THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

ANDIDATES' ITEMS RESPONSE ANALYSIS REPORT FOR THE CERTIFICATE OF SECONDARY EDUCATION EXAMINATION (CSEE) 2017

031 PHYSICS

THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

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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 gives a picture of 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.

This candidates' items response analysis report in Physics subject for CSEE, 2017 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 shown 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, inability to follow instructions, lack of mathematical skills and inadequate knowledge of the topics. The recommendations provided will help the educational administrators, school managers, teachers and students to identify proper ways to be followed in order to improve the candidates' performance in future examinations administered by the Council.

The National Examinations Council of Tanzania will highly appreciate observations and suggestions from teachers, students and the public in general that can be used to improve future analysis reports and candidates' performance.

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 indebted 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), 2017 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.

The paper consisted of three (3) sections, namely A, B and C. Section A comprised three (3) Objective Questions which were drawn from various topics. Section B comprised six (6) Short Answer Questions while section C consisted of two (2) Short Answer Questions. Each question in sections B and C had either two or three parts (a), (b) and/or (c). The candidates were required to answer all questions in sections A and B and one question from section C.

The number of candidates who sat for Physics in CSEE, 2017 was 131,243, of which 42.17% passed and 57.83% failed. In the year 2016 the candidates who sat for this subject were 128,329 of which 44.77% passed and 55.23% failed. This indicates that the candidates' performance in Physics for the year 2017 has dropped by 2.60 percent.

The following 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. The performance is considered to be good, average or weak if the percentage of the candidates who scored from 30 percent or above of the marks allocated to the question laid in the interval of 65-100 (green), 30-64 (yellow) and 0-29 (red) 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. Appendix 1 indicates the general performance in each topic and appendix 2 shows the

comparison of the candidates' performance between CSEE 2016 and 2017 in terms of topics.

Finally, the percentage of performance of the candidates per each topic and the recommendations have been given as feedback to the educational stakeholders for improving candidates' performance in future.

2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE PER QUESTION

2.1 Section A: Objective Questions

This section consisted of three compulsory objective questions each with 10 items. Each question weighed 10 marks with each item carrying 1 mark.

2.1.1 Question 1: Multiple Choice Items

This question consisted of ten items numbered (i) to (x). In each item the candidates were required to choose the correct answer among the five given alternatives lettered A to E and write the letter against the item number. The items were constructed from the topics of Thermal Expansion, Introduction to Laboratory Practices, Motion in Straight Line, Waves, Light, Current Electricity, Elementary Astronomy, and Radioactivity.

The question was attempted by almost 100 percent of the candidates, and their scores were as follows: 41.78 percent scored from 0 to 2.5 marks, 54.52 percent scored from 3.0 to 6.0 marks and 3.70 percent scored from 6.5 to 10 marks. These scores indicate that the general performance of the question was average. Figure 1 summarizes the candidates' performance in this question.

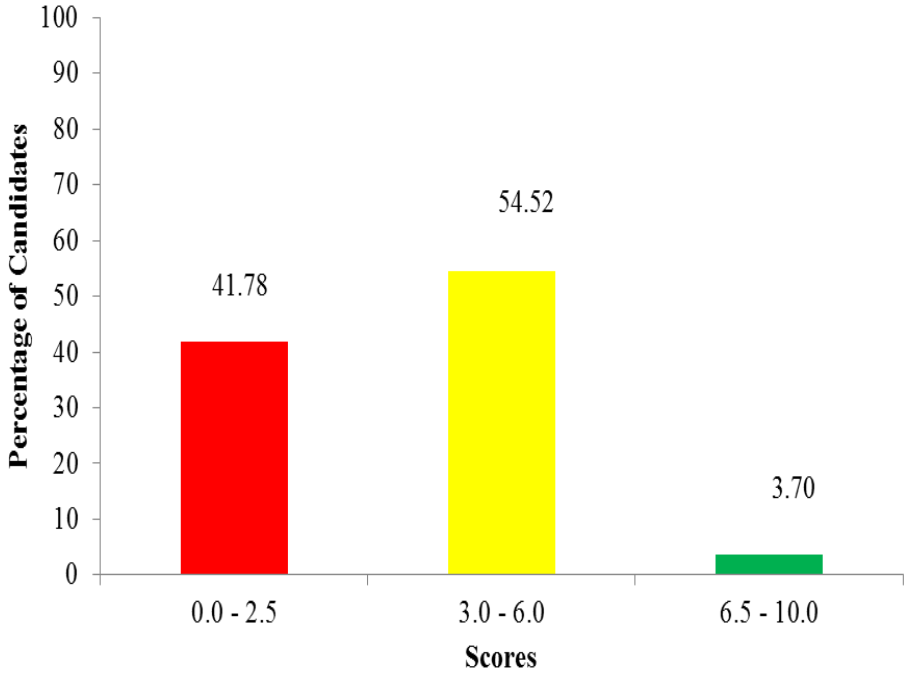


Figure 1*: The performance of candidates in Question 1*

The following is the analysis of the performance of candidates per item:

Item (i) was constructed from the topic of Thermal Expansion of Gases. The candidates were given the initial volume and temperature of the gas as 900 cm^3 and 27^oC respectively, and they were required to choose the alternative which represents the final volume of the gas when warmed at constant pressure to 87^oC. The correct answer was represented by alternative C (1080 cm^3). The candidates were expected to use Charles law to deduce the required volume and identify the letter of the correct response. The candidates' responses on this item showed that some of them selected the correct alternative while others opted for incorrect alternatives. Most of the candidates who failed to choose the correct answer opted for alternative A (900 cm^3). A mathematical computation reveals that the answer in alternative A is obtained when one applies Boyle's law. They failed to realize that Boyle's law is applied at constant temperature and not at constant pressure as stated in the question item. In general, the candidates lacked the understanding of the relationship between volume and temperature of a fixed mass of the gas when pressure is kept constant.

Item (ii) required the candidates to identify the scientific statement which need to be proved through scientific research. The item was constructed from the topic of Introduction to Laboratory Practices. The correct answer for this item was represented by alternative A (Hypothesis). Most of the candidates were able to choose the correct answer but few of them wrote incorrect answers as they were attracted by alternative D (Proposal). This might have been caused by the reason that, both terms hypothesis and proposal are used in research. However, proposal does not need to be proved scientifically. They failed to distinguish between a hypothesis and a proposal in scientific research.

In item (iii) the candidates were required to study the velocity- time graph as depicted in Figure 1 and determine the acceleration of the car. This item was constructed from the topic of Motion in Straight Line.

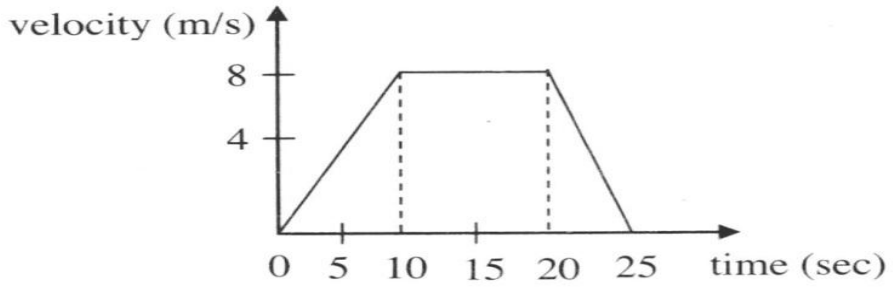


Figure 1

The correct response for this item was A (0.8 m/s^2). Most of the candidates who failed to choose the correct response were attracted by alternative B (0.4 m/s^2). This might be caused by wrong interpretation of initial velocity during the increase of the speed of the car from the given figure. The figure shows that the velocity of 8 m/s corresponds with time of 10 seconds and that the acceleration part of the graph was from the initial velocity, u = 0 m/s up to final velocity, v = 8 m/s when the time taken to reach the maximum height was 10 s. The candidates were supposed to use the first equation of motion, a = (v-u)/t to calculate acceleration 'a' of the car. In general, the candidates failed to interpret the velocity- time graph and to determine the acceleration of the body.

Item (iv) required the candidates to identify the electromagnetic waves having the largest wavelength among the given ones. In order to choose the

correct answer, the candidates were supposed to be acquainted with the ranges of wavelengths of all the electromagnetic waves forming the electromagnetic spectrum. The correct response was D (Radio waves). Most of the candidates attempted this item poorly by choosing alternative C (Gamma rays). It is obvious that these candidates incorrectly associated the tendency of gamma rays to have high penetration power with large wavelength. They were supposed to recall the main bands or the order of arrangement of the electromagnetic waves of the electromagnetic spectrum according to their increasing or decreasing wavelength or frequency which would help them to identify the correct response.

Item (v) required the candidates to choose the name of the device which operates under the principle of total internal reflection of light. The correct answer was represented by alternative D (optical fibre). However, most of the candidates wrote incorrect answers and were highly attracted by alternative C (telescope). This indicates that the candidates were not conversant with the concept of total internal reflection. They did not understand that optical fibre uses the principle of total internal reflection to convey light through a thin glass fibre with very little loss of energy, provided that the angle of incidence is greater than the critical angle. On the other hand, telescope refers to an optical instrument designed to make distant objects appear near, containing an arrangement of lenses, or of curved mirrors and lenses, by which rays of light are collected and focused and the resulting image magnified. The latter does not work under the principle of total internal reflection of light.

In item (vi) the candidates were required to choose the alternative which indicates the current flowing through the bulb when 120 volts were used to light a 30-watt bulb. The correct answer was C (0.25A). Most of the candidates opted for alternative D (4A), indicating that they considered the 30-watt as a resistance of 30 ohms and calculated the current by using the incorrect formula $I = \frac{V}{R}$ which is for the Ohms law instead of using $I = \frac{P}{V}$ and ended up with incorrect answers. These candidates lacked an understanding of the concepts of effects of an electric current in relation to the electrical appliance power ratings.

Item (vii) required the candidates to choose the alternative which represents the electromotive force (e.m.f) of a freshly made lead – acid accumulator.

The correct response was C (2V). This item challenged the majority of the candidates as most of them selected alternative A (1.5 V). It seemed that these candidates regarded the e.m.f of the accumulator as the same as that of a dry cell. The candidates were supposed to understand that the dry cell is a primary cell that provides an electromotive force equal to 1.5 V which sets up a potential difference across the various circuit components thereby driving current through them, while the accumulator is a secondary cell which consists of lead-acid cells and whose plates can develop a potential difference or electromotive force of about 2.0 V.

Item (viii) required the candidates to identify the radiation which can be absorbed by a metal plate among the five given radiations or particles. The correct answer was C Beta (β) particle. Majority of the candidates who chose incorrect responses were highly attracted by alternative B (Gamma rays). This might be due to the tendency of gamma rays to penetrate metals. Therefore, they associated it with absorption. They were supposed to understand that different radiations or particles can be stopped by different materials of varying densities. For instance, alpha particles can be stopped by a piece of paper, beta particles by aluminium metal foil, while gamma rays by lead shields or concrete.

In item (ix), the candidates were required to select the alternative which represents the place in solar system where asteroids are found. The correct answer was represented by alternative C (Between Mars and Jupiter). Majority of the candidates failed to recall correctly the knowledge of astronomy to identify the correct answer. Instead, they selected alternative B (Between Earth and Mars). This might be due to the fact that, they were influenced by an alternative which contained the term earth since asteroids are probably observed from it. They were supposed to remember that asteroids are very small planets that move around the sun between Mars and Jupiter but not between Earth and Mars.

Item (x) was constructed from the topic of radioactivity. It required the candidates to choose the alternative which indicates the fraction of the atoms that would have disintegrated in 72 hours from the element with half-life of 24 hours. The correct alternative was D ($\frac{7}{8}$). Most of the

candidates selected alternative A ($\frac{1}{8}$), implying that, they chose the alternative which represents the fraction of the atoms which remained instead of what disintegrated.

2.1.2 Question 2: Matching Items

This question required the candidates to match the ten **(**10**)** items on list A (phrases) with responses on list B by writing the letter of the correct response beside the item number. The items and the responses were constructed from the topic of Structure and Properties of Matter. The premises and responses of the question are given in the following table.

List A	List B
(i) Ability of liquids to rise or fall in narrow tube	A. Osmosis
(ii) Tendency of an object to fall or drop to lower level in a fluid.	B. Surface Tension
(iii) Capacity of an object to float in a fluid	C. Matter
(iv) Attraction force between molecules of the same substance.	D. Buoyancy
(v) Movement of particles from high concentration to low concentration.	E. Cohesive
(vi) Tendency of matter to be in a state of random motion.	F. Diffusion
(vii) Movement of particles from low to high concentration.	G. Plasticity
(viii) Force which resists a fluid to flow.	H. Brownian motion
(ix) Attraction force between molecules of different substances.	I. Capillarity
(x) Ability of the substance to behave like a fully stretched elastic skin.	J. Viscosity
	K. Adhesive
	L. Elasticity
	M. Sinking

The question was attempted by 100 percent of the candidates, and their scores were as follows: 22.3 percent scored from 0 to 2.5 marks, 32.96 percent scored from 3.0 to 6.0 marks, and 44.74 percent scored from 6.5 to 10 marks. These scores indicate that the general performance of the candidates in this question was good (77.70%). Figure 2 portrays the candidates' performance in this question.

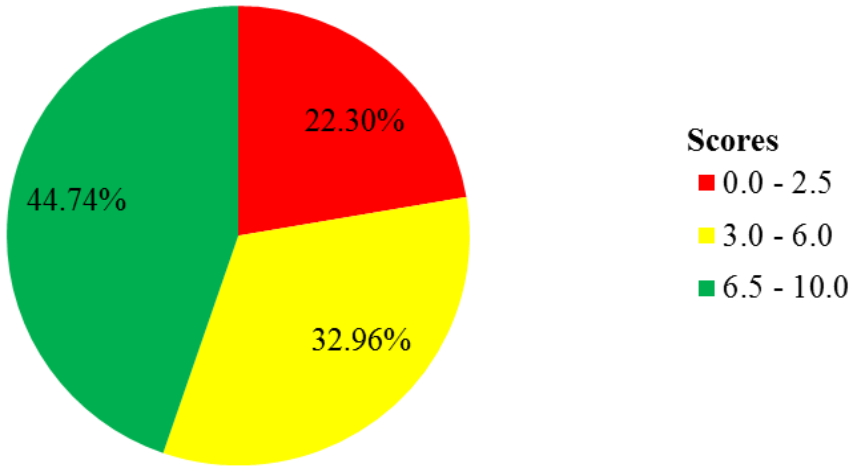


Figure 2: *The candidates' performance in question 2*

The analysis of the performance of the candidates in each of the items in this question is as follows:

In item (i), the candidates were required to provide a suitable response which matched correctly the statement *"ability of liquids to rise or fall in narrow tube"*. The appropriate response was option I which reads *"capillarity"*. Most of the candidates selected response B which reads *"surface tension"*. This might be due to the reason that some phenomena of surface tension show that the surface of the liquid sinks when pressed by even a light insect walking on it and rebounds when the stress is released, hence, the candidates associated it with the fall and rise of the liquid. Their perception was based on the concept on that if an object is placed on the surface of the liquid its weight pushes downwards; causing a deformation which tends to increase the surface area of the liquid and the surface tension resists that increase by pushing upwards on the object. They did not know that surface tension is the ability of the surface of the liquid to behave like a fully stretched elastic skin or membrane but not the rise and fall of the liquid.

In item (ii) the candidates were required to choose the best response which matched correctly with *"tendency of an object to fall or drop to lower level in a fluid"*. Most of the candidates selected the correct response M which reads *"sinking"*. The reason for this might be due to the fact that sinking is a common phenomenon in daily life situations. These candidates were knowledgeable about the context of density that any object with density greater than that of the fluid sinks when placed on it. However, some

candidates who failed to match it correctly opted for response D which reads *"Buoyancy".* The possible reason for this choice is the misunderstanding of the term buoyancy. They were supposed to know that while sinking occurs as a result of a drop or fall of an object to a lower level in fluid, buoyancy provided by the displaced fluid acts upwards.

In item (iii), the candidates were required to find the best response which matched precisely the sentence *"capacity of an object to float in a fluid"*. The correct response was D which reads *"buoyancy"*. A few candidates selected option M which reads *"sinking"*. These candidates failed to differentiate the term sinking from buoyancy and therefore opted for the incorrect response. In general, they lacked knowledge on the law of flotation and failed to distinguish floating from sinking as an integrated part of learning in Structure and Properties of Matter.

Item (iv) required the candidates to identify the correct term which match correctly the sentence *"attraction force between molecules of the same substance"*. The correct response was E *"cohesive"*. Most of the candidates identified the correct answer in this item indicating that they had an insight pertaining to the question item. However, a few candidates were attracted by response K *"adhesive"*. The main contributing factor as to why these candidates got attracted to response K (Adhesive) was that, both cohesive and adhesive forces are intermolecular forces which exist in molecules causing attraction on each other. Besides, they failed to realize that cohesive forces occur between molecules of the same substance, whilst adhesive forces occur between molecules of different substances.

Item (v) required the candidates to choose the response which match correctly the statement *"movement of particles from high concentration to low concentration"*. The correct response was the letter F *"diffusion"*. Most of the candidates got it correctly. However, few candidates who selected the incorrect response were attracted by response A *"osmosis"*. This might be due to the fact that the two quantities are used to describe movement of particles. So, the candidates found it difficult to identify their differences.

In item (vi) the candidates were required to correctly select the response which match with *"tendency of matter to be in a state of random motion".* The correct response was H *"Brownian motion"*. Most of the candidates selected it correctly, although a few candidates failed to give the correct response. Many candidates who selected the inappropriate responses were attracted by letter J, the term *"viscosity"*. These candidates notably, failed

to recall that Brownian motion refers to the random movement of tiny particles suspended in a liquid or gas that occurs as a result of collisions with molecules of the surrounding fluid but viscosity is the internal frictional force which exists in the fluid to some degree to resist the flow of the fluid.

Item (vii) required the candidates to choose the response which match correctly with the statement *"movement of particles from low to high concentration"*. The correct response was the letter A *"osmosis"*. Most of the candidates got it correct. However, few candidates who selected the incorrect response were attracted by response F *"diffusion"*. This might be due to the fact that the two quantities are closely related as both osmosis and diffusion involves movement of particles from low to high and from high to low concentrations respectively.

Item (viii) required the candidates to choose the response which match appropriately the phrase *"force which resists a fluid to flow"*. The correct response was letter J *"viscosity"*. This item was performed well by most of the candidates. However, some of them were attracted by the incorrect response H *"Brownian motion"*. These candidates failed to recall that viscosity involves the resistance to the flow of the fluid but Brownian motion refers to the random movement of particles of matter and not resistance to their motion.

Item (ix), required the candidates to identify the correct term which match correctly with the sentence *"*attraction force between molecules of different substances*"*. The correct response was K which reads *"adhesive"*. Most of the candidates identified the correct answer in this item indicating that they had knowledge pertaining to the question item. However, a few candidates were attracted by response E which reads *"cohesive"*.

Item (x) required the candidates to correctly select the response which match with the phrase *"ability of the substance to behave like a fully stretched elastic skin"*. The correct response was B *"surface Tension"*. This item was poorly performed by majority of the candidates. Most of the candidates selected response L *"elasticity"*. This might be due to the presence of the word elastic in the premises or stem and elasticity in the part of responses which made them to be more attracted to the inappropriate response. These candidates had inadequate knowledge of the

concepts of elasticity and surface tension. They were supposed to know that elasticity refers to the ability of the substance to regain its original shape and size after the deforming forces have been removed, but surface tension is the property of the fluid to behave like an elastic cover or skin on its surface.

2.1.3 Question 3: Fill in the Blank Items

This question consisted of ten items from the topics of Application of vectors, Transfer of Heat Energy, Light, Measurement of Thermal Energy, Electromagnetism, Thermionic Emission, Elementary Astronomy and Waves. In each of the items the candidates were required to fill in the blank spaces by writing the suitable answer for the item in the given answer sheet (s).

A total of 131,204 (100%) candidates attempted this question. The analysis of the data as indicated in Figure 3 reveals that, 58.84 percent scored from 0 to 2.5 marks, 34.53 percent scored from 3 to 6 marks and 6.63 percent scored from 6.5 to 10 marks. Figure 3 shows a pictorial representation of such data.

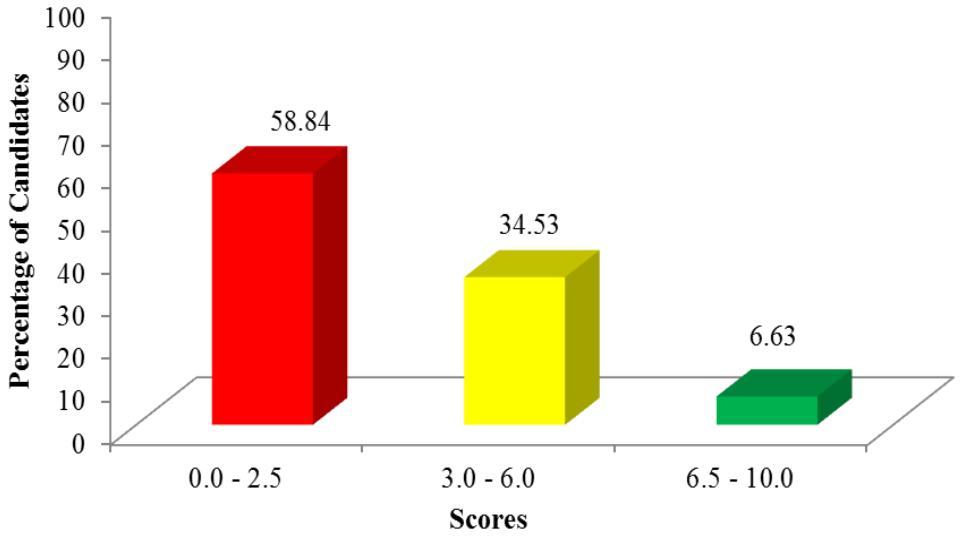


***Figure 3**: The Performance of the candidates in question 3*

The Figure shows that, the total percentage of the candidates who passed this question was 41.16 percent which is an indicator that the question was averagely scored.
Among the factors which lowered the performance of the candidates in this question include lack of physics' vocabularies and inadequate knowledge of the concept tested. For instance, instead of writing the term "Multiplier", some candidates wrote "multiplayer". Only 26 (0.02%) candidates managed to provide correct responses to all of the items in this question. The following is the detailed analysis of the performance of the candidates in each item:

Item (i) required the candidates to write the term used to represent the velocity of the body as noted by a non-stationary observer. It was constructed from the topic of Application of Vectors. The appropriate answer was "relative velocity". The majority of the candidates were able to write the required response for this item indicating that the concept was clearly understood during their learning process. However, few candidates who wrote irrelevant answers lacked adequate knowledge on the concept of relative motion. These candidates were supposed to know that relative velocity denotes measurement of velocity between two objects moving in different frames of reference.

Item (ii) was from the topic of Transfer of Heat Energy. In this item the candidates were required to write the method of heat transfer which does not involve the actual movement of particles from their mean position. The correct response was "conduction". Some of the candidates who failed this item wrote **"**radiation**".** This might be due to the fact that both heat transfers by conduction and radiation do not involve actual movement of particles of the material medium. Moreover, in conduction the particles vibrate about their mean position while in radiation there is no vibration of the particles as heat is being transferred. In addition to that, transfer of heat by radiation does not require material medium but takes place in vacuum.

In item (iii), the candidates were required to give the name of an angle of incidence for which the angle of reflection is 90^{o}. The appropriate response was *right angle or* 90^{o} but most of the candidates wrote critical angle**.** This shows poor concentration of the candidates in reading and interpreting the

demand of the question item. These candidates had the idea about the parameter but failed to recognize that critical angle occurs when at a certain angle of incidence the refracted ray emerges parallel to the boundary between the two media, that the angle of refraction and not reflection is 90^{o}.

Item (iv) required the candidates to write the term used to describe the constant temperature at which solids change to liquids. The appropriate response was *Melting Point*. This question was found to challenge most of the candidates because most of them wrote "latent heat" or "latent heat of fusion". They were misled because latent heat is involved during melting / change of state. The candidates failed to understand the key word 'the point' referred to temperature and not heat. Actually, they interpreted the question erroneously and hence wrote the term used to describe the heat at which the solids change to liquids at constant temperature instead of the required name of the change of state. These candidates ought to know that when matter is heated or cooled it may expand, contract or change its state. The change of state from solids to liquids is called melting. So, the point at which a pure substance melts at a definite temperature is the melting point of that substance.

Item (v) was constructed from the topic of light. The item required the candidates to write the colours which when mixed in a definite ratio yield white colour. The appropriate response was complementary colours. This item was attempted well by most of the candidates, indicating that the knowledge of colour mixing was well understood. However, few candidates who failed to score full marks in this item wrote primary colours. These candidates failed to recall that primary colours cannot be created by mixing other colours.

Item (vi) required the candidates to give the term used to represent the resistor used to convert moving coil galvanometer into voltmeter. The candidates were expected to use the knowledge acquired from the topic of Electromagnetism in conjunction with that of Current Electricity to write the appropriate response. The correct answer was "multiplier". Few of them wrote the correct answer but the majority were found writing "standard resistor", "shunt" or "multiplayer". This indicates that some candidates

possessed the anticipated concept but their answers were affected by spelling mistakes or trial and error approach.

In item (vii) the candidates were required to give the type of rays or particles which the cathode ray tube can be used to produce. The appropriate response was "cathode rays". Most of the candidates were able to write the required response though others wrote "electrons", which meant the same. The candidates who failed to provide the correct response wrote "x-rays". These candidates were supposed to understand that cathode rays are a stream of fast-moving electrons produced in a cathode ray tube but x-rays are electromagnetic radiation produced in x-ray tube when fast moving electrons strike a target like tungsten metal material. Thus, they failed to identify the differences between cathode rays and x-rays and the way they are produced.

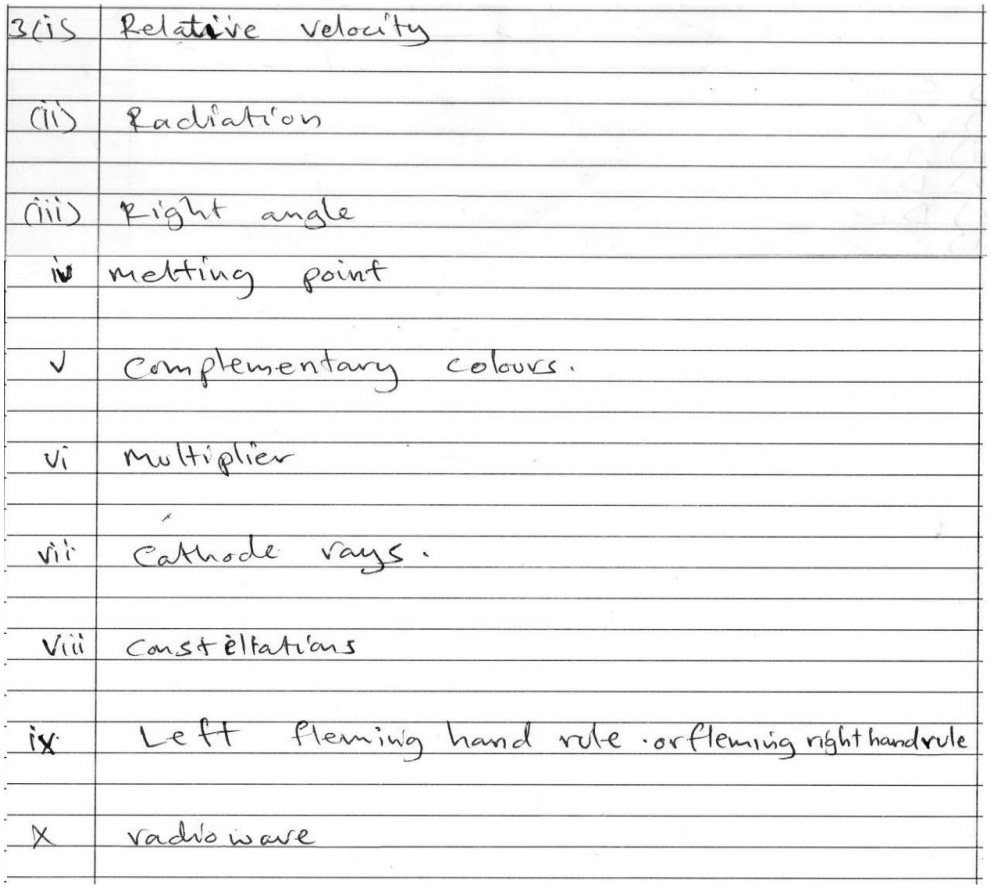
In item (viii) the candidates were required to write the name given to the group of stars that form a definite shape or pattern when viewed from the earth. According to the topic of astronomy the appropriate answer was constellation. The candidates' responses show that most of them wrote the correct answer. However, some of them wrote "galaxy". They failed to realize that the question required a general term used to name the group of stars with definite shape and not the name of a huge group of stars and other heavenly bodies.

Item (ix) was formulated from the topic of electromagnetism. The candidates were required to write the rule which summarizes the relation of force, current and the field being mutually perpendicular to each other. The correct response was either Fleming left hand rule or Fleming right hand rule. The responses of the candidates in this item showed that most of them wrote the correct answer. The candidates who failed to provide correct response wrote Lenz's or Faraday's laws of electromagnetic induction and others left the space without filling anything. This indicates that they lacked knowledge of interpreting Lenz's or Faraday's laws of electromagnetic induction. The candidates who wrote Faraday's law and Lenz's law did not know that, the former relates the magnitude of the induced e.m.f and the rate of change of the magnetic flux linking the conductor while the latter

gives the direction of the induced e.m.f. These laws of Electromagnetic induction do not give the relation of force, current and the magnetic field.

Item (x) was based on the topic of waves and it required the candidates to state the region in electromagnetic spectrum which has the lowest frequency. The appropriate response was "radio waves". This item was responded to poorly by most of the candidates because they either gave incorrect answers or left the unfilled blank space. Furthermore, they failed to tabulate the order of the arrangement of the electromagnetic waves in the electromagnetic spectrum as a guide to identify the correct answer. Extract 3.1 illustrates the response of the candidate who attempted well question 3.

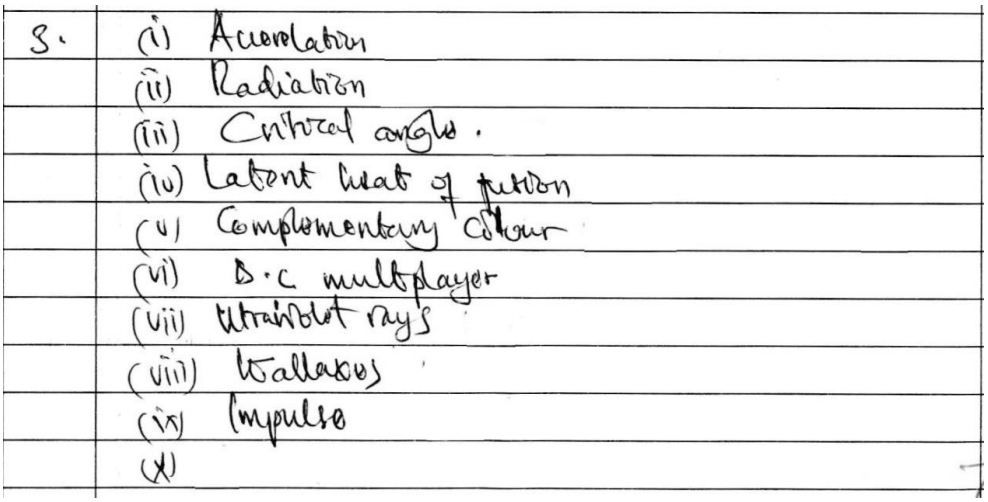
Extract 3.1



In extract 3.1, the candidate managed to provide correct answers to all the items.

Extract 3.2 shows a response of a candidate who attempted question 3 poorly.

Extract 3.2



In extract 3.2, the candidate provided incorrect responses to all the items (i) – (ix). He/she also failed to write the answer for item (x) indicating that he/she had inadequate knowledge of the content examined.

2.2 Section B: Short Answer Questions

This section comprised six (6) compulsory questions each weighing 10 marks. The section contained short answer questions constructed from the topics of Thermal Expansion, Light, Optical Instruments and Simple Machines. The other topics involved were Forces in Equilibrium, Structure & Properties of Matter, and Waves and Electromagnetism. The questions in this section required the candidates to supply their answers by explanation of concepts and or calculations.

2.2.1 Question 4: Thermal Expansion of Solids

This question was constructed from the topic of thermal expansion of solids and had three parts, namely (a), (b) and (c). Part (a) required the candidates to mention four applications of thermal expansion of solids. Part (b) required the candidates to explain briefly why holes are left below the chimney of a kerosene lamp or a kitchen, and part (c) required the

candidates to calculate the temperature with which a steel tyre of diameter 150 cm at 10^{o}C must be heated in order to fit a train wheel of diameter 151cm.

A total number of 131,204 (100%) candidates attempted this question. Only 4 (0.00%) candidates did not attempt the question. A total of 60,458 (46.08%) candidates scored zero. Figure 4 portrays that 67.46 percent scored from 0 to 2.5 marks, 27.5 percent scored from 3 to 6 marks, and 5.04 percent scored from 6.5 to 10 marks. Only 462 (0.35%) candidates scored 10 out of 10 marks. This trend depicts that the question was averagely performed by 32.54 percent.

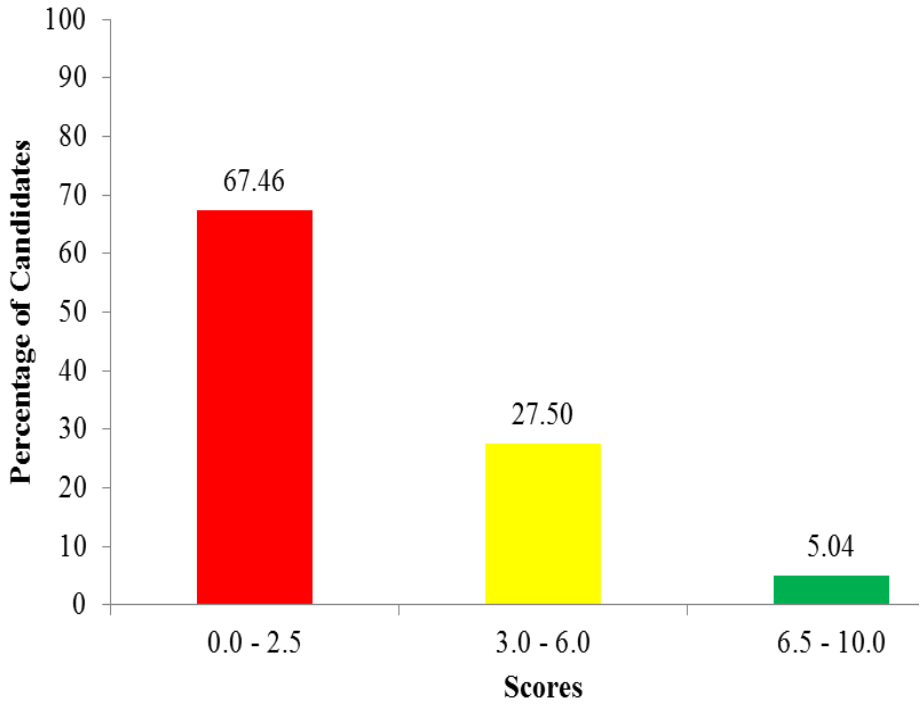


***Figure 4**: The percentage of candidates' performance per score*

The candidates who performed well in this question managed to mention the four applications of thermal expansion of solids and conceptually explained correctly why holes are left below the chimneys of a kerosene lamp or a kitchen. Similarly, these candidates were able to find the temperature to which the tyre should be heated to fit the wheel. Extract 4.1 is an example of a response from a candidate who managed to answer the question well.

Extract 4.1:

4 (a) i/ Construction of roads

ii/ Construction of Bridges

iii/ Used in construction of Roofs of houses

iv/ Used in Construction of Overheading Telephone wires.

(b) Holes are left below the chimneys of Kerosene lamp or Kitchen in order to allow soot to ~~be~~ go away and air to enter in order to support Combustion.

(c) Data Given

Initial diameter (d_0) = 150cm

Initial Temperature (θ_i) = 10°C

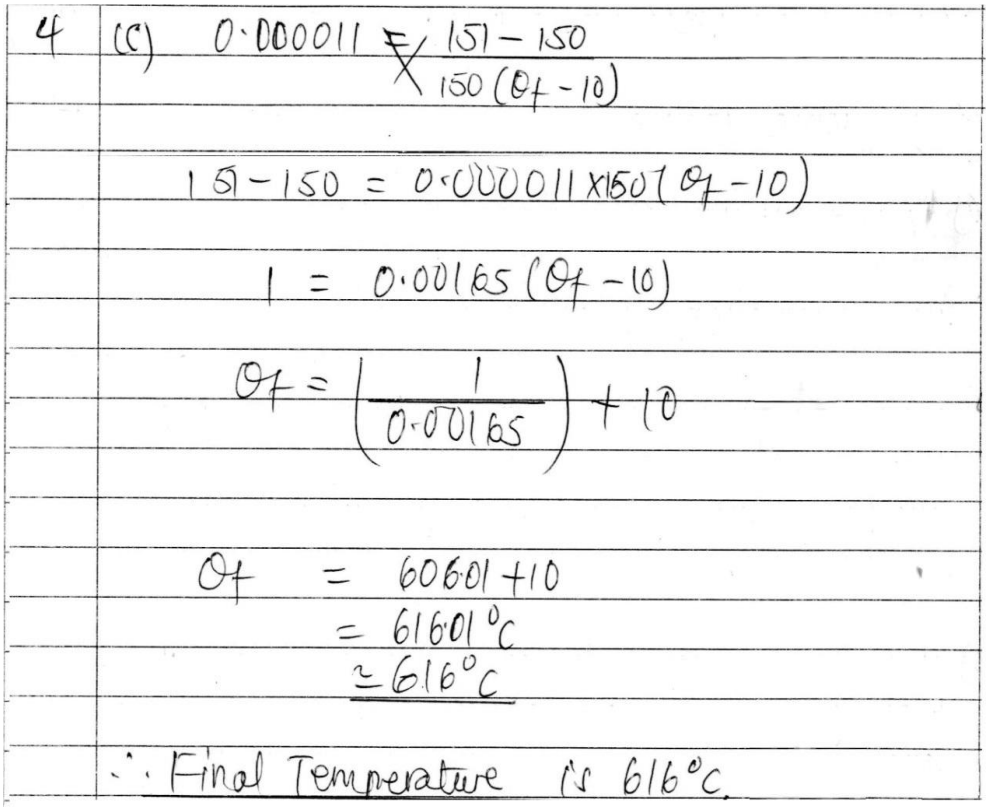
Final Diameter (d) = 151cm

Linear expansivity (α) = 0.000011/K

Required Final Temperature (θ_f) = ?

From

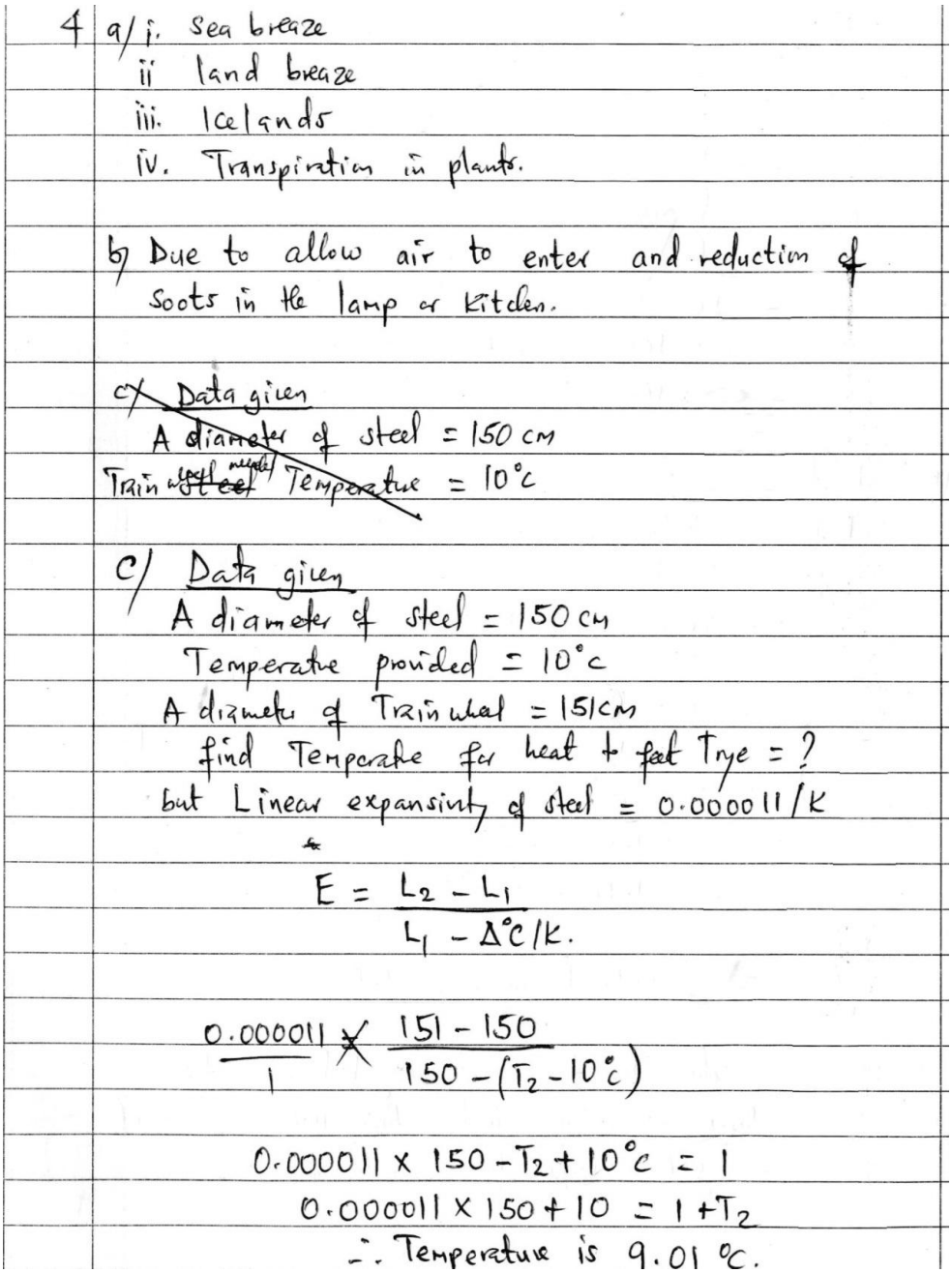
$$\alpha = \frac{d - d_0}{d_0(\theta_f - \theta_i)}$$



In extract 4.1, the candidate provided correct responses to all parts of the question with systematic procedures when performing calculations.

Observation on the responses of the candidates who performed poorly revealed that the factors that affected the performance of the candidates in this question include lack of knowledge on the applications of thermal expansion, inadequate knowledge of the working principle of chimneys, the use of incorrect formula for calculating the temperature which the tyre must be heated to fit the wheel, and incorrect substitution of data during calculation of the temperature. Some of the candidates skipped some items of the question. The candidates were supposed to recognize that the diameter of a train wheel should be greater for the steel tyre to fit in it. They had also to find the change in dimensions (length or diameter) and then apply the correct formulae for the coefficient of linear expansion of a substance to find the final temperature. Extract 4.2 represents the sample answers from one of the candidates with poor responses to this question.

Extract 4.2



4 a/ i. Sea breaze
ii land breaze
iii. Icelands
iv. Transpiration in plants.

b) Due to allow air to enter and reduction of soots in the lamp or kitchen.

c) ~~Data given~~
~~A diameter of steel = 150 cm~~
~~Train wheel Temperature = 10°c~~

c/ Data given
A diameter of steel = 150 cm
Temperature provided = 10°c
A diameter of Train wheel = 151cm
find Temperature for heat + fat Tye = ?
but Linear expansivity of steel = 0.000011/K

$$E = \frac{L_2 - L_1}{L_1 - \Delta^\circ C/K.}$$

$$\frac{0.000011}{1} \times \frac{151 - 150}{150 - (T_2 - 10^\circ C)}$$

$$0.000011 \times 150 - T_2 + 10^\circ C = 1$$
$$0.000011 \times 150 + 10 = 1 + T_2$$
$$\therefore \text{Temperature is } 9.01\ ^\circ C.$$

In extract 4.2, the candidate mentioned applications of thermal expansion in fluids instead of solids. He/she also gave incorrect answer to part (b) and used incorrect formulae in part (c) to calculate temperature.

2.2.2 Question 5: Light and Optical Instruments

This question had two parts (a) and (b). In part (a) the candidates were required to (i) give two reasons why convex mirrors are used as driving mirrors, and (ii) calculate the critical angle for the light emerging from a glass of refractive index 1.50. Part (b) required the candidates to (i) explain how people with short-sighted defect differ from those with long-sighted defect and (ii) calculate the focal length of a lens when a projector is used to produce a sharp image of an object placed at a distance of 120 cm from the screen.

The data analysis shows that 131,207 (100%) candidates attempted this question. Of those, 82.66 percent scored from 0 to 2.5 marks, 15.26 percent scored from 3 to 6 marks, and 2.08 percent scored from 6.5 to 10 marks. These data are presented in Figure 5 and indicate that the question was poorly performed.

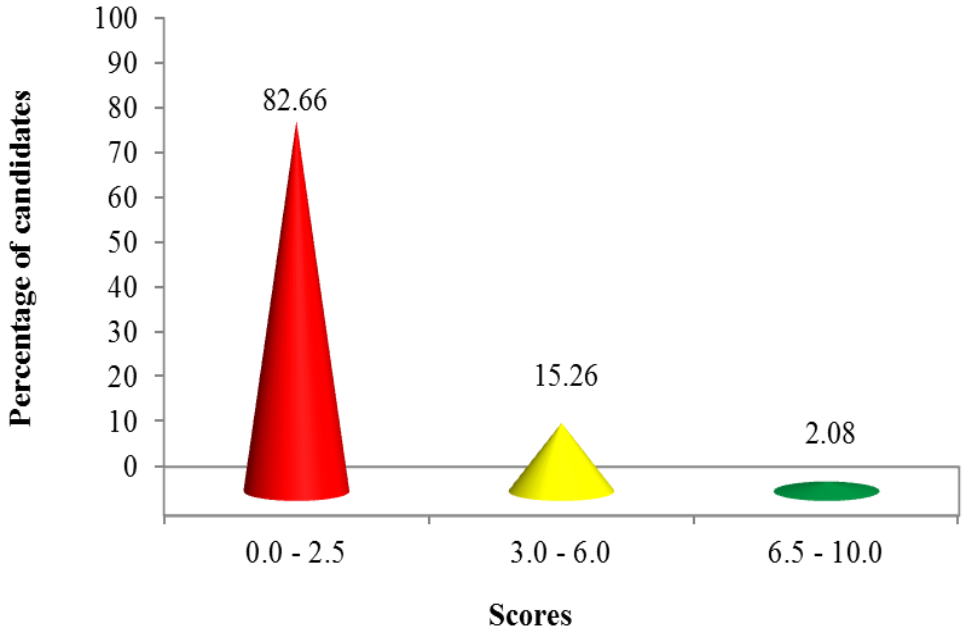


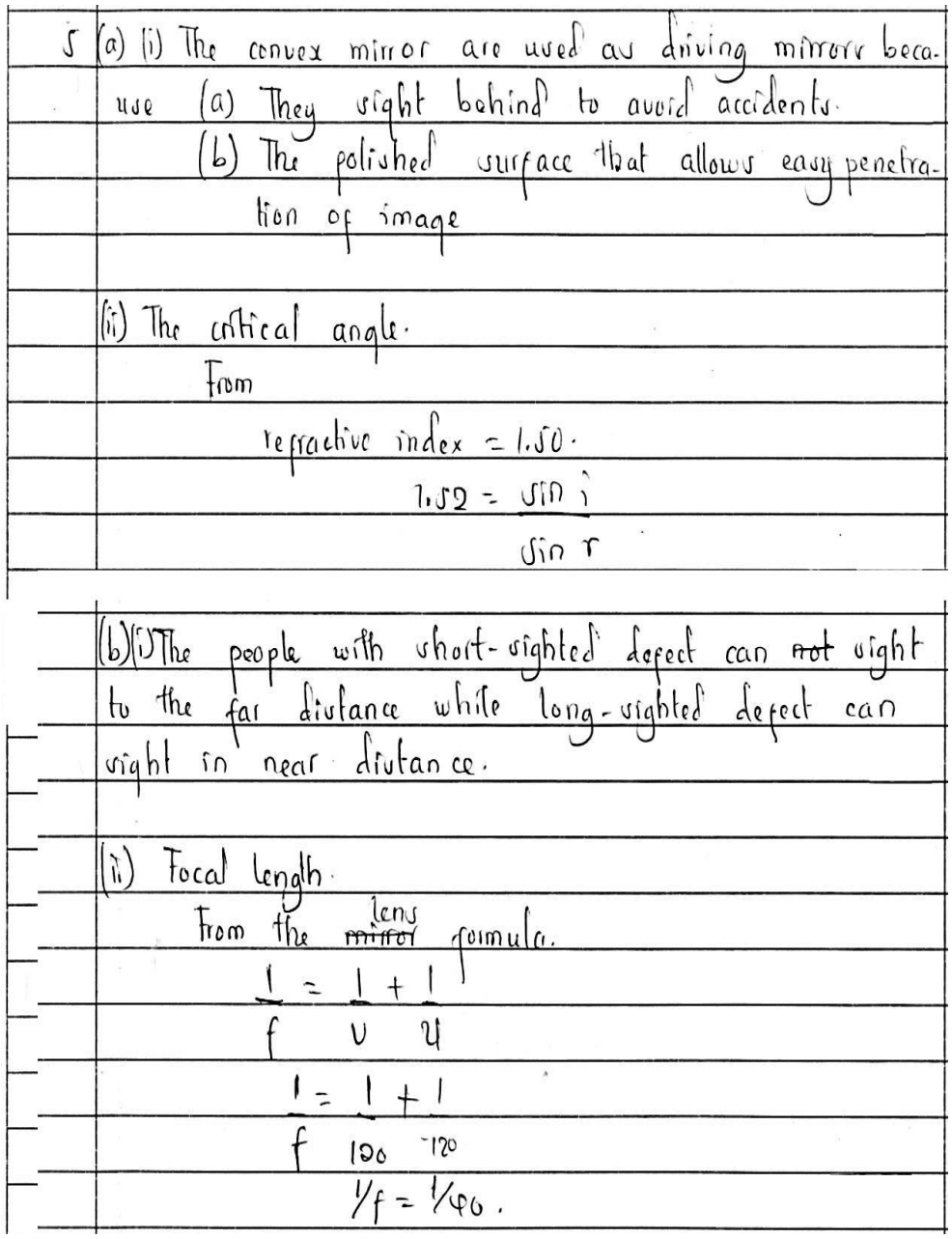
***Figure 5**: The candidates' performance in question 5*

The candidates who scored low marks failed to explain why convex mirrors are used as driving mirrors. These candidates were supposed to remember that car drivers and other motor vehicle drivers always look through mirrors

to see different objects or other cars behind them. They were supposed to understand that the car side mirrors are made of convex mirrors which produce diminished images but with very wide field of view to see clearly all the objects coming behind them. They also failed to calculate the critical angle for the light emerging from a glass of refractive index 1.50, showing that they lacked the concept of the critical angle and how to deal with it mathematically. They were required to know that the sine of the critical angle equals to the reciprocal of the refractive index of the material medium.

Conversely, the majority of the candidates were not able to explain how people with short-sighted defect differ from those with long-sighted defect. They also failed to apply the lens formulae to calculate the focal length of a lens when a projector is used to produce a sharp image of an object placed at a distance of 120 cm from the screen provided that the linear magnification of lens was assumed to be 5. In general, these candidates failed to provide logical reasons on the questions which required explanation and carried out incorrect computations in parts which demanded calculations. Most of them failed to complete some parts of the questions indicating that they had inadequate knowledge required to answer this question. Extract 5.1 shows a sample answer of one of the candidates who failed to give the correct answers to the question.

Extract 5.1


5 (a) (i) The convex mirror are used as driving mirrors because (a) They sight behind to avoid accidents.
(b) The polished surface that allows easy penetration of image

(ii) The critical angle.
From
refractive index = 1.50.
$1.52 = \frac{\sin i}{\sin r}$

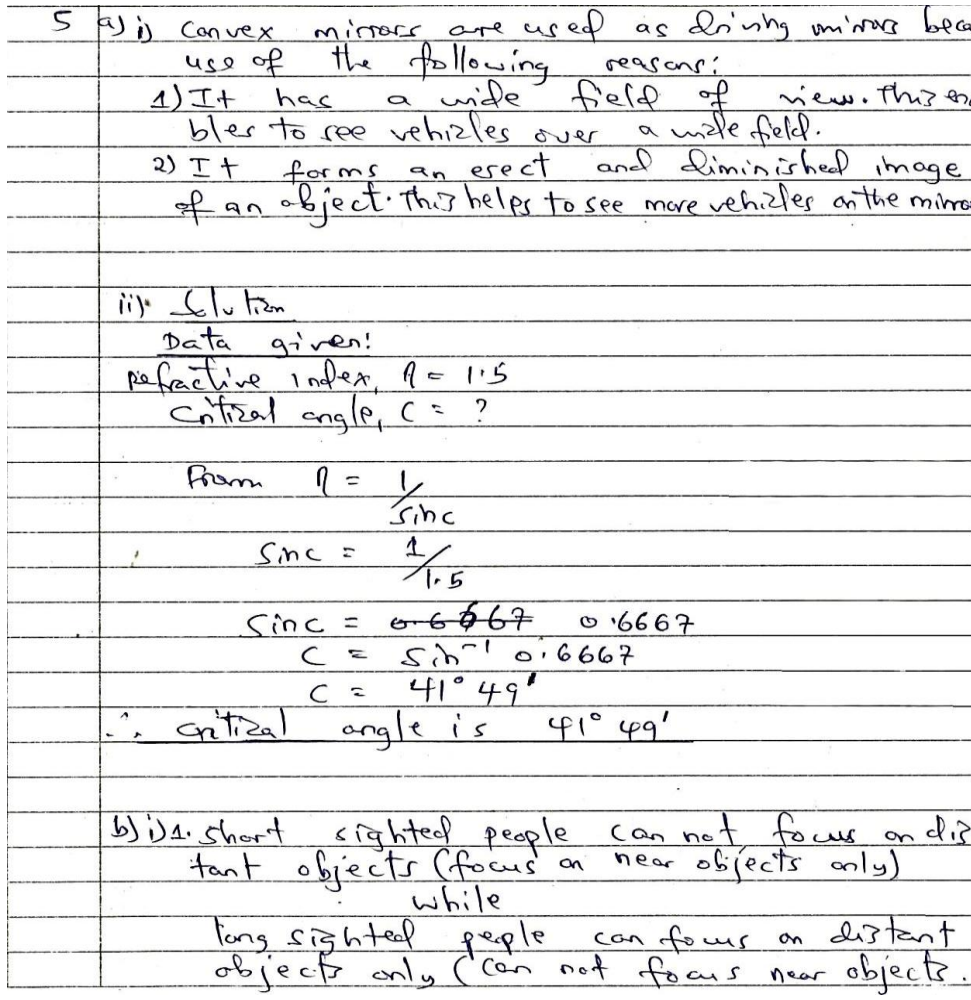
(b)(i) The people with short-sighted defect can ~~not~~ sight to the far distance while long-sighted defect can sight in near distance.

(ii) Focal length.
From the ~~mirror~~ lens formula.
$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$
$\frac{1}{f} = \frac{1}{120} + \frac{1}{-120}$
$1/f = 1/60.$

In extract 5.1, the candidate failed to use proper terms/words to present the answer. For instance, he/she applied appropriate formulae in part (a) (ii) but failed to manipulate the data.

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 assessed. They were able to give reasons for the convex mirrors to be used as driving mirrors. The candidates also applied the appropriate formulae to calculate the critical angle for the light emerging from a glass of refractive index 1.50. Consequently, they managed to differentiate people with short-sighted defect from those with long-sighted defect. Finally, they calculated correctly the focal length of the lens when the projector is used to produce sharp image of an object placed at a distance of 120 cm from the screen. Extract 5.2 is an example of a good response.

Extract 5.2



5 a) i) Convex mirrors are used as driving mirrors because of the following reasons:
1) It has a wide field of view. This enables to see vehicles over a wide field.
2) It forms an erect and diminished image of an object. This helps to see more vehicles on the mirror.

ii) Solution
Data given:
Refractive index, $\eta = 1.5$
Critical angle, $C = ?$

From $\eta = \frac{1}{\sin C}$

$\sin C = \frac{1}{1.5}$

$\sin C = 0.6667$

$C = \sin^{-1} 0.6667$

$C = 41° 49'$

∴ Critical angle is $41° 49'$

b) i) 1. Short sighted people can not focus on distant objects (focus on near objects only) while long sighted people can focus on distant objects only (can not focus near objects.

5 b)i) 2. short sighted people have the long eyeballs.
while
long sighted people have short eyeballs

3. short sighted people corrects their defect using concave spectacles
while
long sighted people corrects their defect using convex spectacles.

b) ii) Solution

Data given:
distance from screen, L = 120 cm
linear magnification, M = 5.
focal length, f = ?

let u = object distance
v = image distance.

$v + u = L$

$v + u = 120$ ---(i)

Also From $M = \frac{V}{u}$

$5 = \frac{V}{u}$

$V = 5u \ldots \ldots (iii)$.

Substituting (iii) in (i)

$v + u = 120$

$5u + u = 120$

$6u = 120$

$u = 20$ cm.

Since $V = 5u$

$V = 5 \times 20$

$V = 100$ cm

From $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$\frac{1}{f} = \frac{1}{100} + \frac{1}{20}$

$\frac{1}{f} = \frac{6}{100}$

$6f = 100$

$f = 100/6$

$f = 16.67$

$\therefore$ focal length is 16.67 Cm.

In extract 5.2, the candidate managed to present correct responses to all items of the question.

2.2.3 Question 6: Simple Machines, Forces in Equilibrium, Archimedes Principle and the Law of Floatation

This question had two parts, namely (a) and (b). Part (a) was constructed from the topics of simple machines and forces in equilibrium and part (b) from the topic of Archimedes principle and the law of floatation. In part (a) the candidates were required to (i) state the peculiar property of the effort in all classes of levers, and (ii) calculate the reaction at the supports of the

metre rule, given that a metre rule of weight 1.0 N was supported horizontally on two knife edges each placed 10.0 cm from the ends of the ruler while the weight of 1.5 N was placed at the mid-point. In part (b), they were required to (i) state the law of floatation and (ii) calculate the fraction of the cork that is partially immersed when a piece of cork of density 0.25g/cm^3 and a mass of 20 g floats in water.

A total of 131,204 (100 %) candidates attempted this question and their scores were as follows: 33.24 percent scored zero, 48.78 percent scored from 0.5 to 2.5 marks, 15.40 percent scored from 3.0 to 6.0 marks, while 2.58 percent scored from 6.5 to 10 marks. The candidates' general performance in this question was weak since only 17.98 percent of the candidates scored from 3.0 to 10 marks while the majority (82.02%) scored from 0 to 2.5 marks. A graphic presentation of these data is as shown in Figure 6.

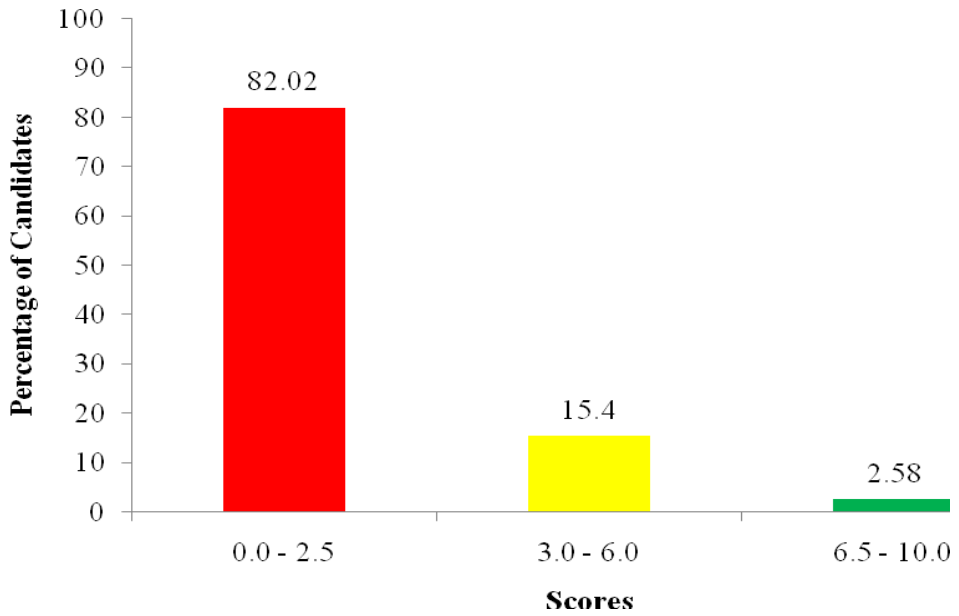
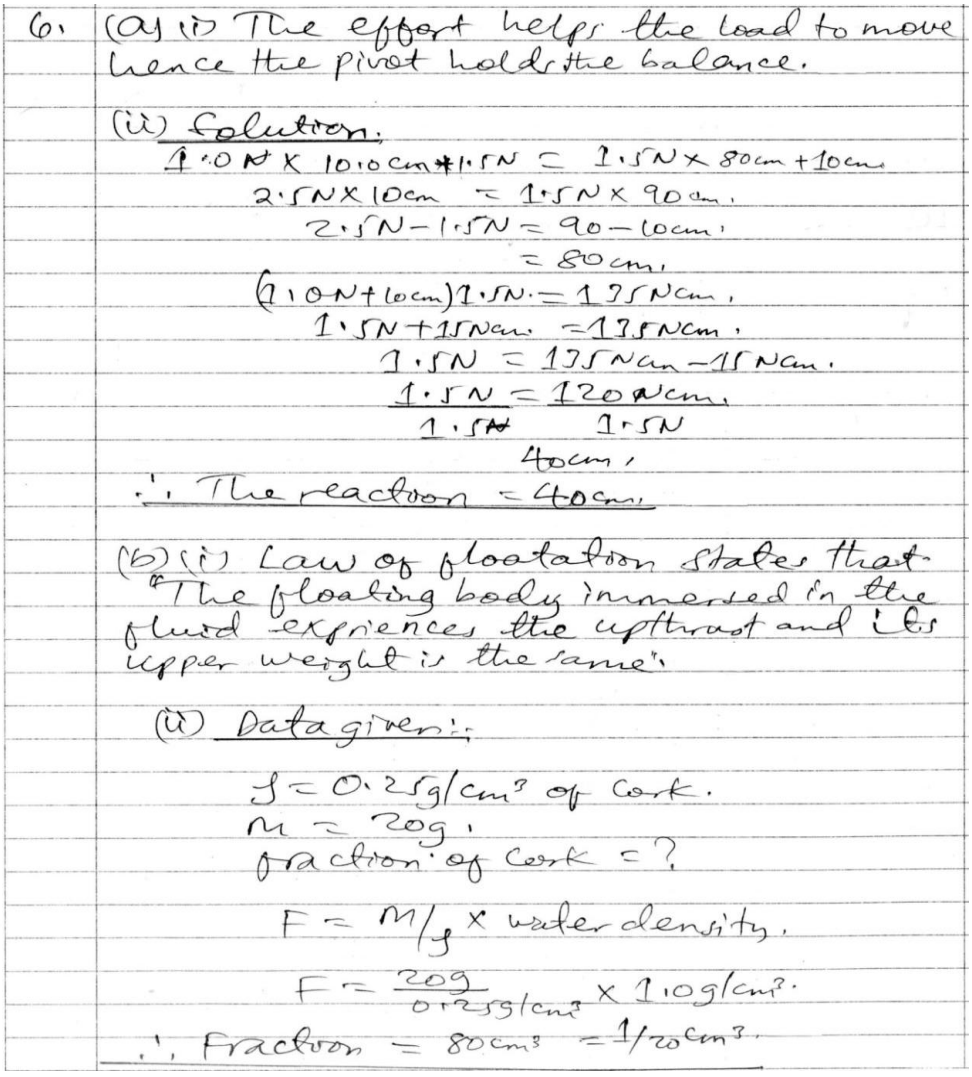


***Figure 6**: Percentage of Candidates' Performance per Score*

The candidates who performed poorly in this question failed to illustrate by diagram the forces acting on a metre rule, identify the clockwise and anticlockwise moments and apply the principle of moment in calculating the reaction at the supports. Other candidates had inadequate understanding

of how Archimedes' principle acts on floating bodies as they failed to use the concepts of upthrust and the law of floatation to get the required answer. These candidates seemed to lack content knowledge as they failed to do either descriptive or numerical parts of the question. For instance, one candidate stated the law of floatation as *the volume of water direct proportional of density of water.* Likewise, the candidate employed irrelevant formulae by writing *Fraction = mass/Density=20 g/0.25g/cm*^{3} *= 0.0008 cm*^{3} to find the fraction of the cork that partially immersed when a piece of cork of the given density and mass floats in water. This candidate did not recognize that the ratio of mass to density is the volume of the substance but not the fraction immersed. In general, the candidates lacked knowledge of how to apply the principle of moments to calculate the reaction at the supports of the metre rule. These candidates also lacked the concepts of Simple Machines especially on classes of levers. Further weakness observed from the candidates was on the use of the Archimedes' principle and the law of flotation to carry out problems involving computations. Extract 6.1 is an example of the responses taken from the script of one candidate who performed this question poorly.

Extract 6.1


6. (a) (i) The effort helps the load to move hence the pivot holds the balance.

(ii) Solution:

1.0N × 10.0cm + 1.5N = 1.5N × 80cm + 10cm

2.5N × 10cm = 1.5N × 90cm.

2.5N − 1.5N = 90 − 10cm.

= 80cm.

(1.0N + 10cm) 1.5N. = 175Ncm.

1.5N + 15Ncm. = 175Ncm.

1.5N = 175Ncm − 15Ncm.

1.5N / 1.5N = 120Ncm / 1.5N

40cm.

∴ The reaction = 40cm.

(b) (i) Law of floatation states that. "The floating body immersed in the fluid experiences the upthrust and its upper weight is the same".

(ii) Data given:

ρ = 0.25g/cm³ of cork.

m = 20g.

fraction of cork = ?

F = m/g × water density.

F = 20g / 0.25g/cm³ × 1.0g/cm³.

∴ Fraction = 80cm³ = 1/20cm³.

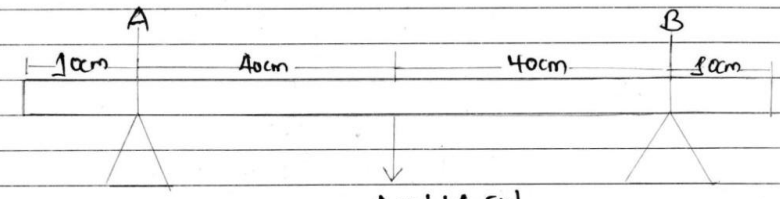
In extract 6.1, the candidate applied inappropriate formula to find the reaction at the supports and incorrectly stated and used the law of floatation to find the fraction of the cork partially immersed in water.

On the other hand, few candidates (17.98%) who answered correctly had good understanding of Simple Machines, Forces in Equilibrium, Archimedes Principle and the Law of Loatation as they were able to illustrate the diagrams and they used the correct formula to calculate the required answers. Extract 6.2 represents one of the good responses to this question.

Extract 6.2

6ai) The effort work to overcome the load in all classes of level.

6a(ii)



From;

Upward force = Downward force

$A + B = 2.5N$ ..... (i)

Taking the moment about point A.

Clockwise moment = $2.5N \times 40cm$

Anticlockwise moment = $B \times 80cm$

But:

Clockwise moment = Anticlockwise moment

$2.5N \times 40cm = B \times 80cm$ ..... (ii)

$B = \frac{2.5N \times 40cm}{80cm}$

$B = \frac{2.5N}{2}$

$B = 1.25N$

But eqn(i) says $A + B = 2.5N$

$\therefore A + 1.25N = 2.5N$

$A = 1.25N$

$\therefore$ The two supports A and B each has $1.25N$

6(a)(i) Law of floatation states that;
"A floating body displaces its own weight of the fluid in which it floats".

6(a)(ii) Given:
Density of cork = $0.25 g/cm^3$
Mass of cork = 20g

Volume of cork = $\frac{\text{Mass of cork}}{\text{Density of cork}}$

$= \frac{20g}{0.25 g/cm^3}$

$\therefore$ Volume of cork = $80 cm^3$

Volume of water displaced = $\frac{\text{Mass of cork}}{\text{Density of water}}$

$= \frac{20g}{1 g/cm^3}$

$\therefore$ Volume of water displaced = $20 cm^3$

But Volume of water displaced = Volume of cork immersed in water

$\therefore$ Volume of cork immersed in water = $20 cm^3$

Fraction of the cork = $\frac{20 cm^3}{80 cm^3}$

$= \frac{1}{4}$

$\therefore$ Fraction of the cork partially immersed in water is 1/4

Extract 6.2 indicates that the candidate was systematic in organizing the concepts, applying the correct formulae, principle and laws to determine the required answers.

2.2.4 Question 7: Structure and Properties of Matter

The question was based on the concept of structure and properties of matter. In part (a) the candidates were required to; (i) state the essential of kinetic theory of matter and (ii) sketch a graph showing variation of applied force with its extension. Part (b) required them to (i) state the Hooke's law and (ii) calculate the load on a scale pan that produces an extension of 16 mm if the scale pan of weight 0.4 N attached on a spring balance produced an extension of 24 mm when a load of 2 N was placed on it.

This question was attempted by 100 percent of the candidates out of which 46.16 percent scored 0 mark, 29.91 percent scored 0.5 to 2.5 marks, 22.0 percent scored 3 to 6 marks, and 1.93 percent scored 6.5 to 10 marks. The pictorial presentation of this data is as shown in Figure 7.

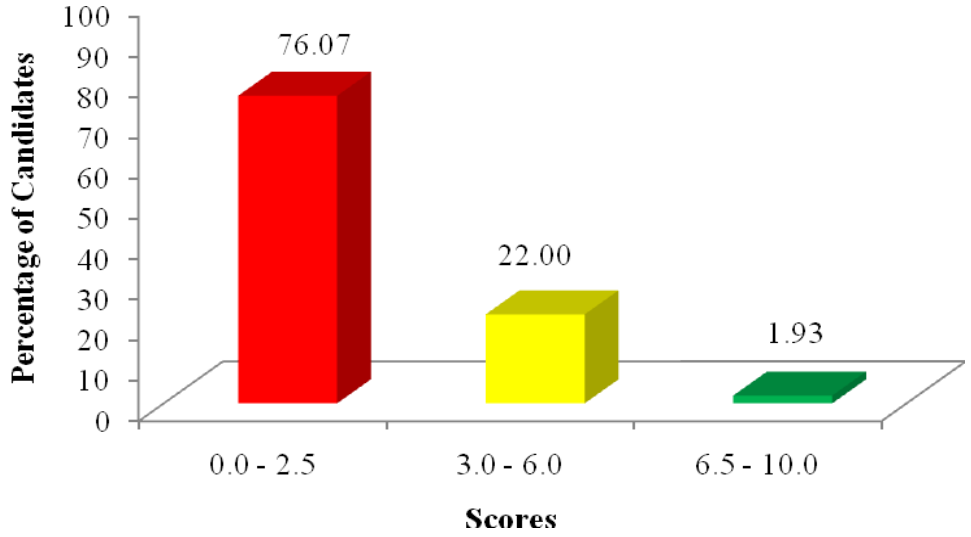
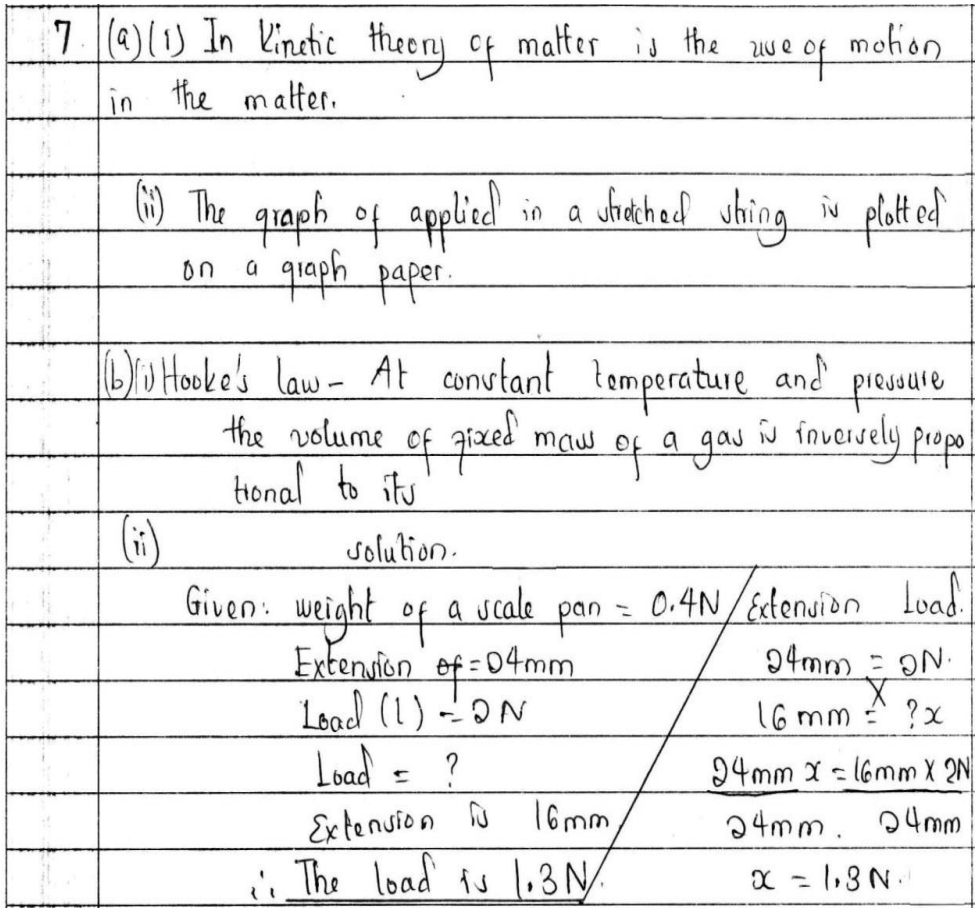


***Figure 7**: The Candidates' Performance in Question 7*

Generally this question was weekly performed by the candidates because majority (76.07%) of them scored 0 to 2.5 marks while only 23.93 percent scored 3 to 10 marks. This was due to lack of knowledge on the concept of structure and properties of matter. These candidates failed to link the essential of kinetic theory of matter with Hooke's law in calculating the load on the scale pan and sketching the graph of force against extension. Some candidates failed to recall Hooke's law. For instance, one candidate stated Hooke's law as *at a constant temperature, the electric current is*

directly proportional to the potential difference across its end. Obviously, this candidate had mixed concepts. He/she did not know that the law stated fits in the concept of Current Electricity for describing the relationship between current and potential difference by Ohm's law. Hooke's law states that there is an elastic limit for the material to be stretched to the extent that they cannot deform. In actual fact, the candidates failed to identify the applications of elasticity in real life and the laws associated with it. Extract 7.1 depicts the case.

Extract 7.1


7 (a)(i) In kinetic theory of matter is the use of motion in the matter.

(ii) The graph of applied in a stretched string is plotted on a graph paper.

(b)(i) Hooke's law - At constant temperature and pressure the volume of fixed mass of a gas is inversely proportional to its

(ii) solution.

Given: weight of a scale pan = 0.4N

Extension of = 24mm

Load (1) = 2N

Load = ?

Extension is 16mm

∴ The load is 1.3N

Extension Load.

24mm = 2N.

16mm = ?x

24mm x = 16mm x 2N

24mm. 24mm

x = 1.3N.

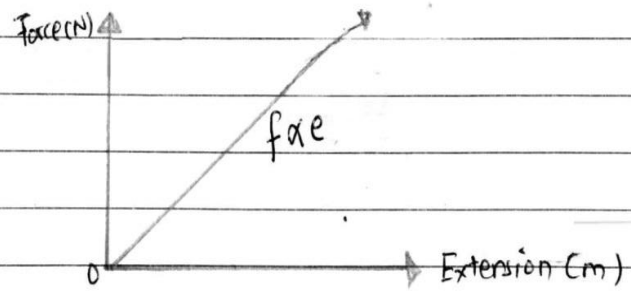
Extract 7.1 shows how the candidate failed to explain the essential of kinetic theory of matter and to apply Hooke's law to find the load on the scale pan. He/she also attempted to state Boyle's law instead of Hooke's law as demanded by the question.

However, the candidates who performed well were able to substantiate the particulate nature of matter and the relation that exists between tension and extension of a loaded elastic material, e.g string. Extract 7.2 is a sample of a good answer taken from the script of one candidate.

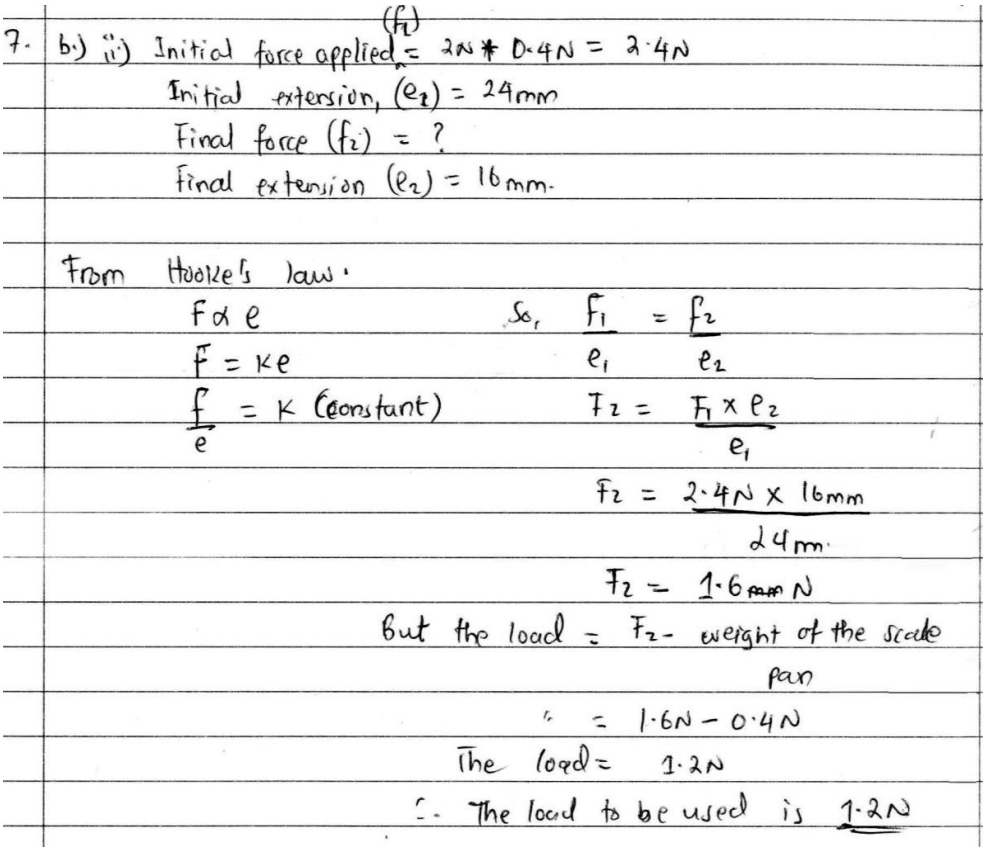
Extract 7.2

7. a) i) Kinetic theory of matter states that "Particles in a matter are in a state of random (continuous) motion".
- This theory is essential in explaining the thermal expansion of solid, liquid and gases.
- Also this theory shows how gases moleaules cause pressure on the container walls.

7. a) ii) A GRAPH OF FORCE APPLIED AGAINST EXTENSION.



7. b) i) Hooke's law states that "The extension of the spring is directly proportional to the force applied, provided that the elastic limit is not exceeded".



In extract 7.2 the candidate correctly gave the essential of kinetic theory of matter, sketched the appropriate graph, stated Hooke's law and computed the exact load.

2.2.5 Question 8: Waves

This question was divided into three parts, namely (a), (b) and (c). Part (a) required the candidates to (i) define the term wave length and (ii) explain how the size of the gap in the barrier affects the diffraction of waves. In part (b), the candidates were asked to (i) state two ways in which visible light differs from radio waves, and (ii) list two applications of gamma rays. Part (c) required the candidates to study carefully the two given figures (Figure 2 and Figure 3) showing how waves travel across water and then to determine the (i) frequency of the waves and (ii) velocity of the wave.

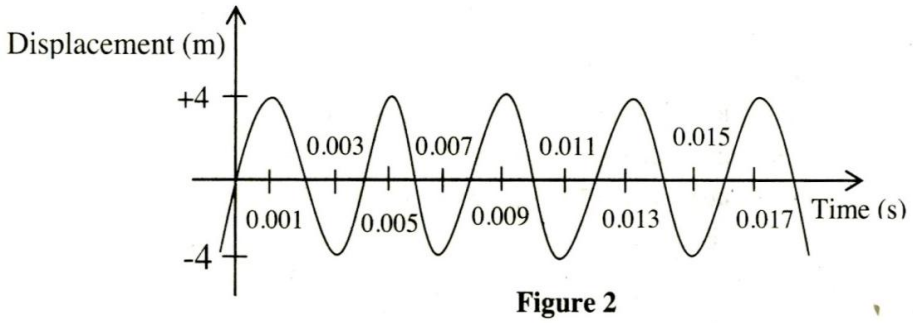


Figure 2

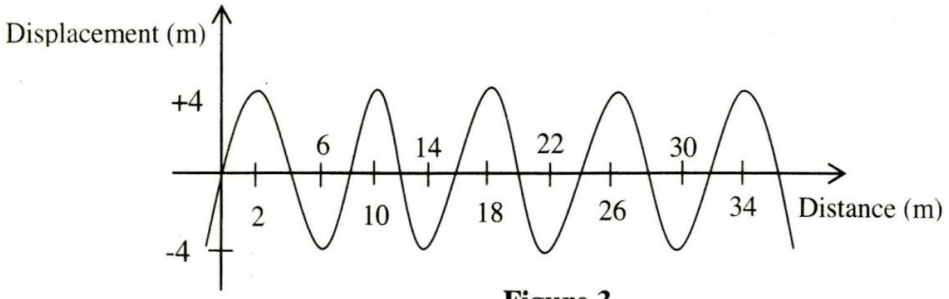


Figure 3

The question was attempted by 100 percent of the candidates of which 34.04 percent scored 0, 42.86 percent scored from 0.5 to 2.5 marks, 19.19 percent scored from 3 to 6 marks, and few (3.91 %) scored from 6.5 to 10 marks. These data imply that the general performance in this question was poor because 76.90 percent of the candidates scored below 3 marks. Figure 8 illustrates the case.

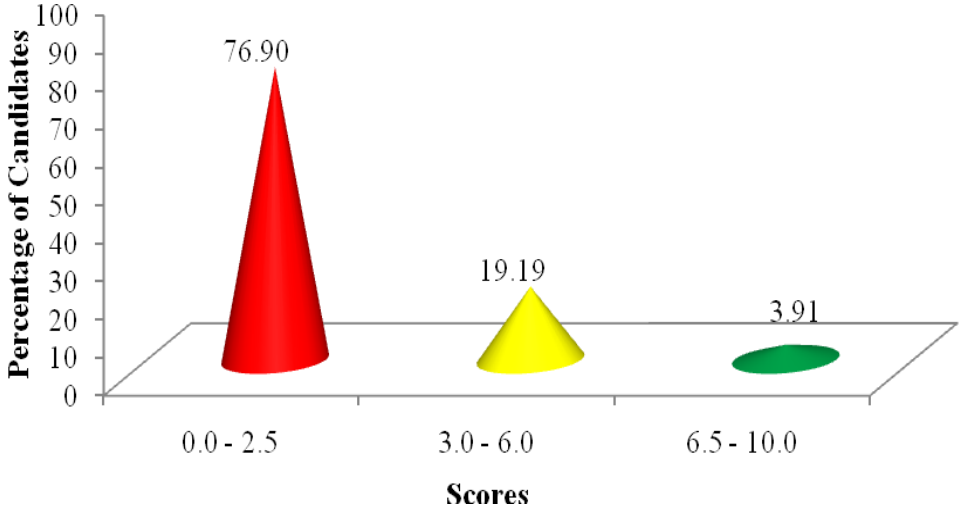
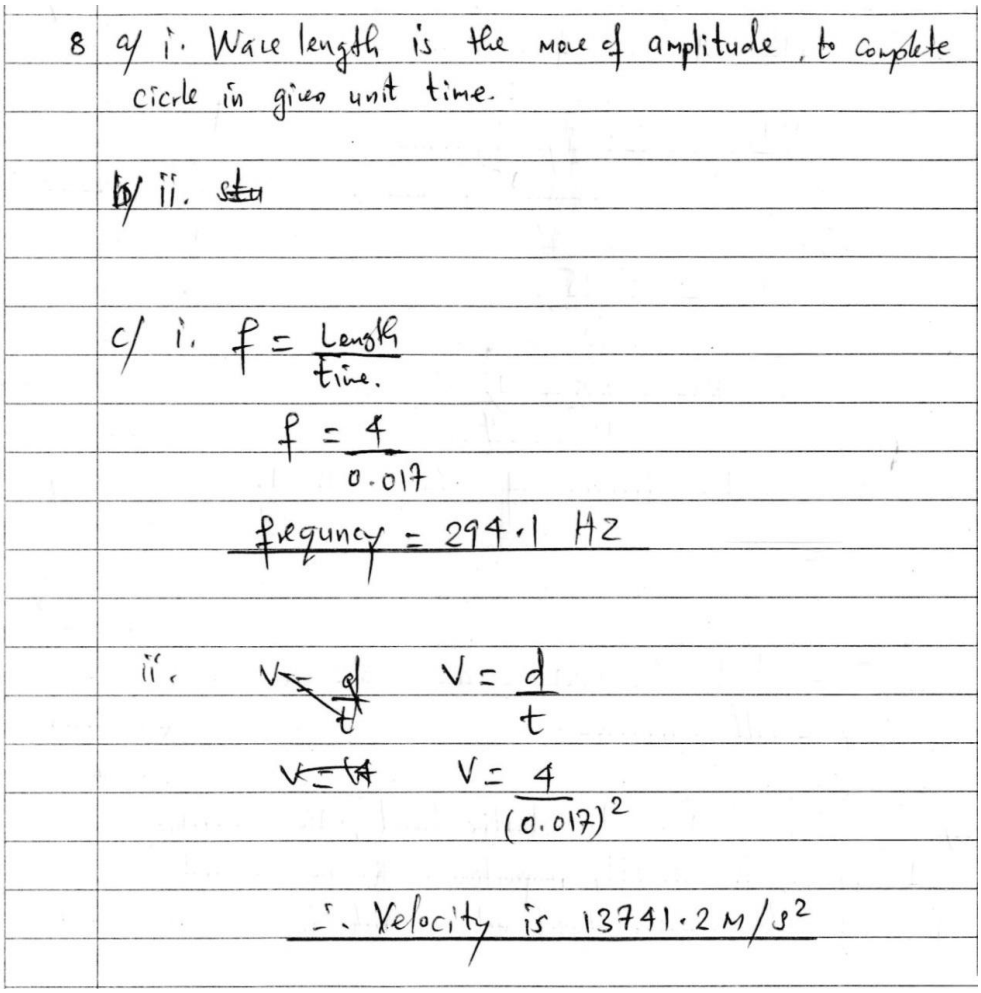


***Figure 8**: The Percentage of Candidates Performance in Question 8*

The reason for poor performance is that some of the candidates failed to identify the behaviour of waves and their applications in daily life situations. They were supposed to know that diffraction refers to various phenomena which occur when a wave encounters an obstacle so that the waves are spread out when they go through the gap. They were further supposed to bear in mind that the extent of the spreading of the waves depends upon the width of the gap in comparison with the wavelength of the waves. They had to recall that diffraction is insignificant if the width of the gap is much more than the wavelength of the waves. The candidates were also not able to state how visible light differ from radio waves. In this category, the candidates were expected to apply the knowledge of the electromagnetic spectrum to give the distinction. They should remember that visible light can be seen and detected by human eyes whilst radio waves cannot be seen by eyes but can be detected by an antennae or aerial. In addition to that, low performance was observed in part (c) where most of the candidates failed to interpret the graphs given in figures 2 & 3 to answer the corresponding questions. This might be due to lack of knowledge on waves parameters as they failed to understand that period is the time taken by the waves to complete one cycle (to be obtained in Figure 2) whose reciprocal gives frequency. Moreover, wavelength of a wave is the distance between two successive crests or troughs (to be obtained in Figure 3) which, when multiplied by frequency, we get velocity of the wave. Extract 8.1 is a sample of poor responses taken from the script of one candidate.

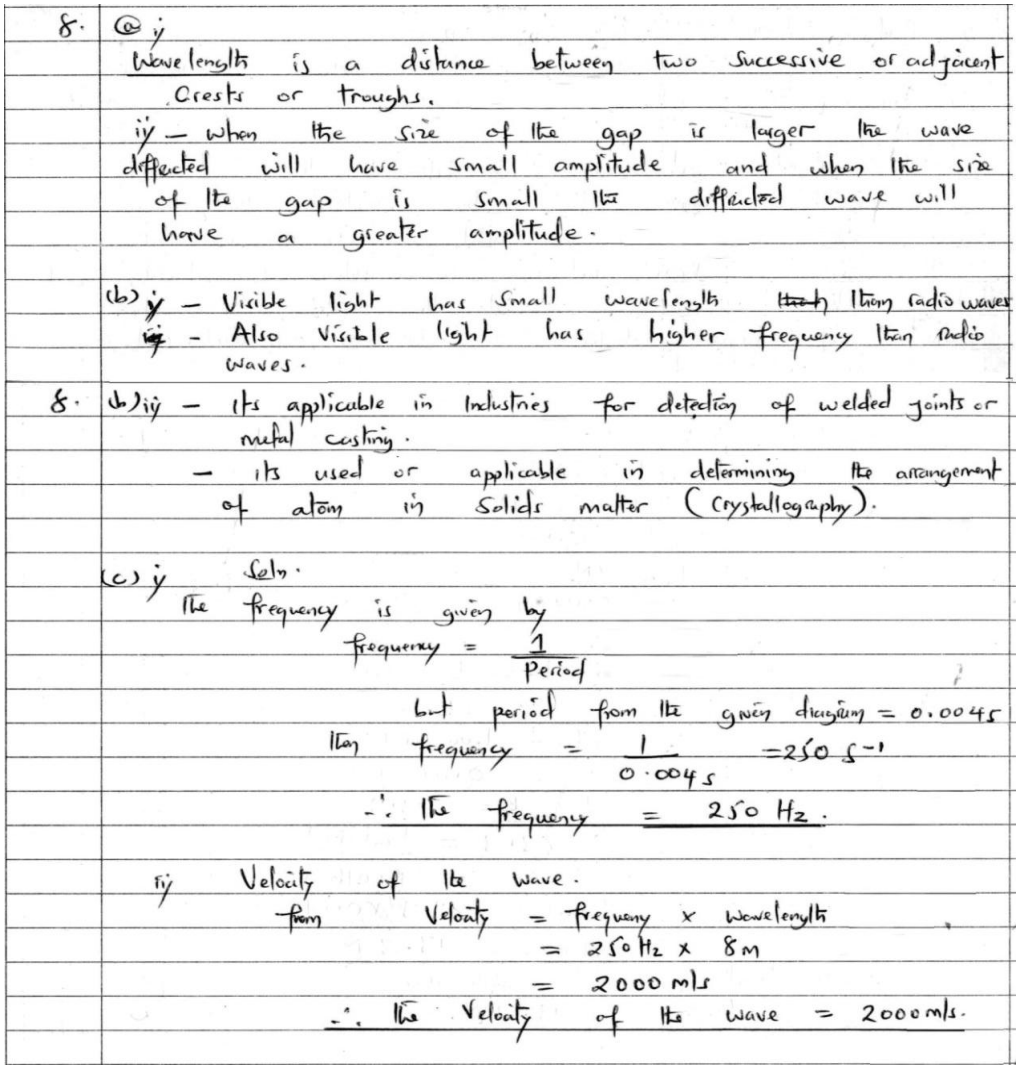
Extract 8.1



In extract 8.1 the candidate wrote an incorrect definition of wavelength and applied an incorrect formula to find frequency and velocity of the wave.

However, few (23.1%) candidates who attempted the question well had shown 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.

Extract 8.2


8. (a) i)
Wavelength is a distance between two successive or adjacent Crests or troughs.
ii) – when the size of the gap is lager the wave diffracted will have small amplitude and when the size of the gap is small the diffracted wave will have a greater amplitude.

(b) i) – Visible light has small wavelength than radio waves
– Also visible light has higher frequency than radio waves.

8. (b) ii) – its applicable in Industries for detecting of welded joints or metal casting.
– its used or applicable in determining the arrangement of atom in Solids matter (Crystallography).

(c) i) Soln.
The frequency is given by
$\text{frequency} = \frac{1}{\text{Period}}$
but period from the given diagram = 0.0045
then frequency $= \frac{1}{0.004\,s} = 250\,s^{-1}$
∴ The frequency = 250 Hz.

ii) Velocity of the wave.
from Velocity = frequency × wavelength
= 250 Hz × 8m
= 2000 m/s
∴ The Velocity of the wave = 2000 m/s.

Extract 8.2 illustrates how the candidate was conversant with the concept of waves and hence presented the work correctly and systematically.

2.2.6 Question 9: Electromagnetism

In part (a) the candidates were required to (i) state the meaning of mutual induction and (ii) illustrate how the right hand grip rule is used to determine electric current and magnetic field directions. Part (b) required the candidates to (i) draw the diagram of direct current (d.c) generator and

show its important parts, and (ii) explain briefly how a simple a.c dynamo can be converted to a simple d.c dynamo.

A total of 131,200 (99.99%) candidates attempted this question and their scores were as follows: 86.67 percent scored from 0 to 2.5 marks, 11.2 percent scored from 3 to 6 marks, and 2.13 percent scored from 6.5 to 10 marks. Generally, the analysis shows that this question was poorly performed by the candidates because only 13.33 percent of them managed to score from 3 to 10 marks. Figure 9 summarizes the candidates' performance in this question.

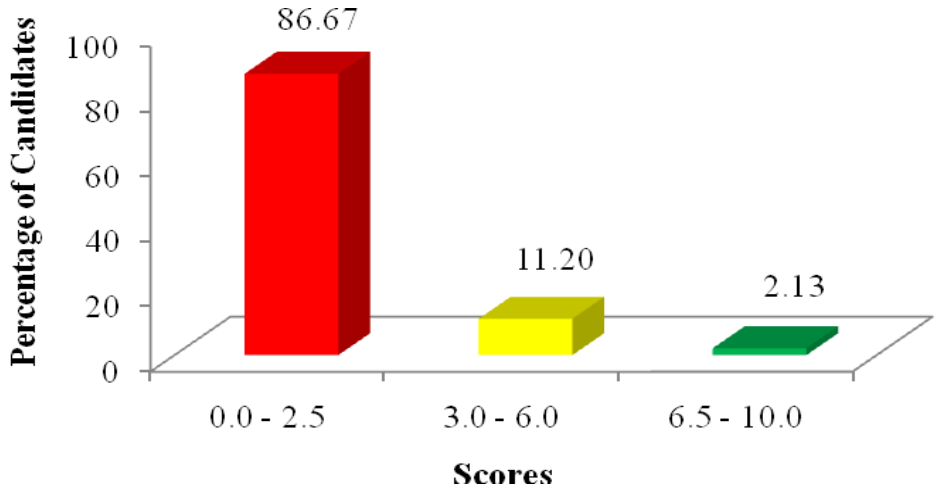
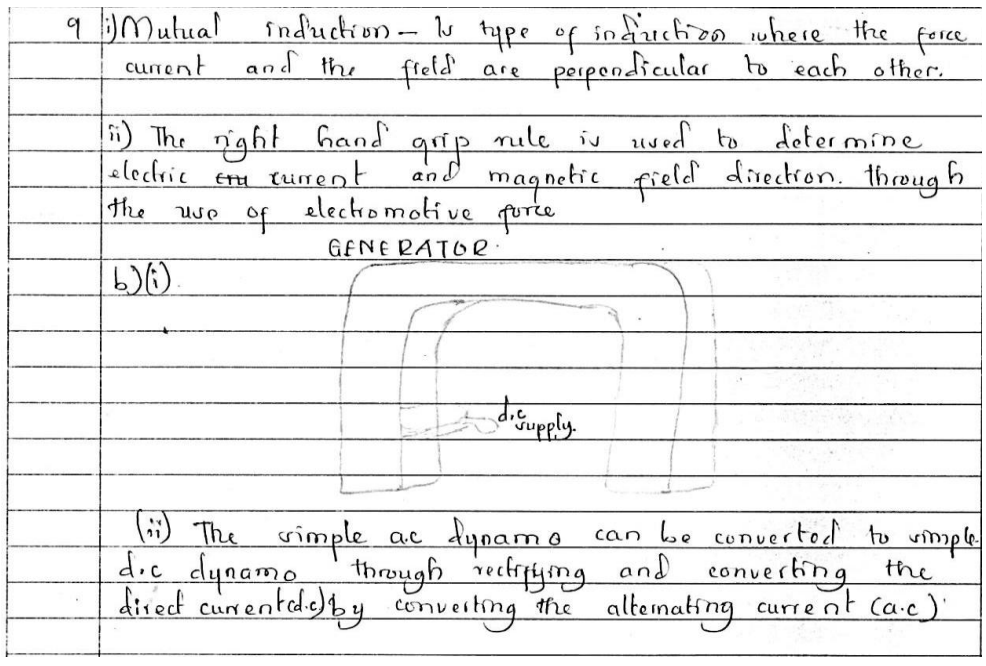


***Figure 9**: A Summary of Candidates' Performance in Question 9*

The analysis of candidates' responses revealed that most of the candidates who performed poorly lacked knowledge of electromagnetism as they failed to explain the concept of mutual induction and to illustrate how right a hand grip rule is used to determine the directions of electric current and magnetic field. In this case the candidates had to understand that if two coils are placed near each other, a varying current in one coil will induce a current in the other, hence a phenomenon called mutual induction. Similarly, if the solenoid is grasped by the right hand in such a way that it points to the direction of current, then the thumb will point to the direction of magnetic field. The candidates also demonstrated poor drawing and labelling skills in drawing the direct current (d.c) generator. In order to be able to draw the the d.c generator, the candidates were supposed to know

the structure or the important parts of the generator, which are a rectangular coil of a wire which is rotated in the magnetic field between the poles of a U-shaped permanent magnet called the field magnet, the carbon brushes, and a single split ring called a commutator or current reverser. This could guide them to draw the d.c generator. Some of the candidates drew and labelled the diagram of the transformer instead of that of the d.c generator. Others drew and labelled the diagram of the cathode ray tube indicating that they lacked knowledge on the content matter. Again, the candidates failed to explain how a simple a.c dynamo can be converted to simple d.c dynamo. To be able to explain the conversion of simple a.c dynamo to simple d.c dynamo, the candidates were supposed to know that if the slip rings and brushes of the simple a.c dynamo are replaced by a single split ring with two diametrically opposed brushes the machine becomes converted into d.c dynamo. In this part of the question one candidate wrote *a simple a.c dyanamo can be converted to a simple d.c dynamo by increasing the number of turns in the primary coil and decreasing the number of turns in the secondary coil*. This candidate provided, one of the factors governing the magnitude of the induced e.m.f in the conductor but not the way a simple a.c dyanamo has to be converted into a simple d.c dynamo. Extracts 9.1 is a sample of candidates' poor response.

Extracts 9.1



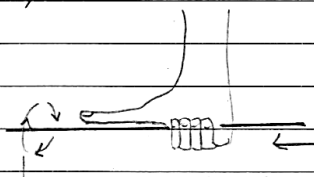
In extract 9.1 the candidate wrote incorrect responses to all parts of the question. For instance in 9 (b) (i) the candidate drew the diagram of a horse (U-shaped) magnet instead of the complete d.c generator.

On the other hand, the candidates who attempted well this question had adequate knowledge on electromagnetism as well as good drawing skills, since they were capable of drawing and labelling diagram of the d,c generator correctly. Extracts 9.2 is a sample of good answers taken from the script of one of the candidates.

Extract 9.2

09. a) i) Mutual induction is the process of inducing e.m.f to a conductor due to magnetic flux change caused by another conductor nearby.
- Mutual induction is used in induction coils.

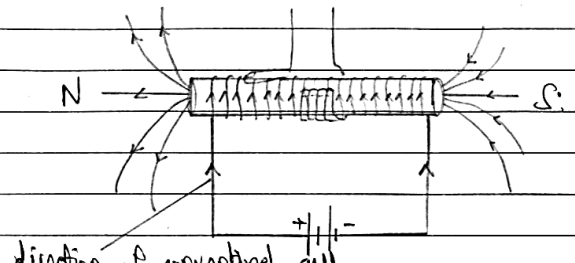
09. a) ii) Right Hand grip rule states,
"Imagine a conductor is gripped by the right hand with the thumb pointing in the direction of the conventional current, then the fingers curling around the conductor show the direction of magnetic fields."
That is;



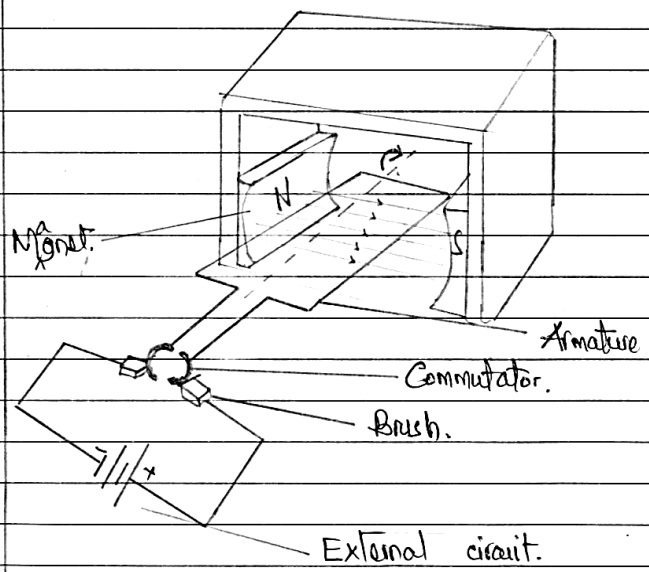
Magnetic field directions

For a solenoid,
"Imagine a solenoid is gripped by the right hand with the fingers indicating the flow of conventional current, then the thum will point in the direction of the North pole of the resulting magnetic field."

09 a) ii, That is,



09. b) i, DIAGRAM SHOWING A D.C. GENERATOR.



09. b) ii, An a.c. dynamo can be converted into a simple d.c. dynamo by replacing the slip rings in the a.c. dynamo with a commutator.

In extract 9.2 the candidate gave the correct concept of mutual induction, illustrated well the right hand grip rule and finally drew a well labelled diagram of the simple d.c generator.

2.3 Section C: Short Answer Questions

This section was comprised of two questions from the topics of Electronics, Thermionic Emission, Electromagnetism and Current Electricity. The candidates were required to answer one (1) question.

2.3.1 Question 10: Electronics, Thermionic Emission and Electromagnetism

This question contained three parts, namely (a), (b) and (c). In part (a), the candidates were required to (i) define the term semiconductors and (ii) explain how intrinsic and extrinsic semiconductors differ from each other. In part (b) they were required to (i) list four properties of cathode rays and (ii) describe how x-ray tube is used to produce x-rays. Part (c) required the candidates to (i) mention three uses of induction coil and (ii) explain briefly the working principle of a bicycle dynamo.

A total of 114,052 (86.92%) candidates attempted this question and had the following scores: 68.77 percent scored from 0 to 2.5 marks, 27.13 percent scored from 3 to 6 marks and 4.10 percent scored from 6.5 to 10 marks. Generally this question was averagely performed with 31.23 percent of the candidates scoring from 3 to 10 marks. These scores are presented in Figure 10 as follows:

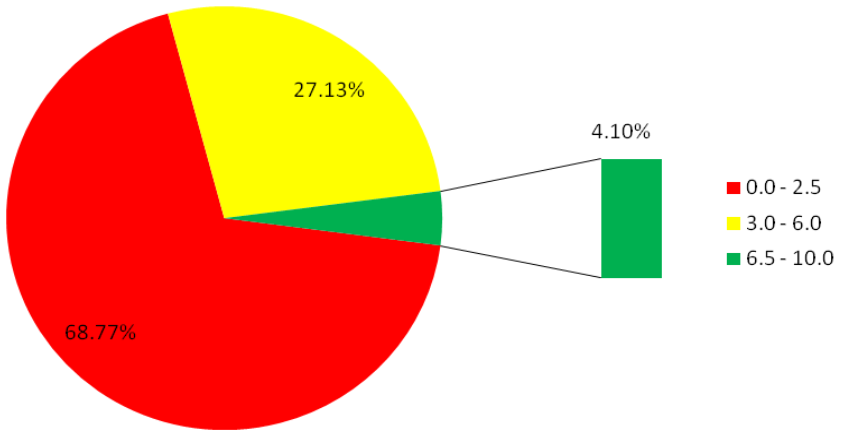
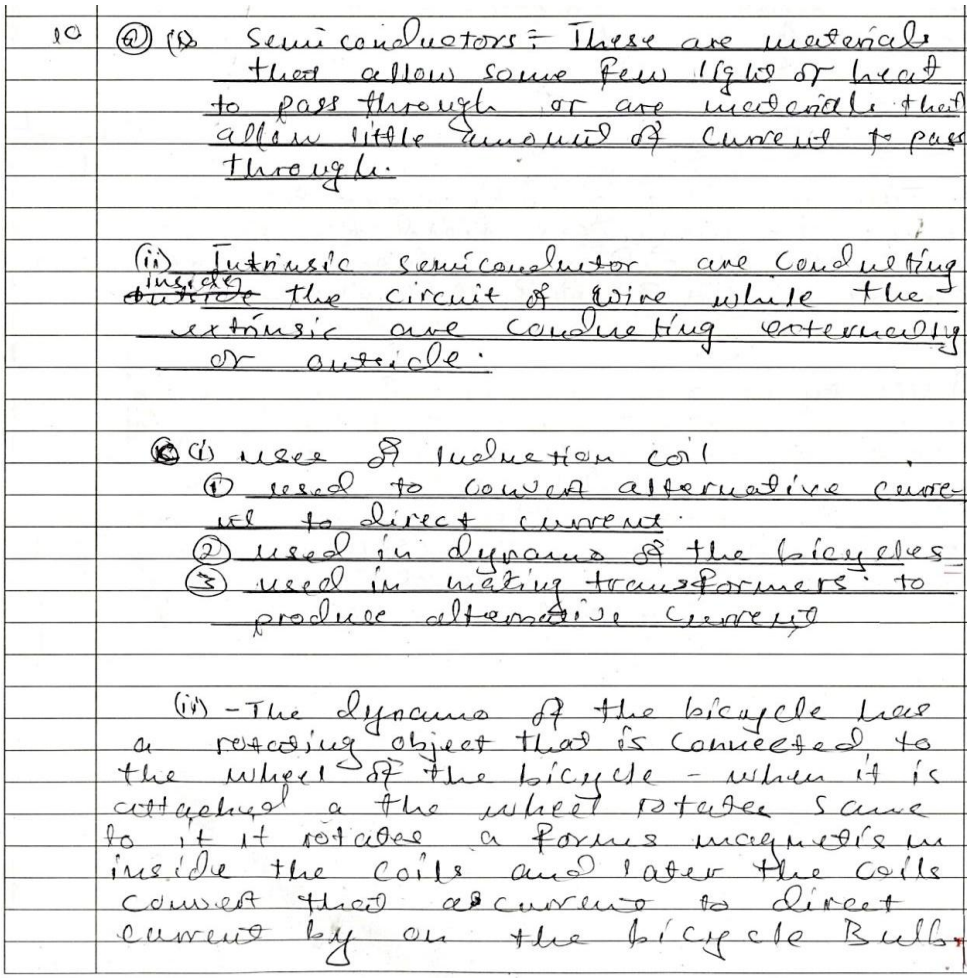


***Figure 10**: Percentage of Candidates' Performance in Question 10*

The question was opted for by most of the candidates, as compared to question 11 which was on the concepts of current electricity. This might be due to the fact that its items were constructed from three related topics and therefore attracted them, but unfortunately the majority (68.77%) 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 in management of physics apparatuses and simple technological appliances as they failed to list the properties of cathode rays and to describe how an x-ray tube is used to produce x-rays. In addition, some of the candidates failed to mention three uses of induction coil, and could not explain the working principle of a bicycle dynamo. Also, many candidates were not able to define semiconductors. For example, one candidate wrote that, *semiconductors is the material which support the slightly conductor of electricity to transfer from one part to another*. This candidate had some knowledge on semiconductors but failed to put it in a meaningful language. The candidates were supposed to define semiconductors as the materials with electrical conductance which are intermediate between those of insulators and conductors. Another candidate gave the properties of cathode rays as *they different in electric feiled, they different in magnetic feiled and they have negative chaqe*. This candidate had some correct concept in mind but failed to present it in proper English. Possibly, the candidate intended to write that, "they are deflected by electric field, they are deflected by magnetic field and that they have negative charge", but poor English language writing skills resulted into loss of marks by this candidate. Also another candidate, when explaining the uses of the induction coil wrote *"production of large alternating current from small direct current, compare two alternating current and production of magnetic field due to simultaneous making and breaking of current"*. The first point seemed to bring about a desired meaning though it has some shortcomings. It could be written as it is used to produce high-voltage alternating current from low-voltage direct current. The candidates were supposed to mention the uses of induction coil as *used in the ignition system of internal combustion engines, to trigger the flash tubes used in cameras and strobe lights and also used in wireless telegraphy*. So, it can be seen that these candidates had absolutely inadequate knowledge on the concept of Induction coil. Extract 10.1 represents the response from a candidate who performed poorly.

Extract 10.1


10 (a) (i) Semiconductors: These are materials that allow some few light or heat to pass through or are materials that allow little amount of current to pass through.

(ii) Intrinsic semiconductor are conducting inside the circuit of wire while the extrinsic are conducting externally or outside.

(b) (i) uses of induction coil
① used to convert alternative current to direct current.
② used in dynamo of the bicycles
③ used in making transformers to produce alternative current

(ii) - The dynamo of the bicycle has a rotating object that is connected to the wheel of the bicycle - when it is attached a the wheel rotates same to it it rotates a forms magnetic in inside the coils and later the coils convert that as current to direct current by on the bicycle Bulb.

Extract 10.1 indicates how the candidate wrote answers contrary to the demand of the question. Semiconductors were incorrectly defined as materials that allow some light or heat to pass through.

On the other hand, the candidates who attempted well this question had adequate knowledge of the concept of energy bands in solids as they managed to define the term semiconductor and described the mode of action of x-ray tube. Others had good understanding on the concept of electromagnetic induction since they were able to describe how the bicycle dynamo and induction coil work. Extract 10.2 illustrate the case.

Extract 10.2

10 (a) (i) Semiconductor is an electrical devices which its electric conductivity lies between insulators and conductors.

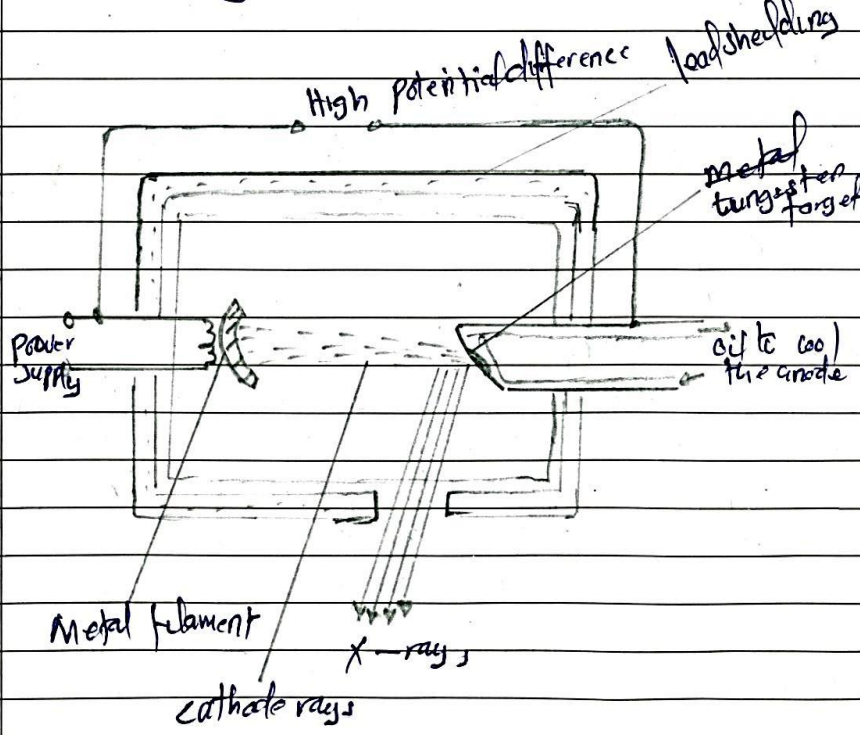
(ii) consider the following table, shows its differences.

intrinsic semiconductor	extrinsic semiconductor
(i) Its conductivity depends on tempera-ture only	(ii) Its conductivity depends on temperature and impurities
(iii) The number of holes and electrons are equal	(iii) The number of holes and electrons are not equal.

1(a)

Intrinsic Semiconductor	extrinsic Semiconductor
(iii) It is pure enough Semiconductor	(iii) It is impure semiconductor
(iv) Its conductivity is not high because the number of hole and electron are equal	(iv) Its conductivity is very high because the number of hole and electron are differ.

1(b) (i) (i) It travels in straight line
(ii) It has negative charge
(iii) It cause fluorescence (glow) when strikes the target
(iv) It has energy and momentum
(ii) Consider the following diagram of the cathode ray Tube



1a(b)(ii) The production of X-rays is done by the metal filament to emmiting cathode rays which goes to strike the tungsten target. When metal filament is heated by the heat from the power supply with high current the metal filament electrons will undergo the Kinetic energy, this cause the metal filament to discharge electrons which goes to strike the tungsten target and X-rays will be produced. There is the high amount of cathode rays emmiting from the metal filament but few of them are converted to X-rays while others are lasted in form of heat energy.

1(c) (i) Induction coil used in internal combustion in the engines
(ii) used in wireless telegraphy.
(iii) Induction coil used to trigger flash used in cameras and strobe lights.

(ii) The working principle of dynamo is to produce induced current by changing the magnetic flux. When the coil rotates in the bicycle dynamo there is cutting off of the magnetic flux linking in the permanent magnets, this cause the current to be induced in the bicycle dynamo by changing or cutting off magnetic flux.

In extract 10.2 the candidate showed good mastery of knowledge on electromagnetism and good drawing skills on the subject matter.

2.3.2 Question 11: Current Electricity

This question had three parts, (a), (b) and (c). Part (a) required the candidates to explain how the increase of length and cross-section area of a conductor affects its resistance. In part (b), they were required to (i) state the function of a circuit breaker in a wiring system and (ii) determine the ratio of resistance of wire A to that of wire B which are made up of the same material if wire A has half the length and twice the diameter of wire B. Part (c) required the candidates to use the 720 W heating units of an electric kettle to determine (i) the current it takes from 240 V mains and (ii) the time taken for the kettle to raise the temperature of 2 kg of water at 30^{o}C to its boiling point.

The question was attempted by 17,166 (13.08%) candidates of which 58.04 percent scored from 0 to 2.5 marks, 31.29 percent scored from 3 to 6 marks, and 10.67 percent scored from 6.5 to 10 marks. Despite the fact that the question was averagely performed, 9,963 (58.04%) of the candidates failed. Figure 11 depicts the performance of the candidates in this question.

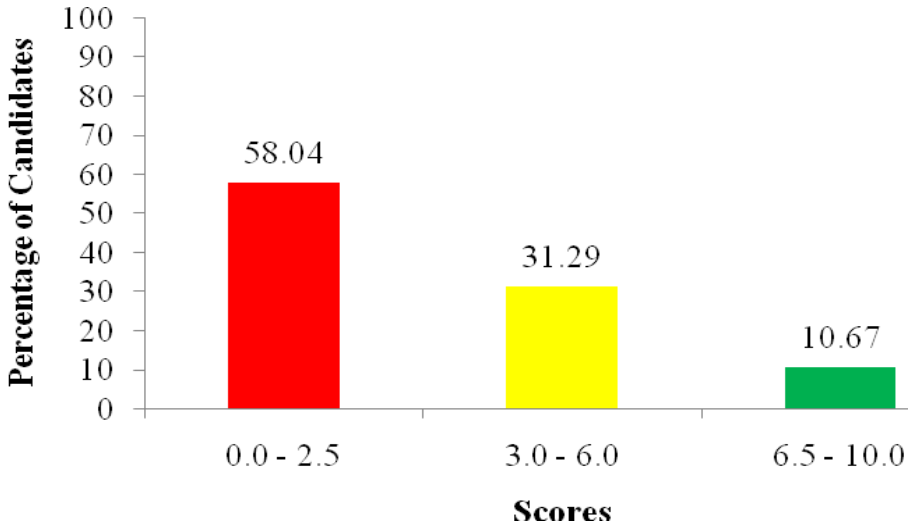
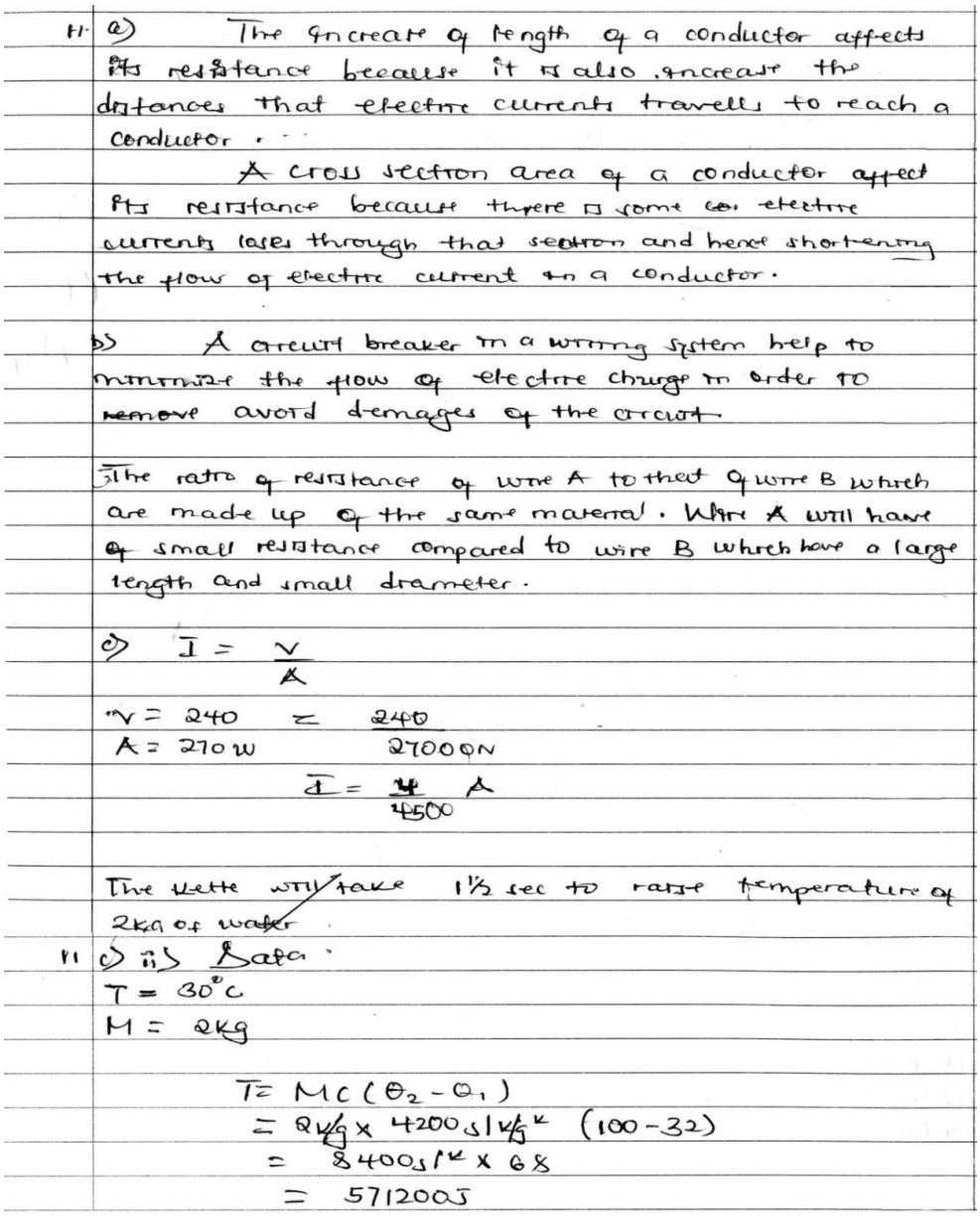


***Figure 11**: Percentage of Candidates' Performance in Question 11*

The analysis of the candidates' responses had identified that most of the candidates who performed poorly in this question faced difficult to interpret the demands of the question based on the given data. Some of them

responded incorrectly while others skipped some parts. Most of the candidates failed to explain how the increase of length and cross-section area of a conductor affects its resistance. In this case, the candidates were required to know the factors that determine the resistance of the conductor. They were supposed to realize that when the length of a conductor is increased while the other factors are held constant, the resistance of the conductor also increases. Likewise, when the cross-sectional area of a conductor is increased while the other factors are held constant, the resistance of the conductor decreases. Most of the candidates were not able to provide relevant explanations about the function of circuit breaker in wiring system, indicating that they had inadequate insight on the concept of electric installation. These candidates were expected to know that a circuit-breaker is a type of a switch that cuts off the flow of current when the current in a circuit exceeds a specific predetermined value and that they are normally thermal or magnetic devices that incorporate a bimetallic strip or an electromagnet to open and close the switch respectively. Besides, they failed to apply the correct formulae for determining the resistance of the conductor to obtain the ratio of the resistance of wire A to that of wire B made of the same material. Conversely, the candidates failed to compute the current consumed by an electric kettle. This indicates that the candidates failed to interpret the power rating of electrical appliances to determine the current and the time taken to raise the temperature of water to its boiling point. Extract 11.1 reveals the case.

Extract 11.1


11. a) The increase of length of a conductor affects its resistance because it is also increase the distances that electric currents travells to reach a conductor.

A cross section area of a conductor affect its resistance because there is some loss electric currents loses through that section and hence shortening the flow of electric current in a conductor.

b) A circuit breaker in a wiring system help to minimize the flow of electric charge in order to remove avoid demages of the circuit.

The ratio of resistance of wire A to that of wire B which are made up of the same material. Wire A will have of small resistance compared to wire B which have a large length and small drameter.

c) $I = \frac{V}{A}$

$V = 240 = \frac{240}{27000N}$

$A = 270W$

$I = \frac{4}{4500} A$

The kettle will take 1½ sec to raise temperature of 2kg of water

11 c) iii) Data.

$T = 30^{\circ}C$

$M = 2kg$

$T = MC(\theta_2 - \theta_1)$

$= 2kg \times 4200J/kg^{K} \quad (100-32)$

$= 8400J/^{K} \times 68$

$= 571200J$

Extract 11.1 indicates how the candidate gave incorrect answers and applied irrelevant formula to perform the calculations involved.

However, few candidates who scored high marks in this question gave clear and precise explanations which fulfilled the demands of the question. Furthermore, some of the candidates were very systematic in all parts

which required mathematical computations. Extract 11.2 shows the response taken from the sample answers of one candidate for illustration.

Extract 11.2

11.a i) Increase in length of a conductor increases the resistance of the conductor. Due to increasing length.

$R \propto l$

ii) Increase in the cross-section area of the conductors, results into a decrease in the resistance of the conductor.

$R \propto 1/A$

b) i) A circuit breaker is a type of switch which breaks / leaves contact with the circuit in case higher currents flow through it. It uses a bimetallic strip in its operation.

The main function is to prevent the excess current into the components which would lead to blowing up of appliances.

ii) $R = \rho l / A$

$$\frac{l_1}{A_1} = \frac{l_2}{A_2} = \frac{1/2\,l}{\frac{\pi(2d)^2}{4}} = \frac{l}{\frac{\pi d^2}{4}}$$

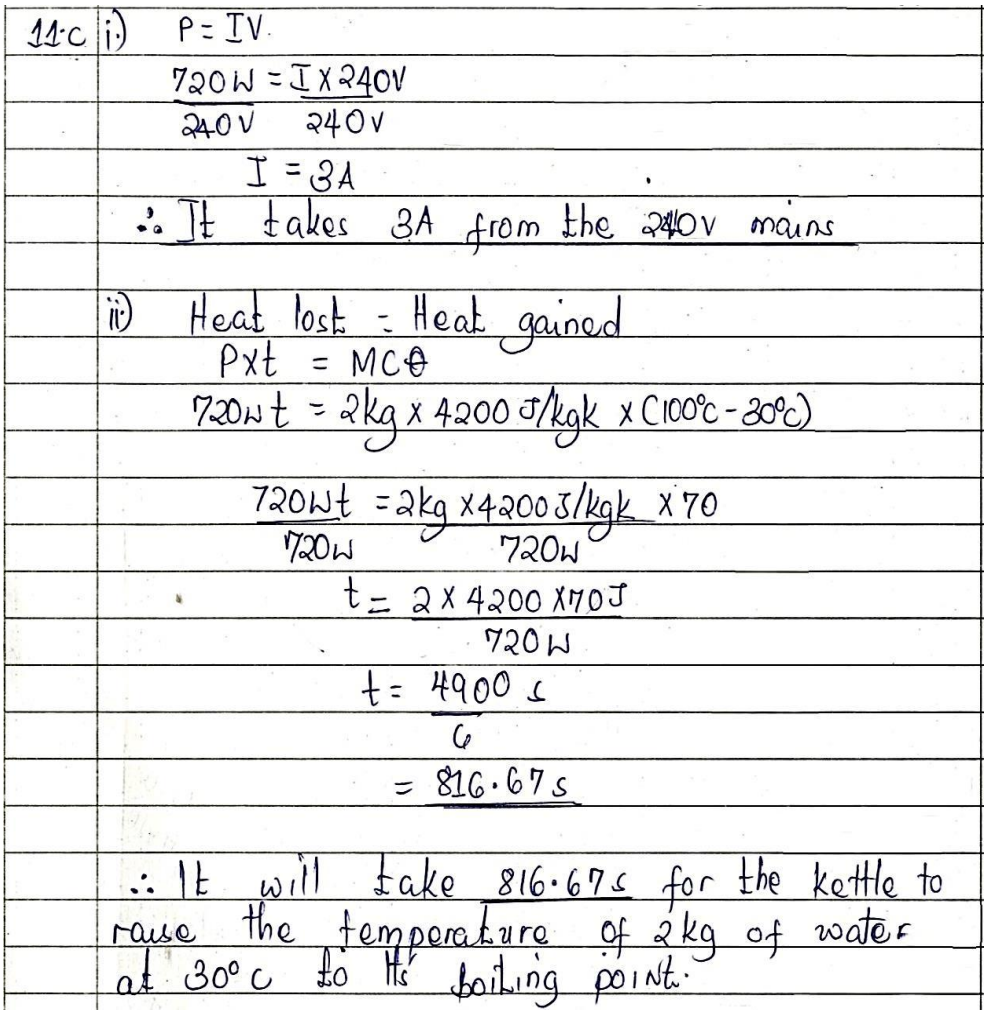
$$= \frac{l}{2\pi d^2} = \frac{4l}{\pi d^2}$$

$$2 \times l/2 = 4l \times 2$$

$$l = 8l$$

$$1:8$$

∴ The ratio of resistance of A to that of B is 1:8



Extract 11.2 shows how the candidate was able to answer the question correctly with supportive illustrations and good computation skills.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE PER TOPIC

3.1 Candidates' Performance Per Topic in 2017

The analysis of the candidates' performance in each topic shows that no topic was good performed, though the topic of Structure and Properties of Matter in question 2 showed high performance (77.70%) by the candidates. This performance was influenced or lowered by the performance in question 7 of the same topic which made its average performance to be 55.81 percent. The detail of the performance of the candidates per topic

reveals that, the Multiple Choice Items tested from the topics of Thermal Expansion, Introduction to Laboratory Practices, Motion in Straight Line, Waves, Light, Current Electricity, Elementary Astronomy and Radioactivity had an average performance of 58.22 percent. The analytical statistics also shows that, the topic of Current Electricity was averagely done by 41.96 percent. Likewise, question 3 which contained filling in the blank items derived from various topics including Application of vectors, Transfer of Heat Energy, Light, Measurement of Thermal Energy, Electromagnetism, Thermionic Emission, Elementary Astronomy and Waves had an average performance of 41.16 percent. Other topics which were observed to have average performance encompass Thermal Expansion (32.54%) of question 4, Electronics, Thermionic Emission and Electromagnetism (31.23%) which appeared in question 10 altogether.

Further analysis depicts that the candidates' performance was weak in the topics of Waves (23.10%) in question 8, Simple Machines, Forces in Equilibrium, Archimedes Principle and the Law of Flotation (17.98%) in question 6. Others include the topics of Light and Optical Instruments (17.34%) in question 5 while the weakest performance is observed in the topic of Electromagnetism (13.33%) in question 9. The summary of how candidates performed or scored in each topic is presented in appendix 1.

3.2 Comparison of the Candidates' Performance between 2016 and 2017 Topic-Wise

When the candidates' performance in the topics tested in CSEE 2016 and 2017 was compared, there was a drop or rise of performance in some of the topics. The reflection of the performance of the candidates shows a slight increase in performance from 56.7 percent in 2016 to 58.22 percent in 2017 for the Multiple Choice Items in question 1 derived from different topics. Moreover, an enormous rise in performance was observed in the topic of Current Electricity in which the performance of the candidates in 2016 was weak (14.7%) compared with performance in 2017 which has increased up to 41.96 percent. This rapid increase of performance in this topic is an indicator that teachers and students put much effort to improve the performance as the topic has been done poorly over a period of recent years. Furthermore, the analysis reveals that in 2016 the performance was

weak (13.9%) in the topic of Thermal Expansion, but in the contrary, the performance in 2017 in the same topic has increased to an average of 32.54 percent showing a significant improvement.

Despite this achievement in the mentioned topics, the following topics still need to be seriously dealt with to improve the candidates' performance. These topics are Simple Machines, Forces in Equilibrium, Archimedes Principle and the Law of Flotation whose performance was 11.9 percent in 2016 and 17.98 percent in 2017. Congruently, the topics of Light and Optical Instruments continued to drop in performance for two consecutive years 2016 and 2017 with performance of 18.6 percent and 17.34 percent respectively. Furthermore, poor performance observed was from the topic of Electromagnetism whereby in 2016, the performance was 18.7 percent while in 2017, the performance has decreased much to 13.33 percent. See appendix 2.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The question-wise analysis of the candidates' performance identified the challenges which confronted the candidates in endeavouring to do the questions. The analysis also provided the summary of the performance in each topic and the recommendations that will assist to overcome the observed challenges.

The analysis of the candidates' performance has shown that, the key hindrance to candidates who scored low marks was insufficient knowledge of the various topics tested. Due to this problem, the candidates failed to demonstrate their skills by giving inappropriate responses to most of the questions. For example, they showed inadequate knowledge on the topics of Waves, Simple Machines and Forces in Equilibrium, Archimedes' Principle and the Law of Flotation. In these topics, the candidates lacked the desired knowledge which could enable them attempt the questions appropriately. Most of them were found doing some parts of the questions while skipping others. Similarly, some candidates faced difficulties in stating the various principles and laws given in the questions as applied in

everyday life experience. They failed to relate principles or laws with their corresponding subject matter or topic and hence, used irrelevant words to state them. For example, question 6 and 7 where the candidates failed to state the law of floatation and Hooke's law respectively.

Another difficulty that faced the candidates was lack of skills in solving questions which involve the use of mathematics or calculations. This was found to be very challenging to most of the candidates as they absolutely showed incompetent in formulating and using the proper formulae and data given in calculations. For example, question 4, 5, 6, 7, 8 and 11, many candidates used incorrect formulae which caused them to arrive at incorrect answers.

Poor drawing skills were another obstacle towards good performance to some of the candidates. This was observed in question 7 where candidates failed to sketch a graph showing how force applied in a stretched string varies with its extension. Similarly, some candidates proved failure in drawing and labelling the diagram of the direct current (d.c) generator as observed in question 9.

Low English Language proficiency was another obstacle which some candidates encountered especially for the questions which required detailed explanations or giving reasons. For example, most of the candidates failed to give explanation in question 4 about the holes left below the chimneys of kerosene lamp or kitchen. Some of the candidates failed to give explanation in question 5 as to why convex mirrors are used as driving mirrors. The same challenge affected performance of candidates in question 10. Furthermore, some of the candidates failed to give correct answers because they could not identify the demand of the questions, which might have been attributed by lack of sufficient exercises. This obstacle was observed in questions 4, 7, 9 and 10.

4.2 Recommendations

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

(a) Teachers should finish or cover the syllabus on time and provide adequate assignments to their students to make them fit for National Examination.

(b) Teachers should identify struggling 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.

(c) Apart from classroom discussions, teachers should use various methods of teaching such as project works, games, physics clubs and study tours or excursions, so that to raise interest of students to learn physics.

(d) Teachers should use table of specification during formative assessment in schools such as midterm tests, terminal, annual and mock examinations to ensure that all objectives from the syllabus are assessed.

(e) Teachers and students should put emphasis on the observed poorly performed topics of Waves, Simple Machines, Forces in Equilibrium, Archimedes' Principle and the Law of Flotation, Light, Optical Instruments and Electromagnetism in order to improve the performance in these topics.

(f) 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 last National Examinations. This will avoid skipping of some of the questions tested in the examination.

(g) 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.

(h) The Ministry of Education, Science and Technology as well as the private school owners should provide supportive environment for teachers to share their teaching experiences so that to have common interpretation of the syllabus and examination formats hence to reduce the gap of performance between the schools in this subject.

Appendices

Appendix 1

THE CANDIDATES' PERFORMANCE PER TOPIC IN 2017

S/n	Topic	Total number of Questions	Question Number	Percentage of candidates who scored 30% and above	Remarks
1.	(Multiple Choice Questions) Thermal Expansion, Introduction to Laboratory Practices, Motion in Straight Line, Waves, Light, Current Electricity, Elementary Astronomy and Radioactivity.	1	1	58.22	Average
2.	Structure & Properties of Matter.	2	2 &7	55.81	Average
3.	Current Electricity	1	11	41.96	Average
4.	(Fill in the Blanks Spaces) Application of Vectors, Transfer of Heat Energy, Light, Measurement of Thermal Energy, Electromagnetism, Thermionic Emission, Elementary Astronomy and Waves.	1	3	41.16	Average
5.	Thermal Expansion	1	4	32.54	Average
6.	Electronics, Thermionic Emission and	1	10	31.23	Average

S/n	Topic	Total number of Questions	Question Number	Percentage of candidates who scored 30% and above	Remarks
	Electromagnetism.				
7.	Waves	1	8	23.10	Weak
8.	Simple Machines, Forces in Equilibrium, Archimedes Principle & The Law of Flotation	1	6	17.98	Weak
9.	Light and Optical instruments.	1	5	17.34	Weak
10.	Electromagnetism	1	9	13.33	Weak

Appendix 2

THE COMPARISON OF THE CANDIDATES' PERFORMANCE BETWEEN CSEE 2016 AND 2017 TOPIC-WISE

S/n	TOPIC	EXAMINATION FOR 2016			EXAMINATION FOR 2017		
		Total number of Questions	Percentage of candidates who scored 30% and above	Remarks	Total number of Questions	Percentage of candidates who scored 30% and above	Remarks
1	(Multiple choice Questions)	1	56.7		1	58.22	Average
2	Structure & Properties of Matter.				2	55.81	Average
3	Current Electricity	1	14.7	Weak	1	41.96	Average
4	Fill in the Blanks Questions	1	36.3	Average	1	41.16	Average
5	Thermal Expansion	1	13.9	Weak	1	32.54	Average
6	Electronics, Thermionic Emission and Electromagnetism.				1	31.23	Average
7	Waves				1	23.10	Weak
8	Simple Machines, Forces in Equilibrium, Archimedes Principle & The Law of Flotation	1	11.9	Weak	1	17.98	Weak
9	Light and Optical instruments.	1	18.6	Weak	1	17.34	Weak
10	Electromagnetism	1	18.7	Weak	1	13.33	Weak