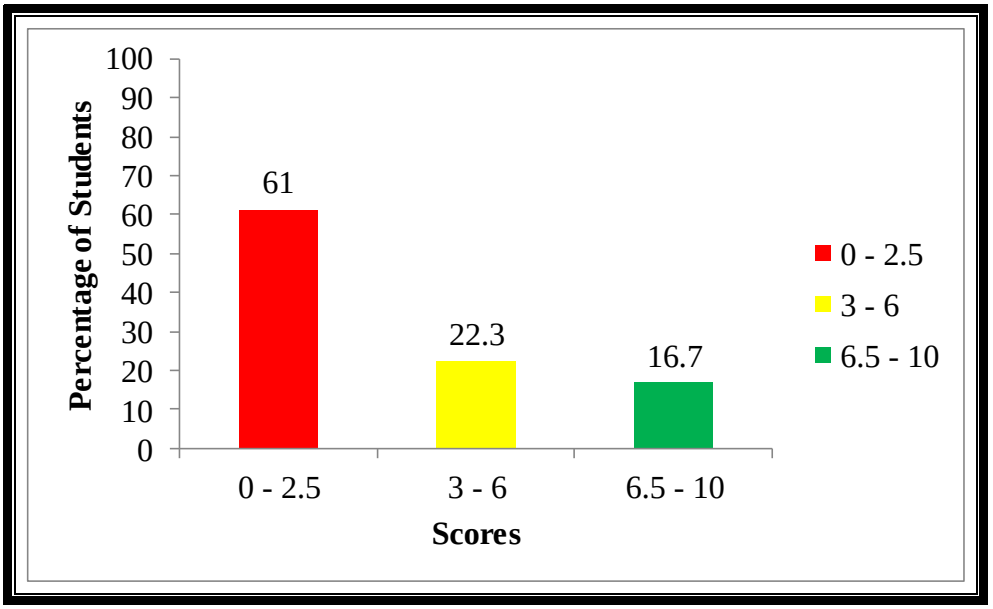
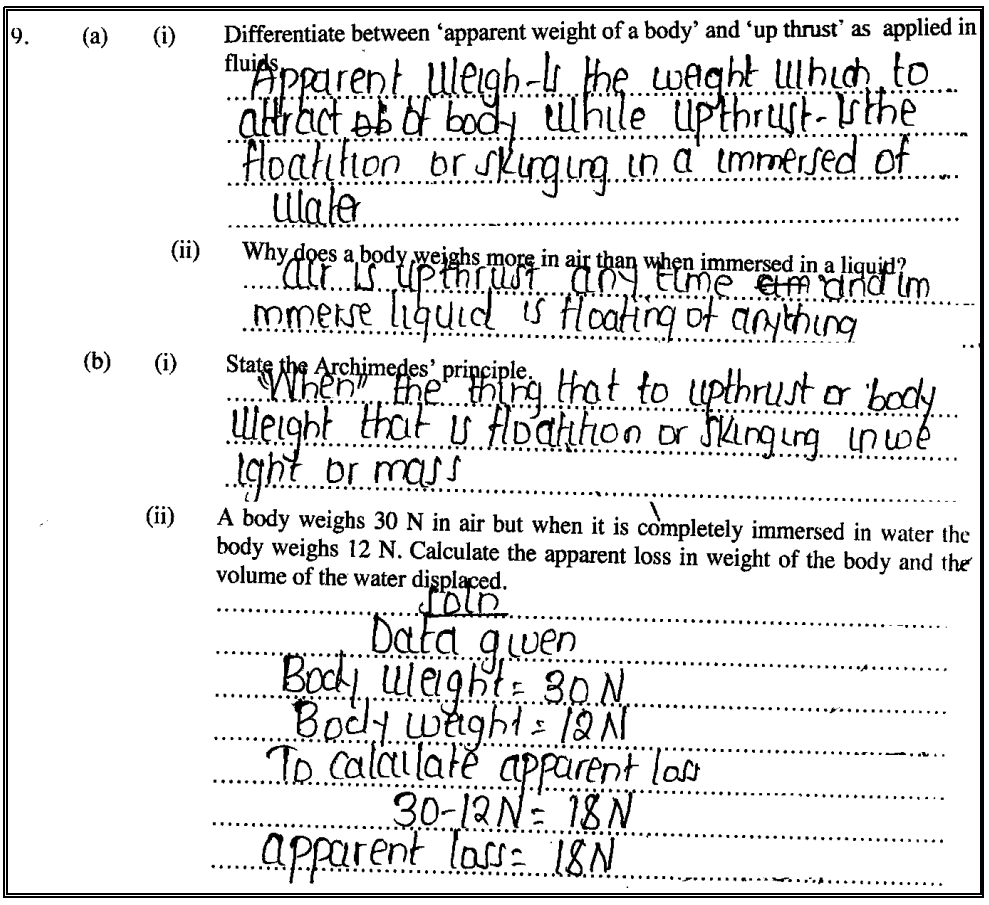


Figure 10

The students who scored 0 mark failed to present any correct answer. Their responses revealed that they had insufficient knowledge on the topic of "Fluid Mechanics" and that is why they failed to differentiate between apparent weight of a body and upthrust as applied in Fluid Mechanics. They did not understand that apparent weight of a body is the weight of a body when it is in fluid whereas upthrust is an upward force that acts on an object when it is totally or partially immersed in a fluid. They failed to understand that a body weigh more in air than when immersed in a liquid because a liquid exert an upward force which tends to reduce the weight of a body. They didn't remember that Archimedes principle state that when a body is totally or partially immersed in a fluid it experiences an upthrust which is equal to the weight of fluid displaced'. These students failed to apply the formula to calculate the apparent loss of weight such that, Apparent loss in weight = weight of an object in air - weight of an object when immersed in fluid. Most of them wrote irrelevant answers, such as; *Apparent weight of a body is the instrument used to measure the weight of a body while upthrust is the instrument used to measure the weight of a body*. Another student wrote weight *more in air than when immersed in a liquid due to the Archimedes principle*. Another student's response was *Apparent weight of a body is immersed of fluid of water. While upthrust is applied in fluid in the take place of immersed by fluid.* From the responses of students it was revealed that students from this group were not familiar with the topic of Fluid Mechanics. Extract 9.1


9. (a) (i) Differentiate between 'apparent weight of a body' and 'up thrust' as applied in fluids.

Apparent Weigh-is the weight which to attract ~~ob~~ of body while upthrust-is the floatition or sinking in a immersed of Wate

(ii) Why does a body weighs more in air than when immersed in a liquid?

air is upthrust any time ~~em~~ and im mense liquid is floating of anything

(b) (i) State the Archimedes' principle.

"When" the thing that to upthrust or body Weight that is floatition or sinking in we ight or mass

(ii) A body weighs 30 N in air but when it is completely immersed in water the body weighs 12 N. Calculate the apparent loss in weight of the body and the volume of the water displaced.

Soln

Data given

Body Weight = 30 N

Body weight = 12 N

To calcilate apparent loss

30-12 N = 18 N

apparent loss = 18 N

Extract 9.1 is a sample of a response from the script of a student who demonstrated poor responses. He/she wrote irrelevant responses to all parts of the questions.

Some of those who scored from 0.5 to 2.5 marks, managed to differentiate between apparent weight of a body and upthrust correctly. Others managed to state Archimedes principles correctly. There were a few students who managed write only a formula of 'volume $= \frac{mass}{density}$' in order to calculate volume of water displaced and therefore scored less than 3 marks.

The students who scored from 3 to 6 marks were considered to have some ideas with what the question was asking. Some of students were able to answer correctly part (a) and partly in part (b), the majority failed to apply the formula to find apparent loss in weight while others failed to apply formula to determine the volume of water displaced.

Some of them differentiated between apparent weight of a body and upthrust and explained why a body weights more in air than when immersed in water and therefore they scored 3 marks. Others stated the Archimedes principle and did some computation to calculate the apparent loss in weight of the body but they did not understand that weight of water displaced = apparent loss in weight of a body, where apparent loss in weight of body is equivalent to the mass of water displaced x acceleration due to gravity. This could help them to find volume of the water displaced. The majority in this group scored between 3 and 6 marks.

Some of the students who scored from 6.5 to 9.5 managed to attempt all part of the question except some parts and steps where they made some mistakes through calculations and others failed to distinguish between apparent weight of a body and upthrust or to state Archimedes principle which led them to score less than 10 marks.

Others were able to differentiate between apparent weight of a body and upthrust, and stated correctly the Archimedes principle and managed to write the formula density = $\frac{mass}{volume}$ and volume = $\frac{mass}{density}$ but did understand that the apparent loss in weight is equal to the weight of the water displaced and that the mass of water displaced $= \frac{weight\ of\ water\ displaced}{acceleration\ due\ gravity\ \ (g)}$. Although they calculated the apparent loss in weight of body, they didn't calculate the mass of water displaced and therefore they failed to calculate the volume of water displaced ending up with a score of less than 10 marks.

50 (3.3%) students managed to score all 10 marks. These students were able to differentiate between apparent weight of a body and upthrust, state the Archimedes principle and write all necessary formula and calculate the apparent loss in weight of the body and volume of the water displaced. They had the concept that, mass of the water displaced is given by; mass $= \frac{weight\ of\ water\ displaced}{acceleration\ due\ gravity\ \ (g)}$. They computed through all manipulation steps and therefore they scored all 10 marks. These students were familiar with the topic of fluid mechanics. Extract 9.2 is a sample of a good response from a script of student.

9. (a) (i) Differentiate between 'apparent weight of a body' and 'up thrust' as applied in fluids.

Apparent weight of a body ; Is the weight of a body when placed (totally or partially immersed) in a fluid while upthrust; Is an upward force which temporarily reduces weight of objects totally or partially immersed in a fluid.

(ii) Why does a body weighs more in air than when immersed in a liquid?

A body weighs more in air than when immersed in a liquid due to the upthrust the body immersed in a liquid tend to experience which temporarily reduces the weight of a body.

(b) (i) State the Archimedes' principle.

When an object is totally or partially immersed into a fluid it then experiences an upward force equal to the weight of the displaced liquid

(ii) A body weighs 30 N in air but when it is completely immersed in water the body weighs 12 N. Calculate the apparent loss in weight of the body and the volume of the water displaced.

solution

Data given;

Weight in air = 30N

Apparent weight = 12N

from,

Apparent loss = Upthrust = Weight in air − Apparent weight

= 30N − 12N

= 18N

∴ Apparent loss in weight is 18N

Weight = m x g

Weight = m
g

18N = m
10N/kg

1·8 kg = m

Volume = mass
Density

= 1·8 kg
1000 kg/m³

= 0·0018 m³

∴ Volume of water displaced is 0·0018 m³

Extract 9.2: A sample of responses from the student's script that distinguish between apparent weight and upthrust, and was able to calculate the apparent loss in weight and the volume of water displaced by applying the correct formulae.

2.2.7 Question 10: Heat

This question was from the topic of Heat. It consisted of three parts (a), (b) and (c); the question was as follows:

(a) *The temperature of a gas is 650^{o}C. What is the value of this temperature on the Kelvin scale of Temperature?*

(b) *Find the heat capacity of a lump of copper of mass 50 kg if the specific heat capacity of copper is 420 J/kgK.*

(c) *A copper rod has a length of 40 cm on a day when the temperature is 22.3^{o}C. What would be its length on a day when the temperature is 30^{o}C? The linear expansivity of copper is 0.000017 $^{o}C^{-1}$*

The question was attempted by 88.7 percent of the students out of which 53.92 percent scored from 0 to 2.5 marks, with 31.3 percent scored 0 mark. Moreover 26.64 percent of the students scored from 3 to 6 and 19.44 percent scored from 6.5 to 10 marks. The students' performance in this question was average. The graphical presentation of the groups of scores with respective percentage of students who did this question is summarised in Figure 11

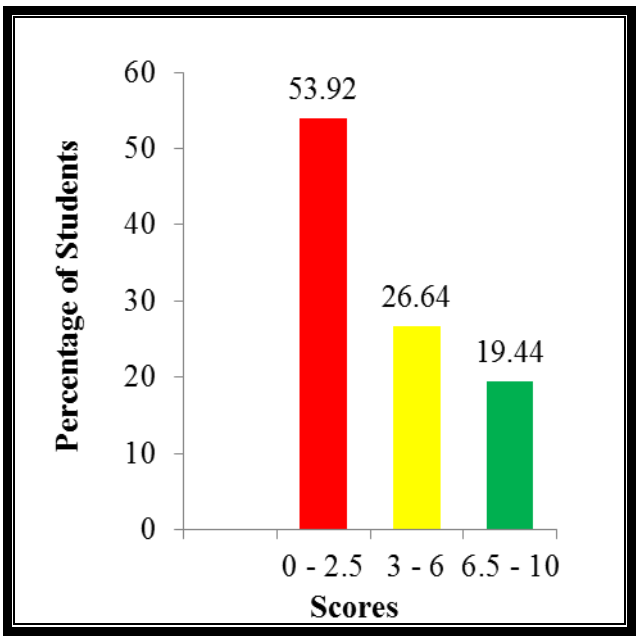
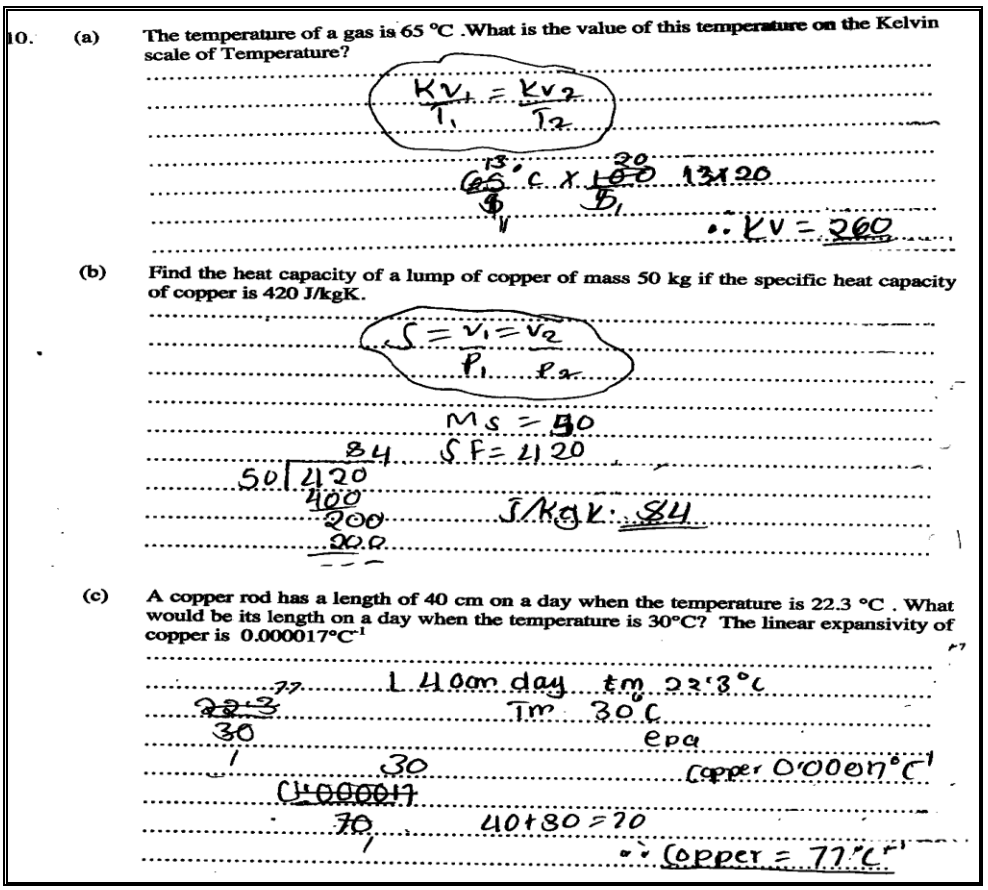


Figure 11

The students who scored 0 mark on this question, either had misconception with respect to this sub-topic or were not familiar with the topic of heat. These students failed to convert 65^{o}C from Celsius centigrade into Kelvin scale in part (a). They were not able to remember the formula used in this conversions which is T = (t + 273)K. Some of them confused the formula and wrote 5/9(C-32) instead of T = (t + 273)K. Others wrote 9/5(F-32) instead of T = (t + 273)K in part (a) as a result they ended up with wrong response in their computation. In part (b) they did not remember the formula and lacked knowledge on how to apply the formula to find heat capacity. They failed to remember that heat capacity = mass x specific heat capacity and in part (c) they had no knowledge of the sub-topic of thermal expansion of solids where they were supposed to find the length of a copper rod when the temperature of 22.3^{o}C changes to 30^{o}C. Extract 10.1 shows a poor response from one of scripts.


10. (a) The temperature of a gas is 65 °C .What is the value of this temperature on the Kelvin scale of Temperature?

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{65^{13}}{5} \times \frac{20}{1} = \frac{13 \times 20}{5_1}$

$\therefore V = 260$

(b) Find the heat capacity of a lump of copper of mass 50 kg if the specific heat capacity of copper is 420 J/kgK.

$S = \frac{V_1}{P_1} = \frac{V_2}{P_2}$

$MS = 50$

$SF = 4120$

$50 \overline{)4120}$ 84

400

200

200

$S/KgK = 84$

(c) A copper rod has a length of 40 cm on a day when the temperature is 22.3 °C . What would be its length on a day when the temperature is 30°C? The linear expansivity of copper is 0.000017°C^{-1}

L 40cm day t_m 22·3°C

T_m 30°C

22·3

30

1

30

epa

copper 0·00017°C^{-1}

0·000017

70

1

40+30 = 70

$\therefore$ Copper = 77°C

Extract 10.1 shows a sample of responses from the student who failed to answer any part of this question. He/she wrote irrelevant formula and solutions.

The majority of students who scored from 0.5 to 2.5 marks were able to write the formula for heat capacity in part (b) but failed to convert Celsius centigrade to Kelvin. A few others attempted part (a) only by converting Celsius centigrade to Kelvin and failed the remaining parts of the question thus they scored less than 3 marks on this question.

Some of the students who scored from 3 to 6 marks attempted part (a) and (b) but failed to attempt part (c) while others were able to attempt part (c). only Those who attempted part (a) were familiar with the conversion of temperature scales. They managed to write correct formula for conversion and converted the degree Celsius to degree Kelvin. Others were able to remember the formula for heat capacity and computed the correct answer for heat capacity but failed to write formula for Linear expansivity and were not able to convert the degree Celsius to degree Kelvin thus scoring averagely on this question.

Some of students who scored from 6.5 to 10 managed to attempt part (a) ,(b) and (c) but failed some steps in making computation and therefore scored high marks. Others were able to attempt all parts of the question correctly and scored all 10 marks.

Some of students who scored between 6.5 and 9.5 mark were able to attempt part (b) and (c) correctly but did not remember the formula for conversion of temperature scales. Others attempted all parts except computation of one wrong steps, for example one student substituted $\Delta t = 30^oC$ instead of $(t_1 - t_2)$, where $t_2 = 22.3^oC$ and $\Delta t = (30^oC – 22.3^oC)$ which is 7.7^oC in the equation $L_2= L_1 + \alpha L_1(t_2 - t_1)$ thus ended up with wrong solution of the final length. The analysis from this group of students suggests that, these students were capable of attempting the question but they lacked the concentration during attempting the question and this led them not to score all marks from this question.

A group of 108 (6.7%) students managed to score all 10 marks. These revealed that they managed to answer correctly part (a), (b) and (c);They did correctly in part (a) by applying the formula T=(t+273)K and converted correctly from degree centigrade to Kelvin scale. In part (b) they applied the formula which is; Heat capacity = mass x specific heat capacity, that is (Heat capacity = m x C) and managed to compute the correct value of heat capacity and in part (c) they computed the length of copper rod by applying the correct formula; $L_2= L_1 + \alpha L_1(t_2 - t_1)$. This group of students demonstrated their competence in the topic of heat. Generally, the performance of students in this question was average. Extract 10.2 shows a sample of the good response.

10. (a) The temperature of a gas is 65 °C .What is the value of this temperature on the Kelvin scale of Temperature?

solution

$T = (°C + 273)\,K$

$= (65 + 273)\,K$

$= 338K$

∴ Kelvin scale is 338K

(b) Find the heat capacity of a lump of copper of mass 50 kg if the specific heat capacity of copper is 420 J/kgK.

solution

Data;

Mass = 50kg

Specific heat capacity (c) = 420 J/kgK

from,

Required Heat capacity

Heat capacity = m x c

$= 50kg \times 420\,J/kgK$

$= 21000\,J/K$

(c) A copper rod has a length of 40 cm on a day when the temperature is 22.3 °C . What would be its length on a day when the temperature is 30°C? The linear expansivity of copper is $0.000017°C^{-1}$

solution

Initial length (L_1) = 40cm

Temperature (t_1) = 22.3 °C

Temperature (t_2) = 30°C

Linear expansivity of copper (α) = 0.000017/K

Required final length (L_2)

from,

$L_2 = L_1 + L_1 \alpha (t_2 - t_1)$

$= 40 + 40 \times 0.000017 \times (30 - 22.3)$

$= 40 + 40 \times 0.000017 \times 7.7$

$= 40 + (40 \times \frac{17}{1000000} \times \frac{77}{10})$

$= 40 + 0.005236$

$= 40.005236$

∴ length at temperature 30°C is

40.005236m

Extract 10.2: A good response from one of the students who managed to convert degree Celsius to degree Kelvin. Calculate heat capacity and computed the final length of the rod.

3.0 THE STUDENTS' PERFORMANCE IN EACH TOPIC

The analysis of the students' performance in each topic shows that the following question were well performed, True or False question performance from the topics of Work, Energy and Power, Sound, Force, Fluid Mechanics, Turning Force, Electricity and Magnetism, Heat, Measurement, Friction Force, and Linear Motion was 98.6 percent. Likewise, the multiple choice questions from the topics of Linear Motion, Turning Force, Electricity and Magnetism, Simple Machine, Heat, Work, Energy and Power, Friction Force, Sound, and Light had good performance as 82 percent of the students scored average and above. Also the following topics had good performance, Simple Machine (71.6%) and Work, Energy and Power (65.7%).

The topics which were performed averagely were Optics (Light) (52.5%), Heat (46.1%), Electricity and Magnetism (44.4%), Fluid Mechanics (39%) and Linear Motion (36.1%).

The performance in the question 2 which is the 'Fill in the blanks' composed from topics of Measurement, Heat, Turning force, Linear Motion, Work, Energy and Power, Sound, Simple Machine, fluid mechanics, and Electricity and Magnetism was 25.6 percent which was below average, thus performance of this question was poor.

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

The general performance of the students in Engineering Science subject for the Form Two National Assessment (FTNA) in 2018 was average.

The analysis of the students' responses reveals a number of factors that possibly affected performance.

(a) Students' inability to identify the demands of the questions. It seemed that students rushed to attempt questions before reading them carefully.

(b) Poor knowledge of the concepts related to topics and lack of skills such as arithmetic computation and drawing. This led to weak topics performance. It seems that students do not revise all the form I and II topics before the beginning of the FTNA assessment.

(c) Poor mastery of English Language which affected them from identifying questions' demand and flexibility in answering the questions.

(d) Poor application of scientific knowledge and procedures also affected the students' performance. This was possibly a result of lacking self-preparation or class assessment that could enable teachers to identify students' weaknesses.

4.2 Recommendations

Based on these findings from Students Item Response Analysis (SIRA), the following recommendations are presented so as for further improvement of performance in the Engineering Science subject.

(a) Students are advised to read questions carefully before answering them. This will enable them to understand the requirement of questions.

(b) Teachers are advised to continue applying various teaching methods to make sure that students learn in an inquiry oriented way. They should strive to instill deep understanding of the content matters to students.

(c) Teachers are advised to assess students' achievements on appropriate basis so that they can give them timely feedback.

(d) Finally, school administration and management should make close follow up on the coverage of the syllabus.

APPENDIX I

A summary of Students' Performance (Question-wise) in Engineering Science Subject.

S/N	Topic	Question Number	Percentage of students who scored 30 percent or more	Recommendation
1	Work, Energy and Power, Sound, Force, Fluid Mechanics, Turning Force, Electricity and Magnetism, Heat, Measurement, Friction Force, and Linear Motion	2	98.6	Good
2	Linear Motion, Turning Force, Electricity and Magnetism, Simple Machine, Heat, Work, Energy and Power, Friction Force, Sound, and Light	1	82	Good
3	Simple Machine	8	71.6	Good
4	Work, Energy and Power	6	65.7	Good
5	Light	7	52.5	Average
6	Heat	10	46.1	Average
7	Electricity and Magnetism	5	44.4	Average
8	Fluid Mechanics	9	39	Average
9	Linear Motion	4	36.1	Average
10	Force, Simple Machine, Electricity and Magnetism, Linear Motion, Light, Sound, Heat, Work, Energy and Power,	3	25.6	Weak

APPENDIX II

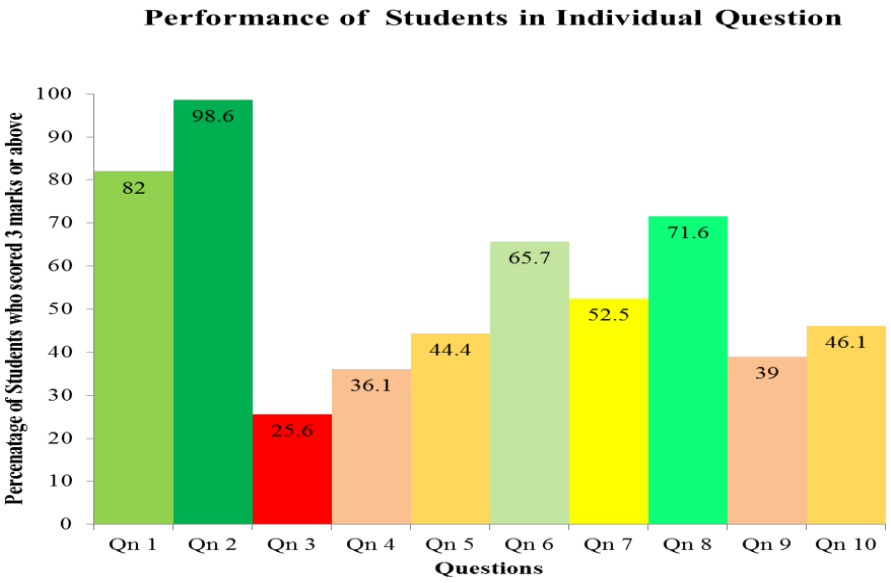


Figure 12

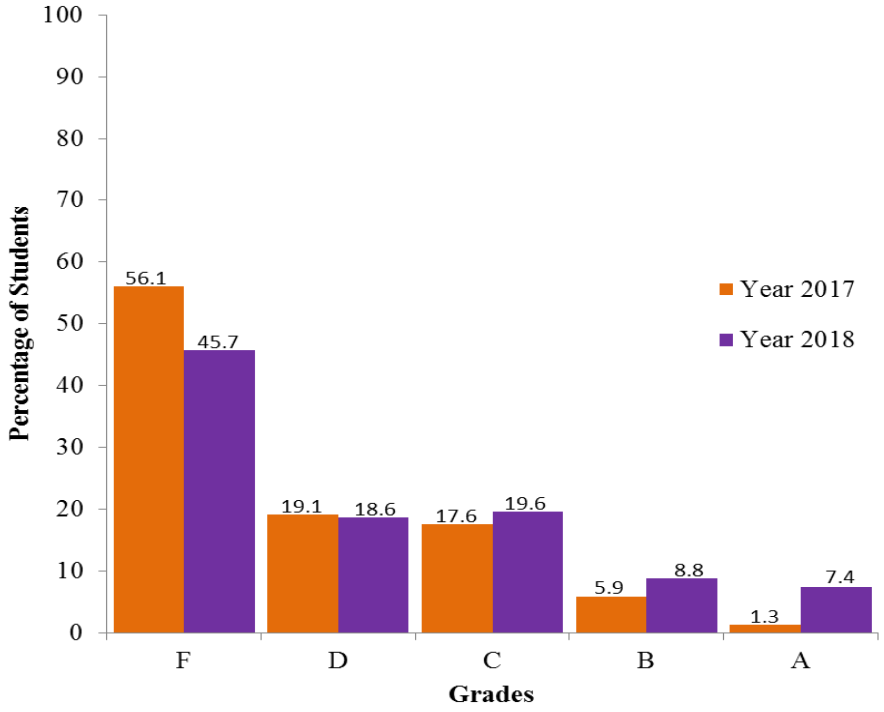


Figure 13: The comparison of the students' performance between 2018 and 2017.