

THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA



**CANDIDATES' ITEM RESPONSE ANALYSIS
REPORT FOR THE CERTIFICATE OF SECONDARY
EDUCATION EXAMINATION (CSEE) 2019**

031 PHYSICS

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031 PHYSICS 1

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FOREWORD

The Certificate of Secondary Education Examination (CSEE) marks the end of four years of secondary education. It shows the effectiveness of the education system in general and the education delivery system in particular as it is a summative evaluation. The candidates' answers to the examination questions is a strong indicator of what the education system was able or unable to offer to the students in their four years of secondary education.

The candidates' item response analysis report in Physics subject for CSEE, 2019 has been prepared in order to give feedback to students, teachers, parents, policy makers and the public in general on how the candidates responded to the examination questions.

The analysis presented in this report will help various stakeholders to understand some of the reasons which led to the performance in Physics subject. It also points out some of the factors which made the candidates fail to score high marks in the questions, including failure to identify the task of the question, lack of English Language proficiency, lack of drawing skills, lack of mathematical skills and inadequate knowledge of the topics. The views provided will help the educational administrators, school managers, teachers and students to identify appropriate methods to be followed in order to improve the candidates' performance in future examinations administered by the Council.

Finally, the Council would like to thank all the examination officers, examiners and all others who participated in the preparation of this report. The Council is also grateful to staff members who were involved in processing the data used in this report.



Dr. Charles E. Msonde

EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report presents an analysis of the performance of the candidates who sat for the Certificate of Secondary Education Examination (CSEE), 2019 in Physics 1 paper. This paper intended to measure the competences attained by the candidates as stipulated in the 2010 Physics syllabus for secondary schools by using the revised format issued in the year 2019..

The paper consisted of three (3) sections, namely A, B and C. Section A comprised two (2) Objective questions where question 1 was set from various topics and question 2 was constructed from the topic of *Radioactivity*. Section B comprised six (6) Short answer questions each carrying 10 marks. Section C consisted of three (3) Short Answer Questions aiming at enabling the candidates manage technological appliances. The candidates were required to choose any two (2) questions from this section. Each question carried 12.5 marks.

The number of candidates who sat for Physics in CSEE 2019 was 129,275 of which 48.38 percent passed and 51.62 percent failed. In the year 2018, the candidates who sat for this subject were 133,616 of which 45.50 percent passed and 54.50 percent failed. This indicates that the candidates' performance in Physics for the year 2019 has increased by 2.88 percent.

The subsequent section analyses the performance of the candidates in each question. It begins by indicating the question demand and then provides the analysis of candidates' performance. It also highlights some misconceptions observed and outlines some reasons behind the candidates' performance in a particular question.

The criteria used in the analysis are as follows: for green, yellow and red colours, the performance is considered to be good, average and weak when the percentage of candidate's marks lay between 65-100, 30-64 and 0-29 respectively. The samples of candidates' responses are inserted as extracts to represent good and weak cases. Some graphs and charts are used to summarize the candidates' performance in a particular question. The report also contains appendix 1 showing the general performance in each topic and appendix II to show the comparison of the candidates' performance between CSEE 2018 and 2019 in terms of grades respectively.

2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH QUESTION

2.1 Section A: Objective Questions

The section comprised two (2) questions all carrying a total of 15 marks. Question 1 consisted of multiple choice items constructed from various topics and question 2 consisted of matching item questions set from the topic of radioactivity.

2.1.1 Question 1: Multiple Choice Items

This question consisted of ten (10) multiple choice items which were composed from the following topics: *Measurement, Archimedes principle, Structure and Properties of matter, Optical Instruments, Light, Magnetism, Motion in a Straight Line, Temperature, Friction and Thermal Energy*. The candidates were required to choose the correct answer from the five given alternatives (A to E) by writing the letter of the most correct answer beside the item number in the answer booklet provided. Each item carried 1 mark.

The question was attempted by almost 100 percent of the candidates and their scores were as follows: 16.0 percent scored from 0 to 2.0 marks, 64.8 percent scored from 3.0 to 6.0 marks and 19.2 percent scored from 7.0 to 10.0 marks. These scores indicate that the general performance of the question was good as 84.0 percent scored from 3.0 marks and above. Figure 1 summarizes the candidates' performance in this question.

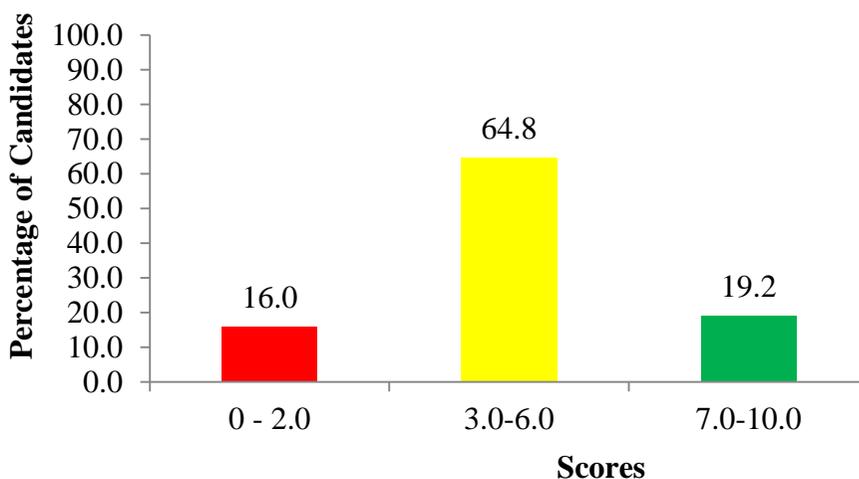


Figure 1: *The candidates' performance in Question 1*

The analysis of the individual item responses is as follows:

Item (i) was from the topic of *Measurement*. The candidates were given pairs of different measuring instruments and required to identify one pair of instruments that would correctly measure the diameter of a small ball bearing. The correct alternative was D, *Micrometre screw gauge and vernier calliper*. The question needed the knowledge on the concept of measurement to be able to select the correct pair. In general, majority of the candidates who lost marks in this question opted for alternative E, *metre rule and micrometre screw gauge*. This is because a metre rule is commonly used compared to a vernier calliper. These candidates were supposed to know that a metre rule is a device which is used to measure length of different objects but not diameters of objects. This showed that many candidates lacked the basic knowledge on different measuring instruments.

Item (ii) was based on the topic of Archimedes principle. The candidates were required to determine the volume of the cork that would be immersed in water when 100 cm^3 of a piece of cork of density 0.25 gcm^{-3} is floating on the surface of water. The correct response was C, 25 cm^3 . The candidates were expected to use mathematical skills to compute volume by relating volume and density so as to come out with the correct answer. They were ought to understand that density is a measurement that compares the amount of matter an object has to its volume. That is, an object with much matter in a certain volume has high density and an object with little matter in the same amount of volume has a low density. Thus, since density is found by dividing mass of an object by its volume, volume is calculated by taking mass of an object divided by its density. Most of candidates who failed this item had little understanding on the concept of density in relation to the Archimedes' Principle and the law of flotation.

Item (iii) was about the concept of Properties of matter. The candidates were supplied with five (5) options of physical properties of matter and required to name only one physical process which supports the observation that a layer of colourless water floating on a blue copper (ii) sulphate solution after sometimes becomes blue. The correct response was A, *Diffusion*. To get the right response, the candidates were required to have

basic knowledge on physical properties of different matter. The majority were attracted by option, A, *osmosis*. This might have been caused by lack of knowledge in differentiating diffusion from osmosis. They failed to understand that *osmosis is the movement of solvent from a region of low concentration to high concentration through semipermeable membrane* while *diffusion is the movement of particles from a region of high to low concentration*, therefore, molecules/particles moved from copper (II) sulphate solution (high concentration) to water (low concentration) due to diffusion.

Item (iv) covered the concept of Optical instruments where the candidates were required to find the diameter of the sun when a pin-hole camera of 200 mm long produces an image of 2 mm diameter of the sun when the sun's distance from the earth is about 1.5×10^8 km. The correct alternative was B, 1.5×10^6 km. The majority of the candidates failed to choose the correct alternative because of lack of knowledge on the concept of magnification. They were required to understand that the diameter of the sun is obtained from the relation; $\frac{\text{Size of image}}{\text{Size of object}} = \frac{\text{Distance of image}}{\text{Distance of object}}$.

The topic covered in item (v) was Light. The candidates were required to give the phenomenon which is a result of the earth being exactly along the same line between the centre of the sun and the moon. The correct response was A, *Lunar eclipse*. Most of the candidates who failed this item chose alternative C, *solar eclipse*. These candidates failed to distinguish between solar eclipse and lunar eclipse. The candidates were supposed to understand that in solar eclipse, the moon comes between the sun and the earth while lunar eclipse occurs when the earth comes between the sun and the moon.

Item (vi) came from the topic of magnetism. The question required the candidates to identify a pair of metal among five (5) given alternatives which will become strongly magnetized when subjected to magnetic field. The correct alternative was C, *Cobalt and iron*. Some candidates got this question right but most of them failed by choosing option A, *Nickel and copper*. These candidates failed to comprehend that cobalt and iron are examples of ferromagnetic materials which contain unpaired electrons each with a small magnetic field of its own that align readily with each other in response to an external magnetic field. Such alignment tends to persist even

when the magnetic field is removed. On the other hand, though Nickel is an example of ferromagnetic material which is highly magnetized when placed in a strong magnetic field. Copper is an example of diamagnetic material which when placed in a magnetic field becomes weakly magnetized in a direction opposite to that of the applied field. In general, they failed to characterize different types of magnetic materials.

Item (vii) was from the topic of *Motion in a Straight Line*. The candidates were required to calculate the time taken by a body to reach the maximum height when moved upward at a distance of 20 m. The correct response was A, 2 seconds. Most of the candidates failed to give a correct answer because they had little understanding on the concept of equations of kinematics for the motion of bodies under gravity. The candidates were supposed to attempt the question by using the following two steps; first, to find ‘initial velocity’ by using the third equation which states that; $v^2 = u^2 + 2gh$ and second, to find ‘time’ by using the first equation which states that; $v = u + gt$. These candidates were also supposed to know that at a maximum height, final velocity v is zero; hence the initial velocity, u , would be obtained by using the relation $u = \sqrt{2gh}$. Finally, the candidates would apply the formulae $v = u + gt$ such that, when $v = 0$; $g = -10 \text{ m/s}^2$, then $t = \frac{u}{g}$. Generally, the candidates lacked the concept of motion of bodies under gravity in conjunction with the equations of motion.

Item (viii) covered the concept of Temperature. The candidates were required to convert the temperature of 300 K of a certain liquid into degree centigrade. The best alternative was E, 27°C . This item was performed well by most of the candidates because they had clear understanding on the concept of conversion of temperature scales. The candidates were required to convert temperature in Kelvin scale into temperature in Centigrade scale by using the relation $\theta(^{\circ}\text{C}) = T(\text{K}) - 273$.

Item (ix) was under the concept of Friction. The candidates were required to select from the given alternatives, the response representing factors that influence friction between tyres of a car moving with a constant speed and the surface of the road. The correct response was C, *Nature of the surface and weight*. Most of candidates performed this question poorly because

they lacked knowledge on the concept of laws of friction. They were required to understand that friction does not depend on speed of an object and surface area in contact but rather depends on the nature of the surface (*roughness*) and weight (*normal force*).

Item (x) was constructed from the topic of Transfer of thermal energy. From the given alternatives, the candidates were required to choose the best alternative which explains why the driving wheel of a car feels warm when the sun shines on the dark-coloured driving wheel. The correct response was C, *It is because the sun radiates thermal energy to the wheel*. This question was performed well by most of the candidates because they had adequate knowledge on the methods of heat transfer (*conduction, convection and radiation*). The candidates were supposed to understand that; *Conduction* is a method of heat transfer in solids by vibration of its molecules; *Convection* is a method of heat transfer in fluids by actual movement of its molecules whereas; *Radiations* is a method of heat transfer in vacuum, where no material medium is required. Therefore, heat is transferred from the sun to the driving wheel of a car by radiation.

2.1.2 Question 2: Matching Items

This question was constructed from the topic of Radioactivity. It consisted of a total of five (5) items in list A each carrying 1 mark; and sheet of paper, aluminium foil and lead block with particles and rays denoted by letters A, B and C in list B. The candidates were required to match the properties of radiations in list A with the corresponding radiations in List B by writing the letter of the correct response beside the item number in the answer booklet provided. The items of this question were as given in the following table.

List A	List B
(i) Has weak-moderate ionising power.	<p>A sheet of paper Aluminium foil A lead block</p>
(ii) Is deflected towards south pole of the magnet.	
(iii) Has high penetrating power but stopped by lead sheet.	
(iv) Has the least penetrating power but stopped by a sheet of paper.	
(v) Has a speed up to 10% times the speed of light in vacuum.	

The question was attempted by almost 100 percent of the candidates. Their scores were as follows; 21.3 percent scored from 0 to 1.0 mark, 53.1 percent scored from 2.0 to 3.0 marks and 25.6 percent scored from 4.0 to 5.0 marks. These scores indicate that the general performance of the candidates in this question was good. Figure 2 portrays the candidates' performance in question 2.

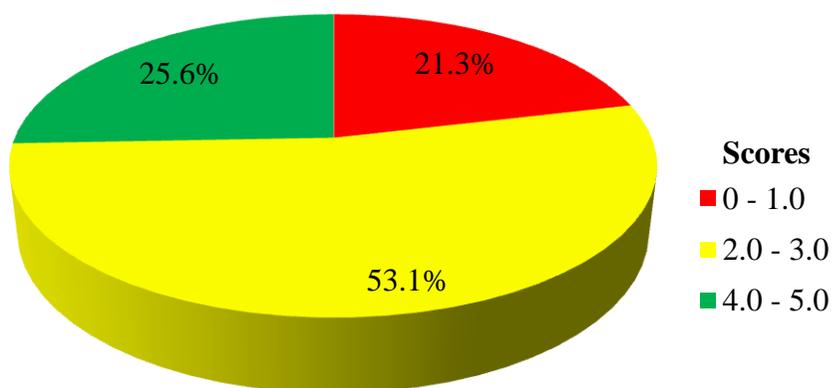


Figure 2: *The candidates' performance in Question 2*

The analysis of the individual item responses were as follows;

In item (i), the candidates were required to find a suitable response which matched correctly with the statement; *has weak-moderate ionizing power*. The appropriate response in this item was letter “B”, which, according to the diagram is stopped by aluminium foil. Most of the candidates opted for the correct response. This shows that they were aware of the properties of nuclear radiations. Few candidates who failed to identify the correct response were attracted by other responses. These candidates lacked content knowledge on the distinctive characteristics of nuclear radiations emitted when an unstable atom undergoes radioactive decay.

Item (ii) required the candidates to choose the letter which matched correctly with the phrase, *“Is deflected towards south pole of the magnet”*. The correct response was A, which is shown to be stopped by a sheet of paper. Practically, the nuclear radiation emitted is the alpha particle. Most of the candidates attempted correctly because they were able to identify the radiation which is deflected towards South Pole of the magnet. Some candidates opted for a wrong response and some wrote the correct answer in words instead of the given letters to represent the items in list A while others wrote numbers instead of a letter from list B. These candidates showed to have little understanding of the concept of deflection of radioactive particles under the influence of magnetic field and some failed to follow the instruction given to the question. They were supposed to know that since in magnetism, the magnetic lines of force emanate from north pole and that in electricity, an electric line of force starts from positive charge, then, the direction of deflection of the magnetic lines of force is towards the south pole of the magnet which is conceptually related to the deflection of a positively charged particle towards the negatively charged plate. Thus, an alpha particle which can be stopped by a sheet of paper is deflected towards the South Pole of the magnet.

In item (iii), the candidates were required to give a letter which matched precisely with the statement, *“Has high penetrating power but stopped by lead sheet”*. The best response was “C”. Most of the candidates responded on this item with the correct response. It shows that they were conversant with penetration properties of nuclear radiations. However, few failed to give the correct response. Some candidates even wrote in words such as ‘*lead block*’ which shows that they failed to understand the demand of the question which required them to write letters A, B or C. These candidates were supposed to recognize that nuclear radiations called gamma rays lettered by C are capable of penetrating through a sheet of paper and aluminium foil but only stopped by a block of lead showing that they have high penetrating power.

Item (iv) required the candidates to write a letter which matched precisely with the phrase “*Has the least penetrating power but stopped by a sheet of paper*”. The correct response was “A”. This item was correctly performed by most of the candidates. Few candidates failed to supply the correct response. The candidates were required to understand the penetrating properties of the three nuclear radiations and hence write the letter for the proper response.

Item (v) required the candidates to select the letter which matched appropriately with the statement “*Has a speed up to 10 % times the speed of light in vacuum*”. The correct response was “A”. This item was performed clearly by few candidates. Those who failed to attempt it lacked understanding on the properties of nuclear radiations in terms of speed.

In general, the candidates who performed well were fully equipped with the knowledge of three nuclear radiations labelled A, B and C which represent *alpha particles, beta particles and gamma rays respectively*. The candidates were required to understand that alpha particles have highest ionising power, beta particles have weak/moderate ionising power and gamma rays have very weak ionising power. Similarly, the candidates were supposed to understand that when alpha particles are placed in magnetic field, they deviate towards the South Pole while beta particles deflect towards the North Pole but gamma rays have no effect on magnetic field. Alpha particles have the least speed of all other nuclear radiations namely beta particles and gamma rays. Alpha particles have a speed of 10 % of speed of light, beta particles have 90 % and gamma rays have the speed equal to that of light.

2.2 Section B: Short Answer Questions

This section comprised six (6) Short Answer Questions each weighing 10 marks. The candidates were required to answer all the questions, each consisting of two (2) parts namely (a) and (b).

2.2.1 Question 3: Light and Optical Instruments

This question had two parts; (a) and (b). Part (a) was constructed from the topic of Light where the candidates were required to draw a well labelled diagram to show the experimental set-up and observation seen on a screen when a narrow beam of light is directed onto a glass prism. Part (b) came from the topic of *Optical instruments* and the candidates were required to explain two (2) ways in which lens camera differ from human eye.

A total number of 129,242 (100 %) candidates attempted this question. 88.7 percent scored from 0 to 2.5 marks, 9.9 percent scored from 3.0 to 6.0 marks and only 1.4 percent scored from 6.5 to 10.0 marks. Only 71 (0.1%) candidates scored 10 out of 10 marks. This trend depicts that the question was poorly performed as 11.3 percent scored 3.0 marks and above. Figure 3 portrays the analysis.

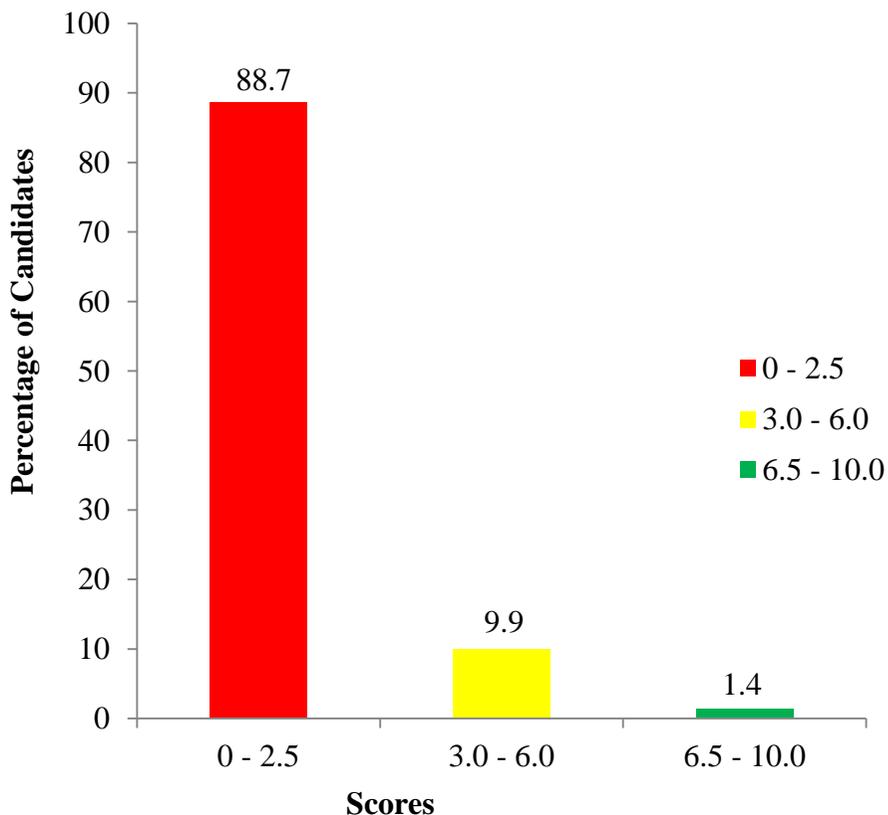


Figure 3: *The percentage of candidates' performance per score in Question 3*

The observations made on the responses of candidates who performed poorly in part (a) of this question revealed that they had very little understanding of the concept of dispersion when light falls on the surface of triangular prism. The majority drew wrong diagrams or drew incident and dispersed light rays without considering the normal as a reference. Moreover, they failed to understand why light with shorter wavelength bends more than that of longer wavelength. Others drew the spring holding pendulum bob, cathode ray oscilloscope, pin-hole camera and rectangular

glass block instead of triangular glass prism. These candidates had no idea on how dispersion of light occurs. They were supposed to understand that white light consists of seven colour components (*red, orange, yellow, green, blue, indigo and violet*) each with different wavelength in the order of decreasing wavelength respectively. Therefore, light with shorter wavelength has higher refractive indices and so; bends more from the normal than that with longer wavelengths.

In part (b), the candidates gave the difference between human eye and lens camera but their answers were irrelevant to the need of the question. A candidate wrote '*human eye is a sense organ while lens camera is an instrument*' and '*human eye is God made while lens camera is man-made*'. The candidates were required to give the functional difference between the lens camera and the human eye. Candidates who failed to attempt this part were not acquainted with the knowledge of structure and mode of action of the lens camera as compared to the human eye. The candidates were required to understand the functions of the lens camera and Human eye and give the differences. The eye is focused by altering the shape of the lens, while the lens camera is focused by altering the distance between the lens and the film. Also, the image formed on the retina is converted to an electric signal that travels along the optical nerve to the brain where the signals are interpreted in terms of intensity and colour to create a final perceived image while the image formed on the film is processed chemically to produce final image. Extract 3.1 is a sample of responses of one of the candidates who did not perform well this question.

3. a)	
	b) Ways in which lens cameras differ from human eye.
	i) lens cameras is large while human eye is small but all take large place to the object.
	ii) lens camera have take long place to see but human eye do not seen long ^{place} area compared with human lens cameras.

Extract 3.1: A sample of the candidate's poor responses in Question 3

In extract 3.1, the candidate failed to provide correct answers in all parts of the question by drawing a spiral spring holding a bob as a prism instead of a triangular glass prism. The candidate also failed to differentiate the functions of the lens camera from those of the human eye.

On the other hand, the candidates who performed well in this question had enough knowledge of light, especially the concept of dispersion, optical instruments, lens camera and the human eye. They were able to illustrate correctly the dispersion of white light into its component colours (*red, orange, yellow, green, blue, indigo* and *violet*) when it passes through a triangular glass prism. Also, they were able to differentiate between lens camera and human eye in terms of their functions. Extract 3.2 shows a sample answer taken from the script of one of the candidates who performed well in the question.

3.	a/ The narrow beam of light that is directed onto a glass prism will be dispersed by this prism whereby a spectrum (band of colours) will be produced on a screen. Seven colours will be seen on a screen which are Red, Orange, yellow, green, blue, indigo and violet Its diagram is as follows
3	a/ by diagram
	b/ i/ Lens cameras form an image at the film through chemical reactions while human eye form the image at the retina through photoreceptor cells. ii/ Lens cameras focus near objects or far objects (accommodation) by changing the distance from the lens to the film while human eye focus near objects or far objects (accommodation) by changing the thickness of lens of eye.

Extract 3.2: A sample of candidate's good responses in Question 3

The candidate provided a good illustration of the concept of dispersion by indicating how the light components bend differently from the normal when white light falls on a triangular prism and clearly differentiated lens camera from human eye in terms of their functions.

2.2.2 Question 4: Pressure and Forces in equilibrium

In part (a) of this question, the candidates were required to explain why a bubble of air increases in volume as it rises from the bottom of the pond of water to the surface. This came from the topic of Pressure. Part (b) covers the concept of Moment of force and it required the candidates to calculate the mass of the half-metre rule AB when pivoted freely at 18 cm from end A which balances horizontally when a body of mass 35 g is hung 48 cm from end B.

A total number of 129,244 (100 %) candidates attempted this question. Among them 88.2 percent of the candidates scored from 0 to 2.5 marks, 9.6 percent scored from 3.0 to 6.0 marks and 2.2 percent scored from 6.5 to 10.0 marks. This trend depicts that the question was poorly performed as portrayed in Fig 4.

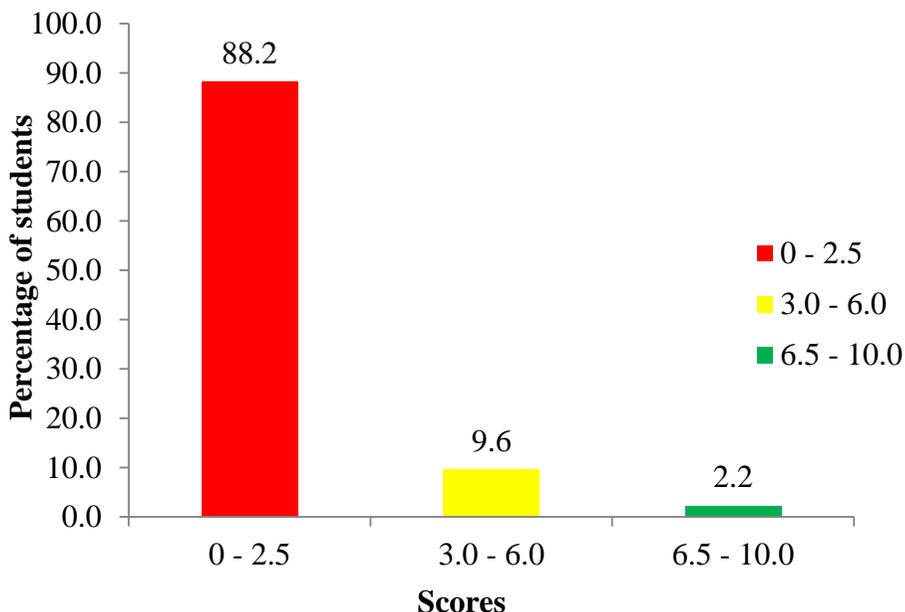


Figure 4: *The percentage of candidates' performance per score in Question 4*

The observation made on the responses of the candidates who performed poorly revealed that, in part (a) some of them related volume and density and also confused between pressure in liquid and atmospheric pressure. These candidates were supposed to describe variation of pressure with depth in accordance to Boyle's law which states that, '*Volume of a fixed mass of a gas at constant temperature is inversely proportional to the pressure*' therefore as the bubble of air rises, pressure decreases and hence the volume increases. In part (b), most of candidates did not understand the requirements of the question that led them use a metre rule instead of half metre rule in calculating the mass of the rule. Despite the fact that they failed to use half metre rule, still they failed to realize that in computing the mass of the rule, one needs to know the concept of the principle of moments which states that for a system to be in rotational balance, the total

clockwise moment must be equal to the total anticlockwise moment. Extract 4.1 is a sample of a poor response from one of the candidates.

Qn: 4a	Bubbles of air they are caused by an increase in temperature, thus effect of temperature in liquids, this temperature when it increases it increases the kinetics ^{Energy} of the water molecules to form bubbles which they move and expand to increase volume of a liquid. example milk to rise up during boiling.
6	Solution.
<p>The diagram shows a horizontal line representing a half-metre rule with endpoints A and B. A vertical dashed line indicates a pivot point located 18 cm from A. A rectangular mass labeled '35g' is suspended from the rule at a point 48 cm from B.</p>	
$\text{mass of a ruler} = \frac{\text{length from B} \times \text{length from A}}{\text{length from A mass}}$	
$L_A \times L_B = \frac{48 \text{ cm} \times 18 \text{ cm}}{35 \text{ g}}$	
$M \text{ (g)} = 240.89 \text{ g/cm}^2$	

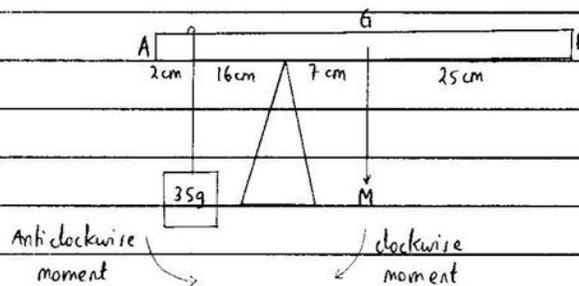
Extract 4.1: A sample of candidate's poor responses in Question 4

In extract 4.1, the candidate failed to relate pressure and volume of air bubble when rising up from the bottom of the pond to the surface. Consequently, he/she failed to calculate the mass of half metre rule because of applying a wrong concept.

On the other hand, some candidates had adequate knowledge on the concept of pressure as they were able to explain correctly how a bubble increases in size as it rises from the bottom of the pond. They also managed to use mathematical skills to work out the mass from the concept of forces in equilibrium as seen in the extract 4.2.

9. (a) A bubble of air increases in volume as it rises from the bottom of a pond of water to the surface because pressure at the bottom of a pond is greater than pressure at the surface and according to Boyle's law, pressure varies inversely proportional to volume hence as the bubble of air rises to the surface, pressure is reduced and volume increases.

(b) Given equilibrium,



Using the principle of moments about the pivot,

$$\sum \text{clockwise moments} = \sum \text{anticlockwise moments}$$

$$M \times 7 \text{ cm} = 35 \text{ g} \times 16 \text{ cm}$$

$$M = \frac{35 \text{ g} \times 16 \text{ cm}}{7 \text{ cm}}$$

$$M = \frac{560 \text{ g cm}}{7 \text{ cm}}$$

$$M = 80 \text{ g}$$

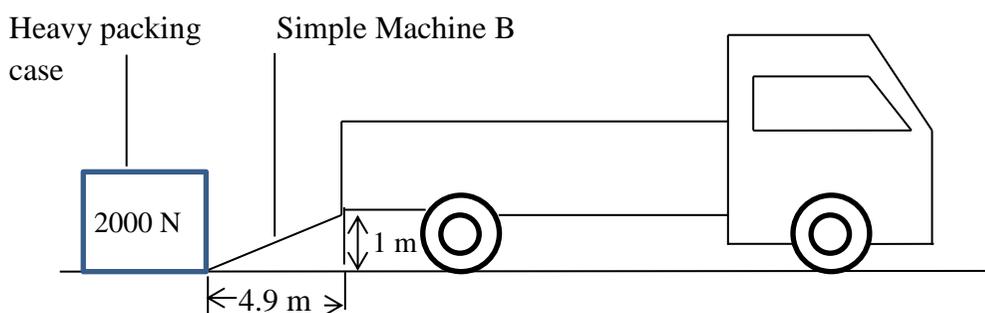
\therefore The mass of the rule is 80 g.

Extract 4.2: The work of the candidate who performed the question well

The candidate explained correctly how pressure relates with volume when a bubble rises from the bottom of the pond to the surface. He/she used proper relation and performed correct calculations to find the mass of half meter rule.

2.2.3 Question 5: Simple machines and Newton's laws of motion

The question comprised two parts (a) and (b). Part (a) of the question covers the concept of Simple Machines where the candidates were required to calculate the efficiency of the machine B used to pull the packing case of 2000 N into the car by an effort of 500 N as shown in the following diagram.



Part (b) was constructed from the topic of Newton's laws of motion. The candidates were required to use a clearly labelled diagram to describe an experiment to investigate the relationship between the force acting on a body and the acceleration produced.

The data analysis shows that 129,245 (100%) candidates attempted this question, where 87.5 percent scored from 0 to 2.5 marks, 12.3 percent scored from 3.0 to 6.0 marks and 0.2 percent scored from 6.5 to 10 marks. The data presented in Figure 5 indicate that the question was poorly performed as 12.5 percent of the candidates scored from 3.0 marks and above.

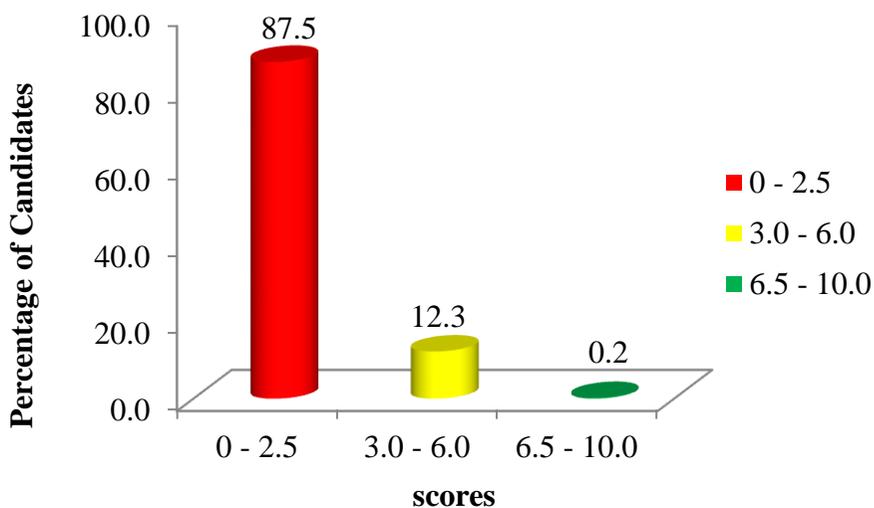
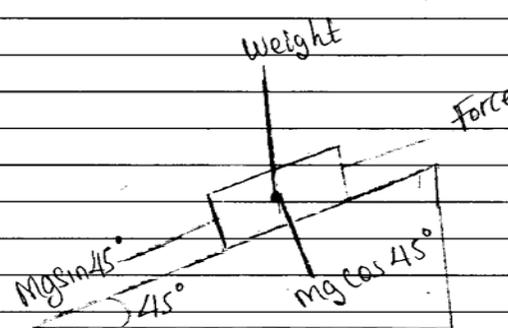


Figure 5: *The candidates' performance in Question 5*

The question was poorly performed especially in part (b). Few candidates who performed poorly in part (a) failed to use Pythagoras theorem to get the slant height (*length of a plane*) instead they used horizontal distance as distance moved by effort. The candidates were supposed to apply Pythagoras theorem to calculate distance moved by effort which would then be used to find velocity ratio of the machine. In part (b), most of candidates skipped this part and for those who attempted failed to differentiate linear acceleration from acceleration due to gravity as they came up with explanations relating simple pendulum experiment instead of ticker timer experiment. The analysis shows that most of the candidates were not familiar with the ticker timer experiment. Extract 5.1 shows the sample of poor responses in this question.

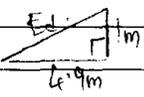
5	<p>or Data given.</p> <p>Load = 2000 N</p> <p>Effort = 500 N</p> <p>Efficiency = ?</p> <p>Formular.</p>
5	<p>or Efficiency = $\frac{\text{work input}}{\text{work out put}} \times 100\%$</p> <p>$e = \frac{w \cdot \text{input}}{w \cdot \text{out put}} \times 100\%$</p> <p>$e = \frac{500 \text{ N}}{2000 \text{ N}} \times 100\%$</p> <p>$e = 0.25 \times 100\%$</p> <p>$e = 25\%$</p> <p>∴ Efficiency of machine</p> <p>B is 25%</p> <p>or</p>  <p>Force = mass x acceleration</p>

Extract 5.1: A sample of the candidate's poor responses in Question 5

In extract 5.1, the candidate failed to find the effort distance to be used to get velocity ratio by using the Pythagoras theorem. Likewise, he/she was not able to design an experiment that shows the relation of force acting on the body and the acceleration produced instead, he/she drew a resolution vector for a body pushed up the inclined plane.

On the contrary, some of the candidates showed great understanding of the question, implying that they had satisfactory knowledge at the expense of the demands of the question on the content tested. They were able to apply Pythagoras theorem and hence managed to obtain the correct value of

efficiency of machine. They were also able to describe how force produces acceleration by using ticker timer. Extract 5.2 is one of the best responses from one of the candidates who did this question.

5a)	Given,
	$L = 2000\text{N}$.
	$E = 500\text{N}$.
	$E_d = ?$
	$L_d = 1\text{m}$.
	
	From Pythagoras theorem
	$c^2 = a^2 + b^2$.
	$E_d = \sqrt{1^2 + 4.9^2}$.
	$= \sqrt{1 + 24.01}$
	$= \sqrt{25.01}$
	$E_d = 5\text{m}$.
	Then,
	$M \cdot A = \frac{\text{Load}}{\text{Effort}}$
	$= \frac{2000}{500}$
	$M \cdot A = 4$
	Also $V \cdot R = \frac{E_d}{L_d}$
	$= \frac{5\text{m}}{1\text{m}}$
	$V \cdot R = 5$.
	Finally $E = \frac{M \cdot A}{V \cdot R} \times 100\%$
	$= \frac{4}{5} \times 100\%$
	$\therefore \text{Efficiency} = 80\%$

5b) Consider the diagram,

The relationship can be obtained as follows,

The ~~of~~ spring balance is pulled for different forces and they are recorded. The ticker tape timer produces ~~pr~~ dots on same rate. Therefore a higher force produces much acceleration and the dots will be widely spaced. The A lower lower force produces dots nearly spaced this shows low acceleration.

Therefore ~~by~~ through frequency of dots the relationship between force applied and acceleration is attained.

Extract 5.2: A sample of the candidate's good responses in Question 5

In extract 5.2, the candidate managed to apply Pythagoras theorem to calculate the value of effort distance. Likewise, he/she calculated correctly the values of velocity ratio, mechanical advantage and efficiency of machine. Also, the candidate established an experiment to determine the relationship between force applied and acceleration produced precisely.

2.2.4 Question 6: Thermal expansion

This question had two parts, namely part (a) and part (b) all covering the concept of Thermal expansion. In part (a), the candidates were required to use a diagram to explain the variation of density of ice with temperature when a beaker containing ice is heated from -5°C to 0°C and from 0°C to 15°C . In part (b), the candidates were given a brick of dimension of 30

cm, 18 cm and 10 cm for length, width and height respectively at 20 °C. From this given information, the candidates were required to calculate the new diameter of the brick when heated to a new temperature of 150 °C.

A total number of 129,237 (about 100%) candidates attempted this question while 12 candidates did not attempt the question. 84.6 percent of the candidates scored from 0 to 2.5 marks, 13.9 percent scored from 3.0 to 6.0 marks and 1.5 percent scored from 6.5 to 10 marks. Only 191 (0.1%) candidates scored 10 out of 10 marks. This trend depicts that the question was poorly performed as 15.4 percent scored 3.0 marks and above. Figure 6 shows the candidates' performance in this question.

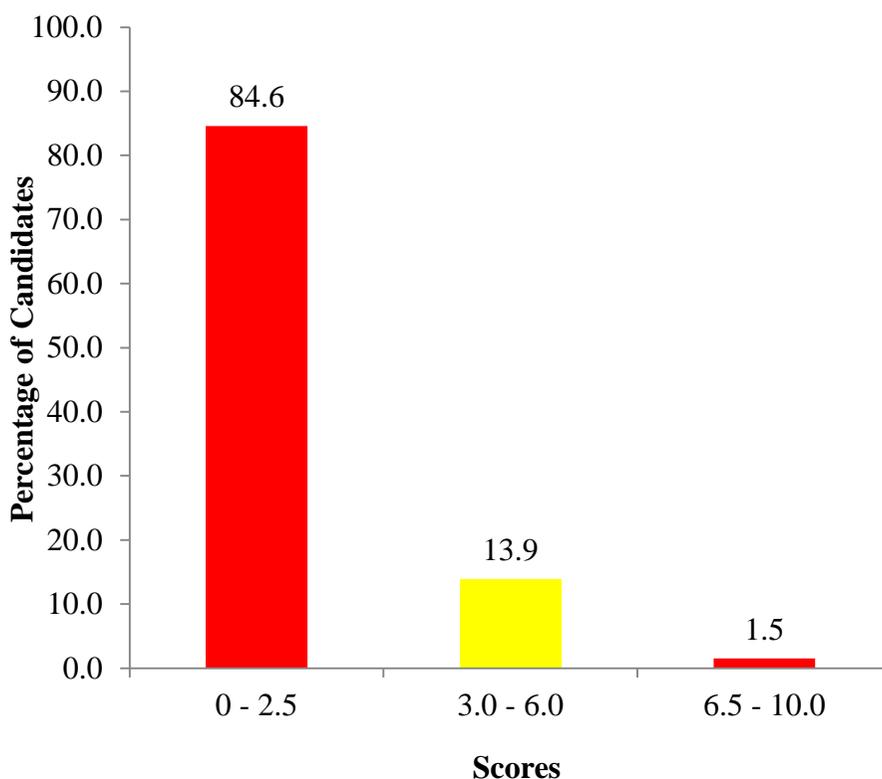


Figure 6: *Percentage of Candidates' Performance per Score*

The candidates who performed poorly in this question lacked knowledge on the concept of anomalous expansion of water as most of them provided irrelevant answers. In part (a), most of them failed to draw the variation of density of water with temperature, because they failed to understand how

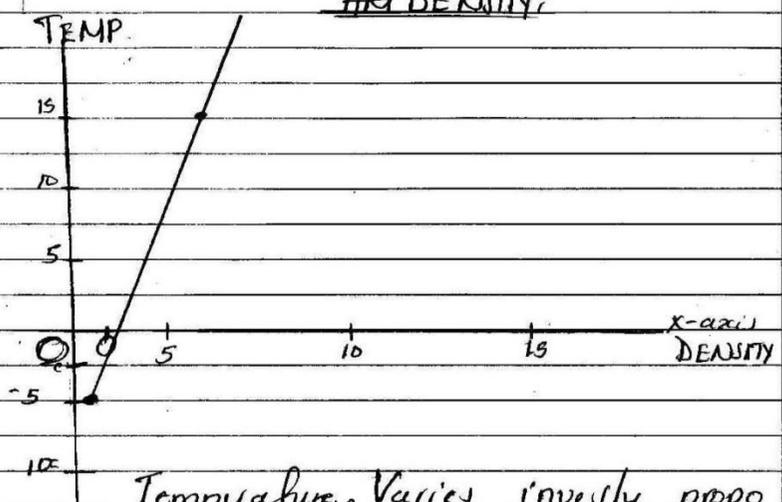
volume of water is related to its density and some of them drew the straight line describing the relation between density and temperature. Other candidates drew the variation of change of state with temperature. Some used heat sources to indicate the change of states with temperature. Moreover, they were supposed to understand that when temperature of ice rises from -5°C to 0°C the slight increase in density is observed. As the temperature raises from 0°C to 4°C , the density of water increases till it attains its maximum density ($1\text{g}/\text{cm}^3$) and then starts to decrease when the temperature increases from 4°C to 15°C .

The candidates who performed poorly in part (b) lacked the concept of thermal expansion in solids, specifically on linear expansivity of a substance as *the increase in length per unit length of a substance when the temperature rises by 1°C or 1K* which means $\alpha = \frac{L_2 - L_1}{L_1 \Delta T}$. Some candidates

were finding the change in length instead of new dimension. Other candidates used a wrong formula and others failed to recognize that change in temperature (ΔT) is the same for both Celsius and Kelvin scale. The candidates were supposed to: first, find the change in temperature (ΔT), then find the new dimensions of the brick in terms of their length, width and height by using equation $L_2 = L_1(\alpha\Delta T + 1)$ for each measurement. Extract 6.1 represents a sample response from one of the candidates who performed the question poorly.

THE GRAPH OF TEMPERATURE AGAINST DENSITY

6. a)



Temperature varies inversely proportion with density.

6
b) Given

$T_1 = 20^\circ\text{C}$

$T_2 = 150^\circ\text{C}$

$D_1 = 5.8 \text{ cm}^3$

$D_2 = ?$

Coefficient of linear Expansion of a brick = 12×10^{-6} when a:

T_1 = initial temperature

T_2 = final temperature

D_1 = initial dimension

D_2 = final (new) dimension.

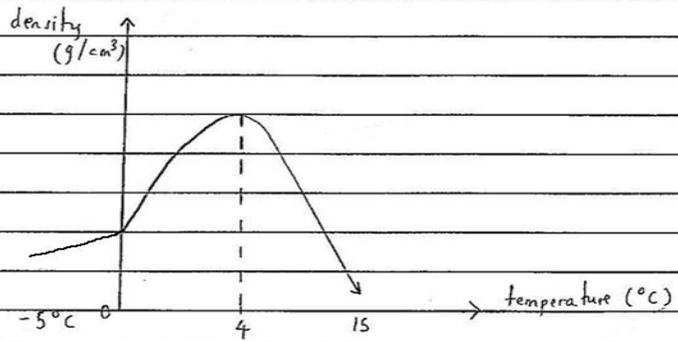
6	
by	<u>Required</u>
	<u>(D₂)</u>
	from
	$D_2 = \frac{T_2 D_1}{T_1}$
	$D_2 = \frac{T_2 - D_1}{T_1}$
	$D_2 = \frac{150 - 20}{1.58}$
	$D_2 = \frac{130}{58}$
	$2.24 (1.2 \times 10^{-5})$
	$\Rightarrow D_2 = 134.4 \text{ cm}^3$
	\therefore A new dimension is 134.4 cm^3

Extract 6.1: A sample of the candidate's poor responses in Question 6

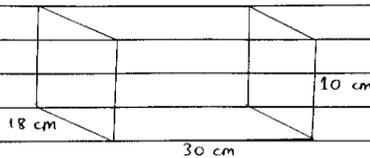
In extract 6.1, the candidate failed to describe the relation between temperature and density of water when heated from -5°C to 15°C . The candidate also failed to organise the given data to determine the new dimension of the brick as required by the question.

On the other hand, few candidates managed to do the question correctly. The candidates' responses show that they had a good understanding of the concept of thermal expansion as they were able to accurately describe the concept of anomalous expansion of water and use appropriate formula. They also manipulated the data and determined the increase in length for each dimension of the brick. Extract 6.2 is a response from a candidate who correctly did the question.

6. (a) When ice at -5°C is then heated to 15°C , its density will increase from the temperature of -5°C to 4°C and then will return to normal or linearly after the temperature of 4°C .



6. (b) Given a brick



$$\alpha = 1.2 \times 10^{-5} \text{ K}^{-1}$$

$$\text{from } l_f = l_0 (1 + \alpha \Delta\theta)$$

$$\Delta\theta = \theta_f - \theta_i$$

$$\Delta\theta = 150^{\circ}\text{C} - 20^{\circ}\text{C}$$

$$\Delta\theta = 130^{\circ}\text{C}$$

New length

$$l_f = l_0 (1 + \alpha \Delta\theta)$$

$$l_f = 30 (1 + 1.2 \times 10^{-5} \times 130)$$

$$l_f = 30 (1 + 1.56 \times 10^{-3})$$

$$l_f = 30 (1 + 1.56 \times 10^{-3})$$

$$l_f = 30 (1 + 1.56 \times 10^{-3})$$

$$l_f = 30 + 0.0468$$

$$l_f = 30.0468 \text{ cm}$$

New width

$$l_f = l_0 (1 + \alpha \Delta\theta)$$

$$l_f = 18 (1 + 1.2 \times 10^{-5} \times 130)$$

$$l_f = 18 (1 + 1.56 \times 10^{-3})$$

$$l_f = 18 + 0.02808$$

$$l_f = 18.02808 \text{ cm}$$

6	(b) New height
	$l = l_0 (1 + \alpha \Delta \theta)$
	$l = 10 (1 + 1.2 \times 10^{-5} \times 130)$
	$l = 10 (1 + 1.56 \times 10^{-3})$
	$l = 10 + 0.0156$
	$l = 10.0156 \text{ cm}$
	\therefore The new dimensions of the brick are 30.0468 cm,
	18.02808 cm and 10.0156 cm for length, width
	and height respectively.

Extract 6.2: A sample of the candidate's good responses in Question 6

In extract 6.2, the candidate presented clear description with a sketch to describe the variation of density of water as it is warmed from -5°C to 15°C . Furthermore, the candidate managed to apply the concept of linear expansivity to calculate the new dimension of the brick.

2.2.5 Question 7: Current electricity

This question was based on the concept of Current electricity. In part (a) the candidates were required to explain the function of a fuse in an electrical appliance with the aid of a diagram. Part (b) required the candidates to determine whether the fuse of 10 A will blow on or off when the appliances given are all turned on and connected to 240 V mains.

Appliance	Power rating
Bulb 1	100 W
Bulb 2	75 W
	300 W
Heater	1500 W

A total number of 129,243 (almost 100%) candidates attempted this question. The analysis reveals that 75.9 percent scored from 0 to 2.5 marks, 17.9 percent scored from 3.0 to 6.0 marks and 6.2 percent scored from 6.5 to 10 marks. This trend depicts that the question was poorly performed. Figure 7 interprets the performance of the candidates in this question.

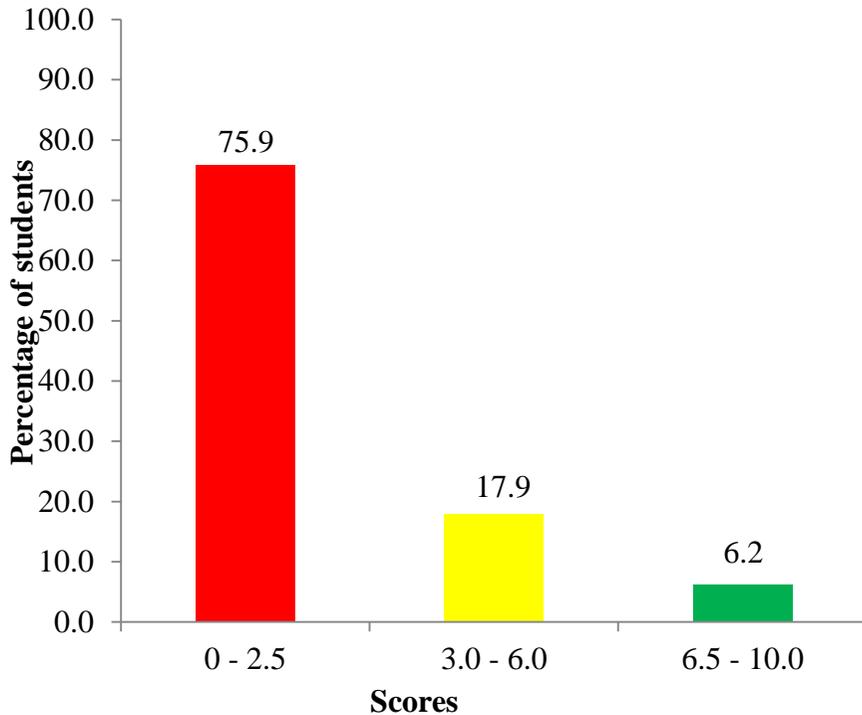
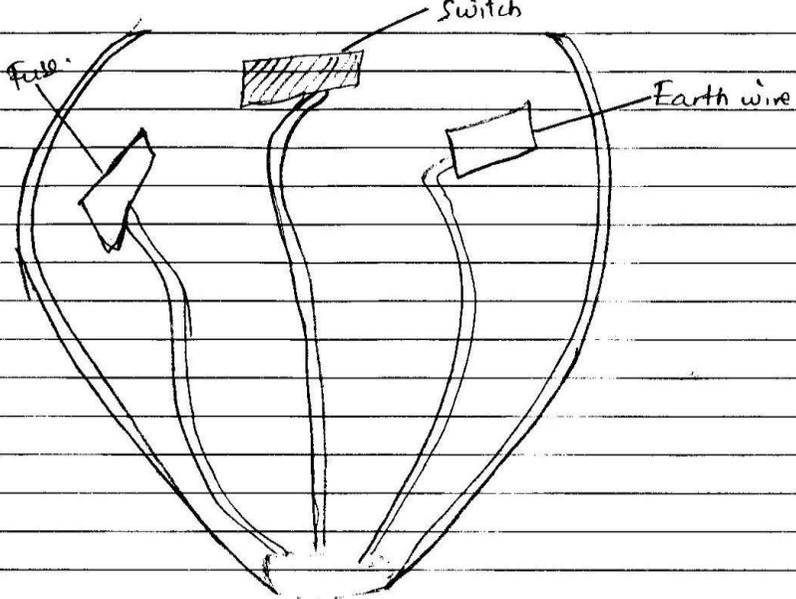


Figure 7: *The Candidates' Performance in Question 7*

The analysis of responses shows that some candidates who performed poorly in this part failed to differentiate between “*three pin plug*” and a fuse. Some failed to understand the terms *blow off* and *blow on*. Others calculated individual voltage of the appliances instead of current. Some candidates responded incorrectly and others skipped some parts indicating that they had little understanding on the concept of domestic electrical installation. They were supposed to understand that practically a fuse is also found in a *three pin plug* connected to the live cable and *it is a safety device used to protect the electric circuit against excess current*. Candidates were supposed to know that the fuse blowing/melting occurs mainly when the circuit is overloaded i.e when there is excess current more than the recommended for a given device.

However; candidates who performed poorly in part (b) of this question lacked knowledge on the concept of electrical rating. Some of them responded incorrectly and others skipped this part. They failed to determine the total power generated by all the appliances connected to the circuit which in turn would help them to find the current passing through the circuit due to the 240 V mains. They were supposed to understand how the fuse works and how much power is generated by the current in the given domestic appliances. Also candidates were supposed to understand that the total power produced by the current from the mains equals to the sum of the power (rate of energy dissipated) produced in each appliance in the house.

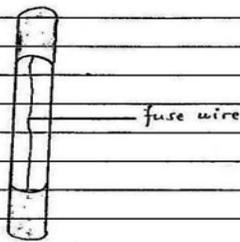
i.e. $P = VI$, hence $I = \frac{P}{V}$. Extract 7.1 depicts the case.

7.	<p>a)</p> 
	<p>The function of fuse in an electrical appliance is to control the amount of electricity passing</p>
	<p>b) The fuse will blow off if all appliances are turn on because the power rating are too high compared to it's ability to control.</p>

Extract 7.1: A sample of candidate's poor responses in question 7

In extract 7.1, the candidate drew a three pin plug socket instead of a fuse. The candidate also failed to use the information given to determine whether the fuse will blow on or off.

Few candidates who scored high marks in part (a) of this question were able to draw correctly a well labelled diagram of a fuse. Moreover, the candidates were able to explain the function of a fuse in an electric appliance. For example, one candidate explained the function of a fuse as follows: A fuse is safety electrical device used to protect an electric circuit against excess current. Another candidate wrote: A fuse consists of an element, usually a piece of copper or tin-lead alloy wire, which melts when current passing through it exceeds a specific predetermined value. These candidates also used the given data to correctly determine whether the fuse will blow or not if the given appliances were connected. Extract 7.2 is a sample of a good answer taken from the script of one of the candidates.

7.	(a) The function of a fuse.
	The function of the fuse in an electrical appliance is to disconnect the circuit by melting when high current is passed through it before entering the appliance.
	The melting of the fuse protects the appliance from high current electricity which in turn could cause damage and even fire out break.
	
	A fuse
	(b) Given Bulb 1 = 100W p.d = 240V
	Bulb 2 = 75W
	TV = 300W
	Heater = 1500W
	Sum of power = 100W + 75W + 300W + 1500W
	= 1975W
	then
	from Joules law equation.
	$P = IV$
	Where $P = 1975W$
	$V = 240V$

7.	(b) then,
	$I = \frac{P}{V}$
	$I = \frac{1975W}{240V}$
	$I = 8.23A.$
	\therefore The fuse will blow on because the appliance will use the low current of 8.23A than the limit of the fuse of 10A.

Extract 7.2: A sample of the candidate's good responses in question 7

In extract 7.2, the candidate managed to explain clearly the functions of a fuse with the aid of a well labelled diagram. The candidate also used the data to determine the total current of all appliances given and came up with correct conclusion that the fuse will not melt.

2.2.6 Question 8: Geophysics and Waves

This question was divided into two (2) parts, (a) and (b). Part (a) was constructed from the topic of Geophysics where the candidates were required to explain why the inner core of the earth is solid while the outer core is liquid. Part (b) covered the concept of Waves where the candidates were required to calculate the frequency of a stringed instrument when the tension is increased by 6 N, if it had a frequency of 400 Hz at a tension of 2 N.

A total number of 129,201 (almost 100%) candidates attempted this question out of which 92.1 percent scored from 0 to 2.5 marks, 6.8 percent scored from 3.0 to 6.0 marks and 1.1 percent scored from 6.5 to 10 marks.

This trend depicts that the question was poorly performed as portrayed in Figure 8.

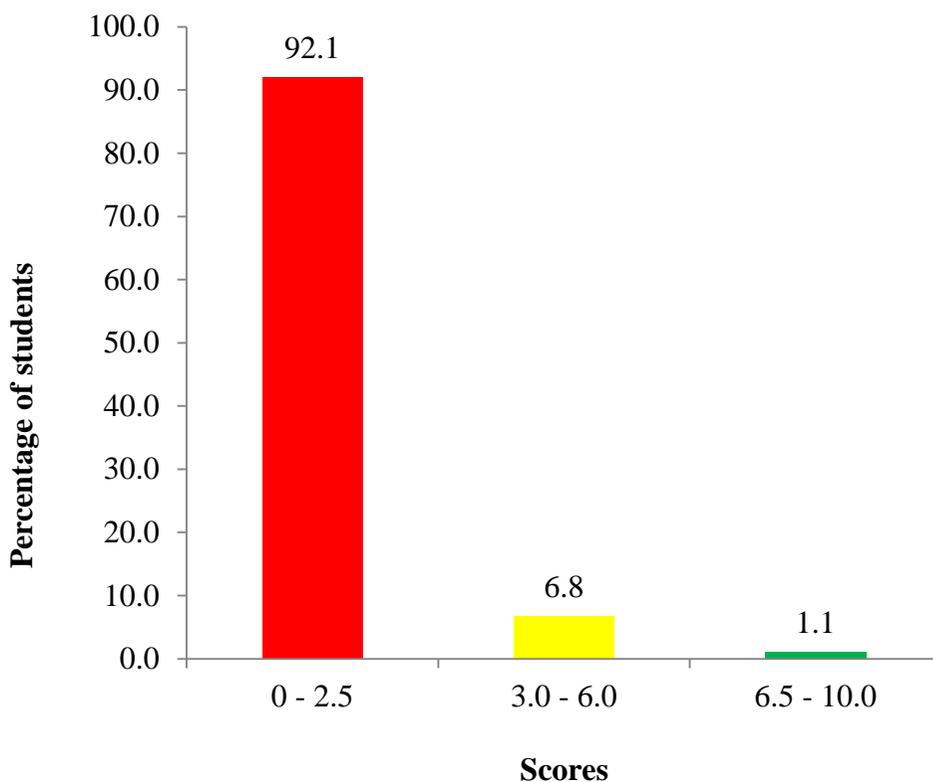


Figure 8: *The percentage of Candidates' Performance in Question 8*

The reason for poor performance is that some of the candidates had inadequate knowledge on the effect of pressure in the core of the earth's internal structure. Some candidates related wrongly the composition of inner and outer core with pressure in the core. Some of them confused the inner core as the earth surface where the living organism exists and the outer core with the atmosphere. Others confused the term core with soft iron core. Consequently, some of them were not aware of the constituents of the inner and outer core. Some candidates wrote: *The inner core contains hard rocks and the outer core contains molten rocks.* Others explained that *the inner core was composed of sial and the outer core was composed of sima.* The candidates were supposed to give a brief description of the materials composed in inner and outer core and explain the effect of pressure on the inner core in relation to the outer core. Moreover, majority

failed to explain the relationship between frequency and tension on stringed instruments under the topic of waves. Some used the relation $f \propto T$ while others wrote a wrong comparison of frequency and tension. Also, some candidates interpreted wrongly part of the question which required them to increase tension by 6 N. They used 6 N as the final tension. Candidates were supposed to use 2 N and 400 Hz as the initial tension and frequency respectively and were required to find new frequency for which tension is $(2\text{ N} + 6\text{ N})$. Extract 8.1 is a sample of poor responses taken from the script of one candidate.

8(a) Why the inner core of the earth is solid while the outer core is liquid.

⇒ The inner core of the earth is solid while the outer core is liquid because of that the inner core of the earth it have different things while the outer core have only the molten stones and other constitution, and the inner core there is the human being which need more priority of living in the earth but the outer it was the place where the constitution and other things live there:

8(b) Data given
 Tension, is 2N
 Tension, is 6N
 Hz = 400
 Frequency

$$F = \frac{\lambda}{Hz}$$

$$f = \frac{6 \times 2\text{N}}{400}$$

Frequency = 0.03

∴ The frequency of the tension is 0.03 Hz

Extract 8.1: A sample of the candidate's poor responses in Question 8

In extract 8.1, the candidate confused the inner core with the earth's surface and the outer core with the earth's atmosphere. Also, the candidate used the wrong formula to find the new frequency.

However, few (7.9%) candidates who attempted the question well showed greater understanding of the concepts involved in almost all parts of the question. These candidates managed to interpret the given tasks and supplied the correct responses to many parts of the question. This observation is illustrated in Extract 8.2.

8(a)	<p>The inner core of the earth is solid because it is subjected to very high pressure. This makes the material making it become very closely compacted forming a core.</p> <p>The outer core is liquid because it is not subjected to very high pressure as the core. The temperature within the earth causes the rocks to melt and cause the outer core become liquid.</p> <p>The materials making inner core are harder than those of outer core.</p>
8(b)	<p style="text-align: center;">Data</p> $T_1 = 2 \text{ N}$ $f = 400 \text{ Hz}$ $T_2 = 2 \text{ N} + 6 \text{ N}$ $= 8 \text{ N}$ $f_2 = ?$ <p>from:</p> $f \propto \sqrt{T}$ $f = k\sqrt{T}$ $k = \frac{f}{\sqrt{T}}$ $\therefore \frac{f_1}{\sqrt{T_1}} = \frac{f_2}{\sqrt{T_2}}$ $\frac{400 \text{ Hz}}{\sqrt{2 \text{ N}}} = \frac{f_2}{\sqrt{8 \text{ N}}}$ $f_2 = \left(\frac{400 \times \sqrt{8}}{\sqrt{2}} \right) \text{ Hz}$ $\therefore \text{frequency produced} = 800 \text{ Hz}$

Extract 8.2: A sample of the candidate's good responses in question 8

Extract 8.2 illustrates how the candidate was conversant with the concept of geophysics and waves, hence explained clearly the effect of pressure in the inner core compared to the outer core of the earth. He/she also, used correctly the relation between frequency and tension of the string to find the new frequency when tension was raised by 6 N.

2.3 Section C: Short Answer Questions

The section comprised three (3) questions from the topics of *Electromagnetism*, *Waves*, *Radioactivity* and *Electronics* and each question carried 12½ marks. The candidates were required to answer two (2) questions from this section.

2.3.1 Question 9: Electromagnetism and Waves

This question was divided into three parts; (a), (b) and (c) covering the topic of Electromagnetism and Waves. In part (a), candidates were required to study diagram 2 which showed a design for an electrical operation model for lifting metallic objects. The candidates were then required to explain three things that should be done to lift a heavier iron metal block.

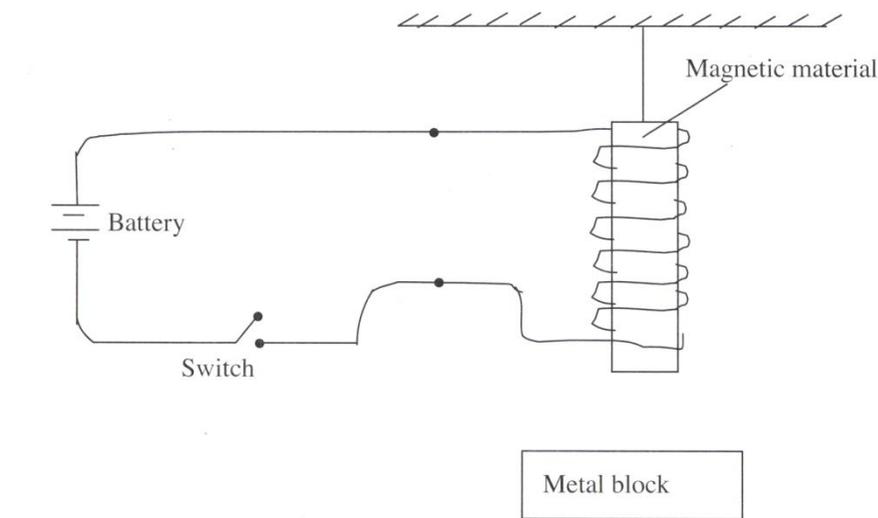


Diagram 2

Part (b) required the candidates to explain why a musician must re-tune a stringed instrument if its temperature changes. In part (c), the candidates were required to determine the distance of the thunderstorm when the time between the flash of light and the thunder is 10 seconds.

A total of 68,935 (53.3%) candidates attempted this question and their scores were as follows: 89.2 percent scored from 0 to 3.5 marks, 9.7 percent scored from 4.0 to 7.5 marks and 1.1 percent scored from 8.0 to 12.5 marks. Generally, the analysis shows that this question was poorly performed by the candidates because only 10.8 percent of them managed to score from 3.0 to 10 marks. Figure 9 summarizes the candidates' performance in this question.

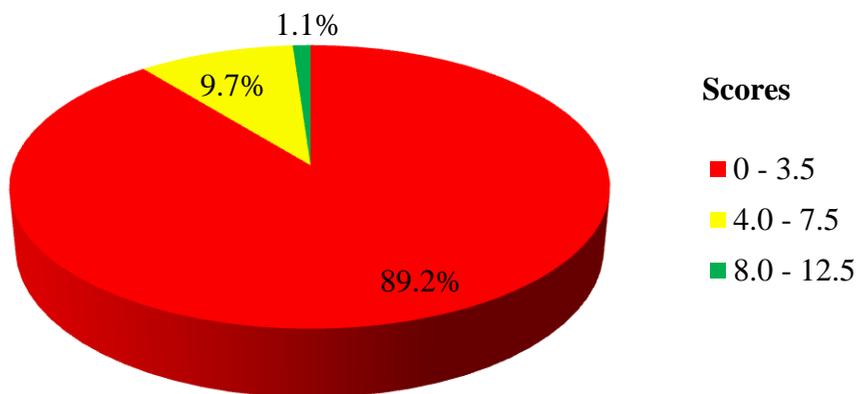


Figure 9: *A summary of Candidates' Performance in Question 9*

The analysis of candidates' responses revealed that most of the candidates who performed poorly lacked knowledge of electromagnetism especially factors affecting the strength of magnet produced due to current carrying conductor; instead they relied on stating current as the only factor suiting this part. In part (b), the responses of candidates who attempted poorly have shown that candidates lacked the concept of the variation of frequency of a stringed instrument with the change of temperature. The candidates were supposed to know that frequency varies inversely proportional to length of a string ($f \propto \frac{1}{l}$) and this is due to the fact that length of any solid matter varies directly with temperature due to expansion. However, some candidates failed to interpret the needs of part (c) of this question, hence applied wrong formula and substitution of data to calculate the distance of the thunderstorm. Extract 9.1 is the sample of a candidate who responded poorly.

9a Three things that I can do so that a heavier iron metal block can be lifted

1. To switch the electromagnetic material. When I switch the switch the electro magnetic material will lift up heavier iron metal.

2. To place the iron metal direction in to opposite direction example South and north in order to allow magnetic material to attract the iron metal and to lift it up. because when direction of the iron metal is not the same with of magnetic material the iron metal will be attracted by magnetic materials

3. To open the gaps of the screw contact of the magnetic material in order to allow magnet to attract the iron metal and to lift it up.

Therefore through these three ways I can lift up the heavier iron metal block

b Musician must retune a stringed instrument if its temperature changes in order to avoid the reflection of sound waves because if the temperature is colder the speed of sound waves is lower so for them to have high frequency of sound they must retune a stringed instrument if its temperature change.

QC	DATA GIVEN
	Time = 10 s
	velocity of light in air 3400 m/s
	distance required.
	FROM the formular
	$V = \frac{2d}{t}$
	$\frac{2d}{2} = \frac{v t}{2}$
	$d = \frac{v t}{2}$
	$d = \frac{10 \times 3400}{2}$
	$= \frac{34000}{2}$
	$d = 17000$
	The thunder storm is far away 17000

Extracts 9.1: A sample of the candidate's poor responses in question 9

In Extract 9.1, the candidate gave wrong explanations about the factors which determine the strength of magnet produced. Also, he/she used wrong formula to find the distance where the thunderstorm is originated and hence ended up with the wrong answer.

On the other hand, the candidates who attained high marks in this question had adequate knowledge on factors which affect the strength of the magnet produced due to current carrying conductor. These candidates wrote the factors such as *increasing electromotive force of the cell, increasing number of turns of the coil and using the soft iron core as the medium of the coil.*

In part (b), the candidates managed to explain clearly the effect of temperature on the frequency of the stringed instrument, that is, frequency varies inversely proportional to length and length varies directly proportional to temperature due to expansion. Hence as the temperature increases, frequency decreases and the musician must re-tune the

instrument in order to attain the best tune. Again the candidates were very good at finding the distance of the thunderstorm by the formula relating distance, velocity and time. Extracts 9.2 is a sample of good answers taken from the script of one of the candidates.

9(a)	<p>(i) Number of turns of the coil around magnetic material should be increased. Since, Number of turns of coil \propto induced magnetism.</p>
	<p>(ii) The magnetic material should be made Soft iron. This is because iron can be easily induced magnetic by an electric current.</p>
	<p>(iii) More powerful battery should be used in order to increase voltage and hence the current flowing. Higher current produces more induced magnetism.</p>
b)	<p>When temperature changes, it varies the length of the string, this causes frequency produced by string to change. Therefore, musician retunes to adjust length for the getting appropriate frequency of sound and hence obtaining desired tone quality.</p>
c)	<p>Given, $\Delta t = 10\text{s}$. $v = 340\text{m/s}$ $v_{\text{light}} = 3 \times 10^8\text{m/s}$. Soln. $v = \frac{d}{t}$. $d = vt$. $t = \frac{d}{v}$.</p> $\Delta t = \frac{d}{v_1} - \frac{d}{v_2}$

910	$10s = \frac{d}{3.8 \times 10^2} - d$
	$\times 3.8 \times 10^2$
	$10 = \frac{d}{340} - d$
	$\times 3.8 \times 10^2$
	$3.8 \times 10^9 = 117647d - d$
	$d = 3400$
	$\therefore \underline{3400m}$

Extract 9.2: A sample of the candidate's good responses in Question 9

In extract 9.2, the candidate gave the correct factors which affect the strength of the magnet produced by the current carrying conductor such as *increasing number of turns, increasing the e.m.f of the cell and using the soft iron as the medium of the coil*. The candidate also gave concise information on why musician must re-tune the instrument when the temperature changes and used clear formulae to calculate the distance from which the thunderstorm is originated.

2.3.2 Question 10: Radioactivity and Electronics

This question contained two (2) parts, namely (a) and (b). Part (a) was constructed from the topic of Radioactivity where the candidates were required to find the fraction of carbon-14, ($^{14}_6C$) that will remain after 11,400 years if a sample of carbon isotope $^{14}_6C$ has a half-life of 5700 years. Part (b) covered the concept of Electronics which required the candidates to describe the construction and mode of action of the p-n junction semiconductor.

A total of 105,067 (81.3%) candidates attempted this question with the following scores: 71.2 percent scored from 0 to 3.5 marks, 20.2 percent scored from 4.0 to 7.5 marks and 8.6 percent scored from 8.0 to 12.5 marks. Generally, this question was poorly performed because 28.8 percent

of candidates scored from 3.0 to 10 marks. These scores are presented in Figure 10 as follows:

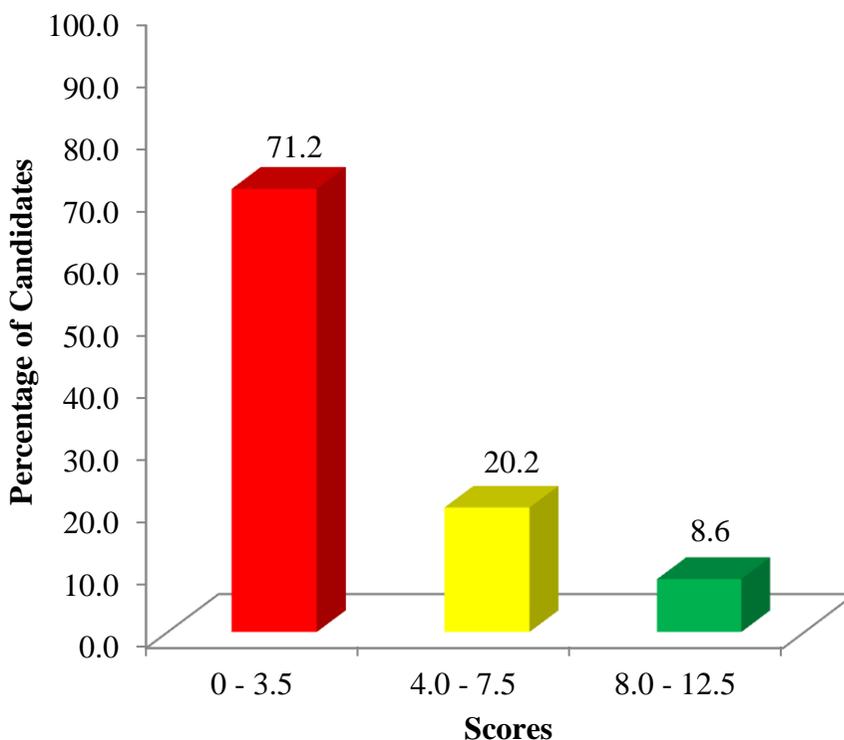


Figure 10: *Percentage of Candidates' Performance in Question 10*

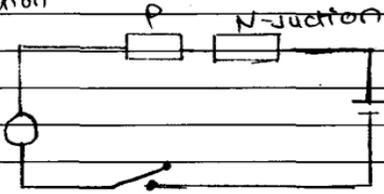
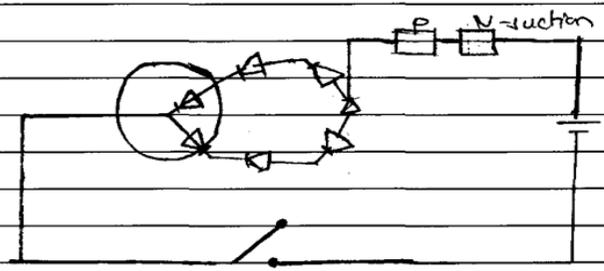
This question was opted by most of the candidates as compared to questions 9 and 11. This might be due to the fact that its items were constructed from two related topics and therefore attracted them, but unfortunately majority (71.2%) did not answer it correctly. Most of the candidates either left some parts of the question without writing anything or answered all the parts of the question incorrectly. These candidates lacked knowledge and skills about disintegration of radioactive materials and failed to find the fraction of $^{14}_6\text{C}$ remained after 11400 years. Most of them relied on finding the difference between time of decay and the half-life of $^{14}_6\text{C}$. Also, they were not able to describe the mode of action of p-n junction semiconductor; instead they tried to draw wrong circuits with wrong symbols of transistor. The candidates were supposed to know the structure

and mode of operation of the p-n junction. Extract 10.1 represents the response from a candidate who performed poorly.

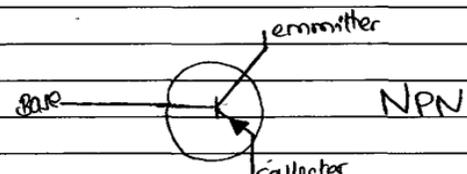
10 @ Data given
 $W_{\text{otope}} = {}^A_Z X$ but half life of 5700 yrs
 $Z = {}^{14}_6 C$ will remain after 11400 years.

but
 half-life - remain yrs
 5700 - 11400
 = 5700 years remained
 \therefore Fraction of ${}^{14}_6 C$ will remain after 5700 years.

(b) construction

(c) Mode of action

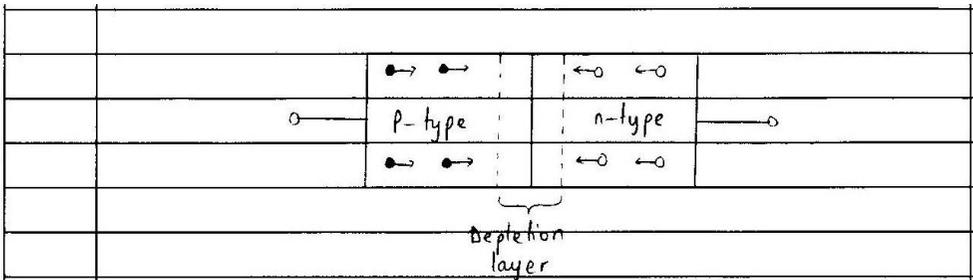


Extract 10.1: A sample of the candidate's responses in Question 10

This extract indicates how the candidate responded contrary to the demand of the question. The candidate was not able to recall the formulae which could lead him/her to the right answer. Confusion is seen in the concept of p-n junction as he/she ended with a wrong diagram.

On the other hand, the candidates who attempted well this question had adequate knowledge of the concept of radioactive decay of a material and applied correctly the relation; $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$ to find the fraction that remains after a given time. Some candidates used alternative ways of getting the fraction of $^{14}_6\text{C}$ that remained by first finding the value of 'n' which defines, $n = \frac{t}{\frac{T}{2}}$. The candidates also managed to describe clearly with the help of a diagram the mode of action of p-n junction semiconductors. Extract 10.2 illustrates the case.

10.	(a) Given a $^{14}_6\text{C}$
	$T_{\frac{1}{2}} = 5700 \text{ years}$
	$t = 11400 \text{ years}$
	$\frac{N}{N_0} = ?$
	from the radioactivity equation,
	$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$
	$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{11400 \text{ years}}{5700 \text{ years}}}$
	$\frac{N}{N_0} = \left(\frac{1}{2}\right)^2$
	$\frac{N}{N_0} = \frac{1}{4}$
	\therefore The fraction of $^{14}_6\text{C}$ that will remain after 11400 years is $\frac{1}{4}$
	(b) Construction of PN junction semiconductor.
	The PN junction semiconductor is made by combining two p-type and n-type semiconductor materials to make a single continuous crystal. When the p-type block and n-type block are combined together, they form a single-continuous crystal with the junction between them with the depletion layer which is the region around the p-n junction which is fairly free of majority charge carriers.

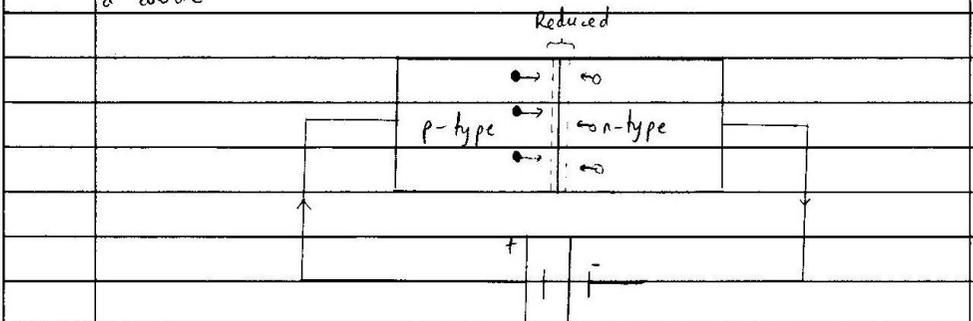


Mode of action of a PN junction semiconductor.

The PN junction semiconductor works when the p-type block and the n-type block are connected to the current through terminals hence giving two types of PN junction semiconductor connections:-

Forward bias of a PN junction semiconductor

Forward bias of a PN junction semiconductor is achieved when the p-type block is connected to the positive terminal and n-type block connected to the negative terminal of current. When this happens, the holes and positive charges repel each other hence pushing the holes towards the junction and the electrons and negative electric charges repel each other pushing the electrons towards the junction and hence decreasing the depletion layer and creating a potential difference across the p-n junction which allows the charge carriers to flow through the PN junction in one direction and hence behaving as a diode.



	Reverse bias of a PN junction semi conductor
	Reverse bias of a PN junction semi conductor is achieved when the p-type block is connected to the negative terminal and n-type block connected to the positive terminal of current. When this happens, the holes and negative charges attract each other and the electrons and the positive charges attract each other thereby pulled away from the p-n junction and the depletion layer is widened. Reverse bias impedes the flow of charge carriers across the p-n junction since the non-conducting depletion layer is large and wide where break down voltage needed is very high.
	Therefore the P-N junction semi-conductor can be used as a forward bias diode and a reverse bias diode depending on the uses.

Extract 10.2: A sample of the candidate's good responses in Question 10

Extract 10.2 shows that the candidate was able to analyse well the data and used the proper formulae to get the fraction of carbon-14 needed. The extract also indicates that the candidate was as good in radioactivity as he/she was able to describe well the construction of p-n junction.

2.3.3 Question 11: Electromagnetism

This was comprised of part (a) and part (b) from the topic of Electromagnetism. In part (a), the candidates were required to explain why the distribution of electrical energy in all parts of Tanzania by the National grid system is done by transmitting alternating current at a very high voltage. Part (b) required the candidates to describe how back e.m.f is induced by self-induction when a generator producing a varying current from 0 to 10 A is allowed to flow in a coil of magnetic field after a flow of current of 4 A.

The question was attempted by 84,339 (65.3%) candidates of which 95.8 percent scored from 0 to 3.5 marks, 4.0 percent scored from 4.0 to 7.5 marks and 0.2 percent scored from 8.0 to 12.5 marks. This was the poorest performed question as only 4.2 percent scored 3.0 marks and above. Figure 11 depicts the performance of the candidates in this question.

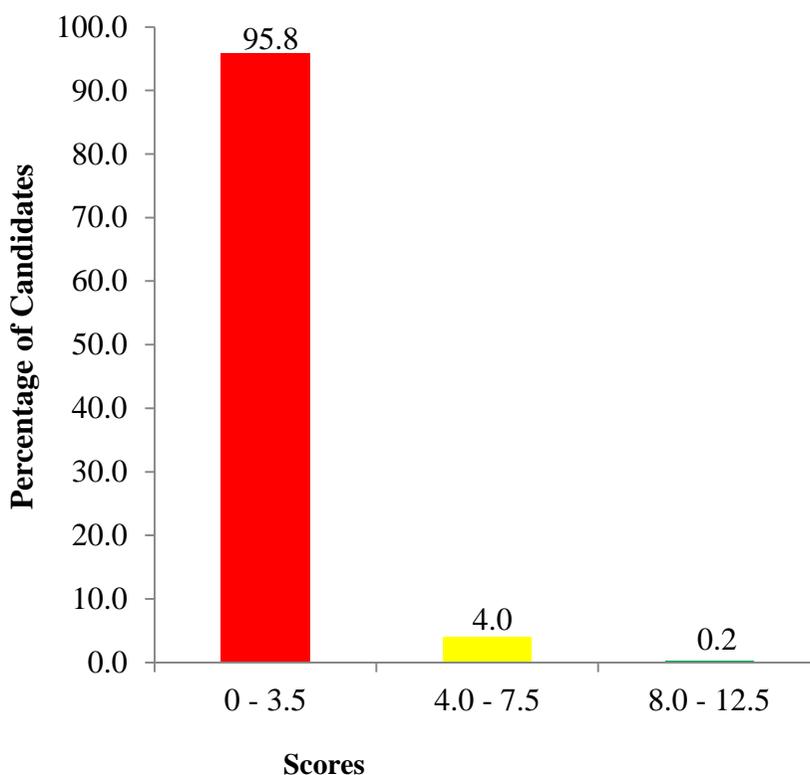


Figure 11: *Percentage of Candidates' Performance in Question 11*

The analysis of the candidates' responses in this question indicates that, most of the candidates who performed poorly in this question, faced problems in interpreting the demands of the question based on the given information. Some of them responded incorrectly while others skipped some parts. They failed to give reasons for the high voltage in transmitting electrical energy in the National grid. Some of them stated that, the reason is to *minimize the resistance of the material which is caused by high temperature*. They didn't know that resistance of material is not controlled by high voltage but they could rely on the voltage which is not directly affected by power losses in terms of heat energy. However, some candidates tried to give their explanations about self-induction but failed to explain it correctly. They could use the knowledge of Lenz's law to explain how the back e.m.f is induced in the circuit. Extract 11.1 reveals the case.

	It is necessary to have a very high voltage.
	Because;
	The many work who conducted in Tanzania for every day has need high electric energy that may help to conduct the activity and when conduct many activity which use high amount of energy the other part should miss the energy for conducting an activity but the many sector need high amount of voltage for consuming electricity in

11	a/ all party of a national so you should allow ed to have high amount of voltage because Many machinery use high amount of voltage When are on. so it is very important to have high amount of voltage for electrical co- nsumption.
	b/ Data given: - The flow current \odot up to 10A. - The observed current 1A.
	\Rightarrow The induced electromotive force produced from generator are flow when the electromoti- ve force are applied in a.c generator so as it led to reduce the amount of magnetic field. so The electro-motive force that during the current was observed was increased from the D.C generator for prod- uction of electromotive forces. so that; The back of induced semi- conductor was produced from D.C generator but not from a.c generator for more producti- on of electromotive force.
	\Rightarrow The use of A.C generator over the use of D.C generator it may led to back of the electromotive force when are induced so that more A.C are used when we compared from D.C generator so as it may cause self induction.

Extract 11.1: A sample of candidate's poor responses in Question 11

Extract 11.1 shows how the candidate failed to explain the reason for transmitting alternating current at a very high voltage by the National grid system. Also, he/she failed to describe how to induce e.m.f by self-induction in a generator.

On the other hand, few candidates who scored high marks in this question gave clear and precise explanations which fulfilled the demands of the question. They used correctly the relation $P = I^2R$ to explain how

electrical energy is saved on transmitting alternating current at a very high voltage. They also used Lenz's law to explain clearly the production of self-induction in the coil. Extract 11.2 shows the response taken from the sample answers of one candidate for illustration.

11a)	It is necessary to do so, so as to ensure loss of power is minimum during transportation. According to the equation:
	$P = I^2 R$, the voltage is inversely proportional to the current. So, high voltage will ensure current is low and hence prevent loss of power during transportation process.
10b)	-> Self Induction is the production of induced emf as a result of changing magnetic flux in the same conduct.
	-> Back emf is the induced current loop that opposes the flow of current in the generator.
	+ According to Lenz's law "The direction of induced emf is such that it opposes the change causing it" then the changing of the magnetic flux produces a current that opposes the production of induced emf. since it flows in both directions (ac generator)
	- The rate of change of magnetic flux is directly proportional to emf production but produces a back emf that opposes it in its direction.

Extract 11.2: A sample of the candidate's good responses in Question 11

Extract 11.2, shows how the candidate was able to answer the question correctly with supportive illustrations and good computational skills. The candidate explained clearly why alternating current is transmitted at high voltage in all parts of Tanzania. He/she applied Lenz's law correctly to explain how the back e.m.f is induced in a circuit.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE

3.1 Candidates' Performance in each Topic

The Physics paper 1 had eleven (11) questions extracted from various topics of Ordinary Level Physics Syllabus for Secondary Education Form I-IV. The analysis of performance shows that two questions, 1 and 2 had good performance. Question 1 set from different topics of *Measurement, Archimedes principle and the Law of flotation, Structure and Properties of matter, Optical instruments, Light, Magnetism, Motion in a Straight Line, Temperature, Friction and Thermal energy* as a Multiple Choice Question had a performance of 84.0 percent. Question 2 was a Matching Item composed from the topic of Radioactivity whose performance was 78.7 percent.

Further analysis has shown that nine (9) out of eleven (11) questions had been poorly performed by the candidates. Stating the performance of the candidates in these questions in the order of decreasing magnitudes, question 10, derived from the topics of radioactivity and Electronics had 28.8 percent. Question 7 set from the topic of Current Electricity had 24.1 percent while question 6 composed from the topic of Thermal Expansion had 15.4 percent.

Likewise, question 5 from the topics of Simple Machines and Newton's Laws of Motion, question 4 from the topics of Pressure and Forces in Equilibrium and question 3 from the topics of Light and Optical Instruments had performance of 12.5, 11.8 and 11.3 percentages respectively. In a similar manner, question 9 constructed from the topics of Electromagnetism and Waves had 10.8 percent, question 8 tested from the topics of Geophysics and Waves had 7.9 percent whilst question 11 assessed from the topic of Electromagnetism was the poorest performed topic of 4.2 percent. From this analysis, few drawbacks were observed to hinder the performance of the candidates. One of the key contributing

factors was an inadequate content knowledge which led the candidates fail to comprehend the demand of the questions, hence provided unwanted responses or irrelevant answers. Another remarkable factor was incompetence in doing questions involving calculations. Most of candidates lacked mathematical skills as they used unacceptable formulae and procedures in attempting the questions. Consequently, lack of English Language Proficiency made some candidates provide responses with full of grammatical errors and lack of logical flow. Another profound effect was lack of drawing skills as many candidates failed to draw the diagrams of the related concepts. A summary of the candidates' performance in different topics is shown in Appendix I.

3.2 Comparison of the Candidates' Performance between 2018 and 2019 in Terms of Grades

The analysis in terms of grades shows that 312 (0.2%) candidates scored an A in 2018 as compared to 436 (0.3%) candidates who scored an A in 2019, being an insignificant rise of 0.1 percent in performance. However, the same amount in percentage of candidates (1.3%) scored a B grade in both years 2018 and 2019. Further analysis reveals that 19,090 (14.4%) candidates scored a C grade in 2018 whilst a number of 16,220 (12.6%) candidates scored the same grade in 2019 indicating a significant drop of 1.8 percent. Consequently, in 2018, 39,366 (29.6%) scored a D grade whereas in 2019, 43,773 (34.1%) scored a D grade showing a substantial decrease of 4.5 percent in performance. Furthermore, the analysis in terms of grade depicts that 72,399 (54.5%) candidates scored a F grade in 2018 as compared to 66,302(51.6%) candidates who scored the same grade in 2019 showing a significant improvement of 2.9 percent. In general, most of candidates scored grades between D and F in both years.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The general performance of Physics paper was average (48.38%). The analysis of the candidates' performance revealed that, candidates faced substantial challenges when attempting the questions. Analytically, it was observed that inadequate content knowledge was one of the major reasons towards poor performance to most of the candidates. In this context, many candidates supplied irrelevant responses with regard to the demand of the

question. Due to lack of knowledge, other candidates skipped some items and left them without answering.

Further analysis has shown that lack of mathematical skills became another impediment to the performance of most of the candidates, particularly to questions that intricate the use of formula and calculations of several steps to reach the required answer. For example, in question 5, candidates were given a Figure with some measurable units each representing a specific implication and required them to calculate the efficiency of machine B. Because of poor knowledge and mathematical skills, they failed to interpret the Figure with their corresponding units of various physical quantities and hence, applied improper mathematical formula and ended up with incorrect answers.

Consequently, poor English Language ability caused some candidates fail to provide responses with free grammatical errors and logical flow. The candidates with a problem of English Language communication skills failed to give the details of the required concept. For instance, question 8 which required them to briefly explain why the inner core of the earth is solid while the outer core is liquid in the topic of Geophysics some failed to explain in details. Also, in question 9 (b) which asked why a musician must retune a stringed instrument if its temperature changes? In these questions, candidates with problems of English Language communication barrier failed to organize their responses and hence scored low or no marks.

Another factor that led to poor performance to some of the candidates was lack of drawing skills. For example, in question 7, candidates were required to use a diagram in order to explain the function of a fuse in electrical appliance. However, they lacked the art of drawing as they failed to draw the structure of the fuse though it is mostly used in normal domestic appliances like in a three-pin plug. Some drew it correctly but failed to indicate its well labelled parts. Most of them were absolutely unable to draw it and hence failed to provide its function.

4.2 Recommendations

For future improvement of the performance of the candidates, it is recommended that:

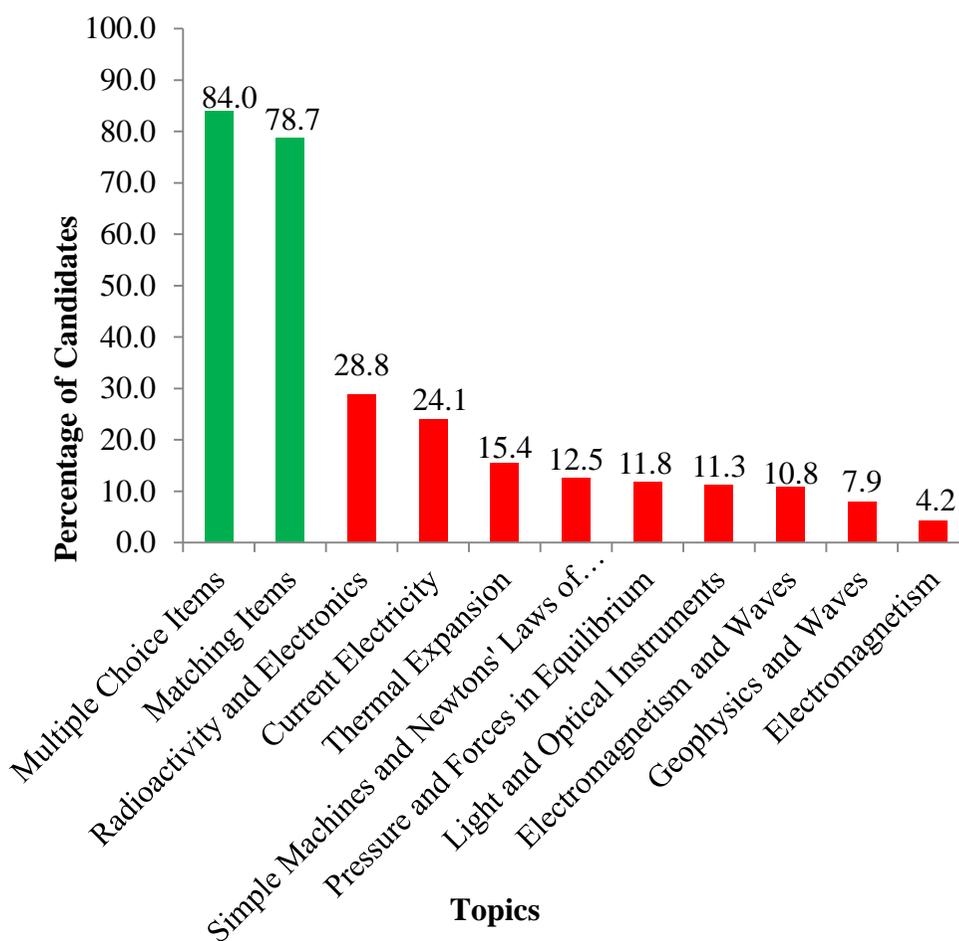
- (a) Teachers should lead students to demonstrate dispersion of white light using a prism. Similarly, they should divide them into groups and discuss the deviation of colours of the white light by using source of white light, triangular prism and a screen. Consequently, students should be guided to describe the mode of action of the lens camera, the structure of the human eye and their distinctive features through question and answers techniques by using a lens camera and a model of the human eye.
- (b) Teachers should guide the students through investigation to apply the principle of moments in daily life by using see-saw, beam balance, metre rule, string and variety of masses.
- (c) Teachers should lead students through think-pair-share to determine the mechanical advantage; velocity ratio and efficiency of inclined plane by using inclined plane, ladder and heavy load. They should also lead students through question and answer technique to describe the concept of acceleration or retardation by using trolleys, ticker-tape-timer and velocity-time graph.
- (d) Teachers should guide students to carry out an experiment to investigate the variation of density with temperature when water is warmed from -5°C to 15°C by using thermometer, ice and graph paper and other related concepts in thermal expansion of different substances.
- (e) Teachers should display different types of fuses and guide students to demonstrate the melting of a fuse wire by loading it and then lead them discuss the properties and functions of a fuse during electrical installations by using copper wire, different types of fuses and fuse wires. They should also guide students to discuss electrical appliance power ratings of heating elements such as electric iron, electric kettle, electric bulbs and TVs.
- (f) Teachers should guide students to discuss and describe the structure and composition of the earth by using the chart of structure of the earth.

- (g) Teachers should guide students to apply Faraday's and Lenz's law of electromagnetic induction to demonstrate the factors affecting the magnitude of induced electromotive force and direction of induced current using a coil and bar magnet.
- (h) Teachers should finish or cover the syllabus on time and provide adequate assignments to their candidates to make them fit for National Examination.
- (i) Teachers should identify slow learners in each topic and use appropriate ways of guiding them to grasp the concepts in order to reduce the gap between lower and higher achievers.
- (j) Apart from classroom discussions, teachers should use various methods of teaching and learning such as project works, games, physics clubs and study tours or excursions, so as to raise interest of the students in learning physics.
- (k) Teachers should use Table of Specification (ToS) during formative assessment in schools such as midterm tests, terminal, annual and mock examinations to ensure that all cognitive levels from the syllabus are tested.
- (l) Teachers and the students should put emphasis on the observed poorly performed topics in order to improve the performance in future National Examinations.
- (m) Students should be guided to realise that each topic in the syllabus is important therefore during revisions, they should not rely only on topics which have appeared in previous National Examinations. This will made them to avoid skipping some of the questions tested in the examination.
- (n) Students should be encouraged to use English language in their day to day communications in order to build both speaking and writing skills in English.

- (o) Students should be encouraged to put much emphasis on achieving mathematical skills in order to develop their learning and eradicate the problem of doing questions which involve computations.
- (p) Students should learn how to draw different structures and diagrams pertaining to a certain subject matter so as to develop the art of drawing.

Appendix I

THE CANDIDATES' PERFORMANCE IN EACH TOPIC



COMPARISON OF THE CANDIDATES' PERFORMANCE BETWEEN 2018 AND 2019 IN TERMS OF GRADES

