THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEM RESPONSE ANALYSIS REPORT ON THE DIPLOMA IN SECONDARY EDUCATION EXAMINATION (DSEE) 2023

PHYSICS

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEM RESPONSE ANALYSIS REPORT ON THE DIPLOMA IN SECONDARY EDUCATION EXAMINATION (DSEE) 2023

731 PHYSICS

Published by:

The National Examinations Council of Tanzania

P.O. Box 2624

Dar es Salaam, Tanzania.

TABLE OF CONTENTS

FOREWORD

The National Examinations Council of Tanzania (NECTA) is pleased to issue this Candidates' Item Response Analysis Report on the Physics subject for the Diploma in Secondary Education Examination (DSEE), 2023. The purpose of this report is to provide feedback to all education stakeholders and student teachers on the achievement of the implementation of the Physics syllabus in the Diploma level through the candidates' performance. This is because, primarily, the candidates' performance is an indicator of the effectiveness of classroom teaching and learning.

The general performance of the candidates in the Physics subject was good. The report displays factors which contributed to the candidates' ability to answer the examination questions correctly and score high marks. The factors include ability to identify the tasks of the questions, good knowledge of the subject matter, good mathematical skills and correct application of the principles in interpreting scientific observations. However, some candidates scored low marks as they lacked such qualities.

It is expected that the suggestion and recommendation provided in this report will enable education administrators, college principals and tutors to take appropriate teaching and learning interventions so as to enable the student teachers to master the skills and knowledge. This will in turn improve candidates' performance in the future examinations administered by the Council.

Finally, the Council extends its gratitude to examination officers who participated in preparing this report.

Dr. Said A. Mohamed
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report analyses candidates' responses in the Physics subject for the Diploma in Secondary Education Examination that was administered in May 2023. It provides feedback to educational stakeholders about the strength and weaknesses of the candidates' performance.

The DSEE 2023 physics examination paper covered the 2009 academic and pedagogy syllabus and was set based on the 2022 Examinations Format. The examination consisted of two papers: Physics 1 (theory) and Physics 2 (practical).

The Physics 1 comprised sections A and B with a total of 14 questions which assessed academic and pedagogy contents. The candidates were required to attempt all questions. Section A consisted of 10 short answer questions which carried 4 marks each while section B had four (4) structured essay questions, each carrying 15 marks. On the other hand, Physics 2 consisted of three (3) questions: questions 1 carried 20 marks while questions 2 and 3 carried 15 marks each. The candidates were required to attempt all questions.

The analysis highlights what the candidates were required to do in each question and evaluates the strengths and weaknesses of the candidates' responses. Furthermore, it provides a statistical analysis of the candidates' performance and samples of extracts which illustrate the candidates' good and weak responses.

The candidates' performance in each question has been classified into three categories which are good, average and weak. Good performance ranges from 70 to 100 per cent, average performance ranges from 40 to 69 per cent and weak performance ranges from 0 to 39 per cent. In addition, green, yellow and red colors are used in charts or graphs to represent these categories respectively.

A total of 338 candidates sat for 731 Physics examination in 2023. Among them, 316 (96.93%) passed the examination. This implies that the general performance in this subject was good. The performance in 2023 has increased by 0.75 per cent compared to the performance in 2022, where 96.18 per cent passed. The analysis of the candidates' performance in 2023 compared to the year 2022 is summarized in Table 1.

Table 1: Comparison of candidates' performance in grades and percentage for the years 2022 and 2023 in Physics

Year	Sat	Number of Candidates and Percentage						
		Passed	Grades					
			A	B	C	D	F	
2023	338	316	0	9	166	141	10	
		96.93%	0.0%	2.76%	50.92%	43.25%	3.07%	
2022	1708	1612	0	17	519	1,076	64	
		96.18%	0.0%	1.00%	30.39%	63.00%	3.75%	

Table 1 indicates that many candidates scored grade C and D in the two consecutively years. It further shows that, there was no candidate who scored grade A in the two years.

Lastly, this report provides conclusion and recommendations that may help to improve the candidates' performance in future examinations. It also presents appendices which indicate the performance in each topic.

2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH QUESTION

This part analyses the candidates' performance in each question in Physics papers 1 and 2. The analysis begins by explaining the requirement of the question as it appeared in the examination paper followed by data analysis and detailed description of candidates' responses and extracts.

2.1 PHYSICS 1 (THEORY)

This was a theory paper which consisted of section A and B with a total of 14 questions. The candidates were required to answer all the questions. Questions in section A weighed 4 marks each while those in section B weighed 15 marks each. The topics which were examined include *Measurements, Properties of Matter, Mechanics, Heat, Current Electricity, Electronics, Planning for Teaching, Physics Laboratory Management, Atomic Physics, Waves, Teaching* and *Fundamental of Teaching and Learning Physics*. The pass mark in section A was 2.0 marks while in section B it was 6.0 marks.

2.1.1 Question 1: Measurements

The question was asked as follows: *The Form One students were given a task to measure a mass of a bob using beam balance. Explain two physical quantities that would be expressed by the students in carrying out such task.*

The question was attempted by 338 (100%) candidates and a summary of their performance is shown in Figure 1.

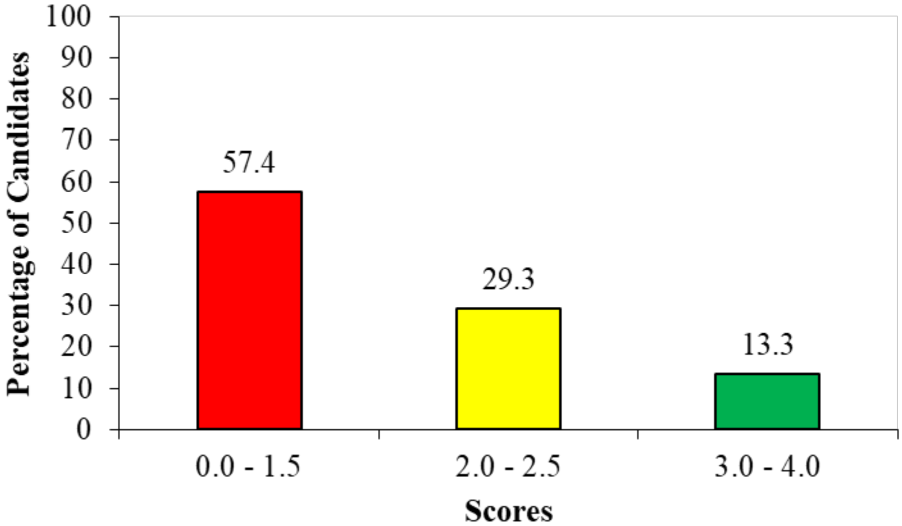


Figure 1: *Candidates' Performance in Question 1*

Figure 1 shows that the overall performance in question 1 was average as 42.6 per cent of candidates scored 2.0 to 4.0 marks.

The candidates who scored high marks (3.0 – 4.0) had sufficient knowledge about physical quantities. They accurately identified mass and weight as the primary physical quantities associated with a bob measurement using beam balance. Specifically, they correctly indicated that mass is directly read from a beam scale while weight is the force exerted due to gravity. They demonstrated a clear understanding of the fact that a bob's weight is a derived physical quantity with its unit being derived from the dimensions of mass and acceleration due to gravity. Moreover, they were aware that a beam balance is an instrument that is used to measure mass of objects such as a bob in unit of kilogram or gram. Extract 1.1 shows responses of a candidate who scored high marks in this question.

1	The two physicap quantities:
	(i) Mass
	This is the quantity of matter in an object.
	-It is a basic fundamentap quantity ,
	(ii) Weight
	This is the amount of force of gravita
	tion fore acted on a body.
	-It is aderived quantity obtained from
	mass, so the students will be able to
	express weight, but weight will not be
	determined by beam balance but by mattema
	ticap calculation that
	Weight = Mass of body x Gravitationap
	fore.

Extract 1.1: A sample of a correct response to question 1

The candidates with average scores (2.0 – 2.5) marks exhibited insufficient knowledge of the relevant physical quantities. These candidates accurately identified only one physical quantity associated with a bob when measured using a beam balance. However, they failed to recognize that both fundamental and derived physical quantities can be expressed when using a beam balance to measure an object's mass.

On the other hand, some candidates who scored low (0.0 – 1.5) marks had insufficient knowledge about the relevant physical quantities. Most of these regarded physical quantities expressed when a bob measured by beam balance as fundamental units. The responses included units such as *kilometer, seconds* and *hours* which were not correct because those units are not expressed from a beam balance which is used to measure a mass. Some of them identified grams and kilograms as the physical quantities while others associated kilograms with daily activities and grams with the measurement instrument. Some candidates wrongly discussed scalar and vector quantities as the physical quantities derived from a beam balance rather than focusing on mass and weight. Additionally, the candidates attempted to differentiate between derived and fundamental physical quantities, stating that *derived quantities depend on fundamental quantities* *while fundamental physical quantity does not depend on the other quantities*. These responses deviated from the requirements of the question. Extract 1.2 is a sample of weak responses from one of the candidates.

1	(i) Legth → this is the fundermental physical quantity at which can be involved in the measurement at which can be expressed in Metre (m) or Centimeter (cm).
	(ii) Time → this is ~~eph~~ fundermental physical quantity at which involve in any measurement of physical quantity by knowing Time interval involved in measurement

Extract 1.2: A sample of an incorrect response to question 1

In Extract 1.2, the candidate incorrectly explained two physical quantities expressed from a beam balance as length and time instead of mass and weight.

2.1.2 Question 2: Properties of Matter

The question was asked as follows: *An experimenter complained to you about a problem of obtaining different readings when using the new and old spring balance. What would be a reason for this difference?*

A total of 338 (100%) candidates attempted this question and the analysis of their performance is presented in Figure 2.

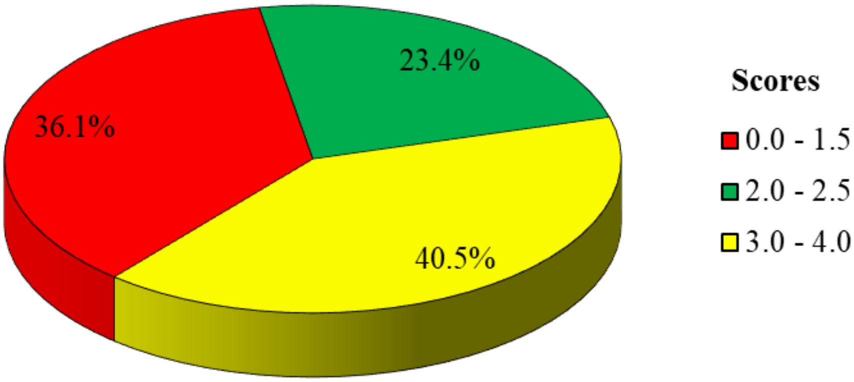


Figure 2: *Candidates' Performance in Question 2*

The statistical data in Figure 2 reveals that the candidates' performance in this question was average because 63.9 per cent scored from 2.0 to 4.0 marks.

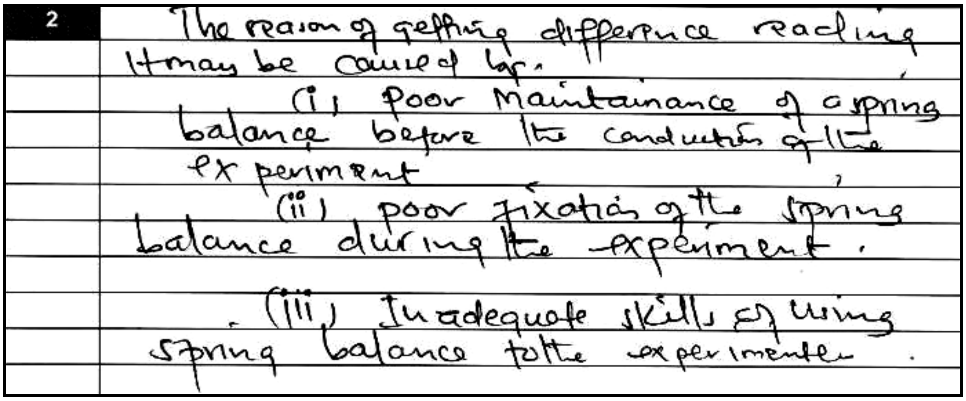
The candidates who scored from 2.0 to 2.5 marks provided one correct response and consequently lost some marks. On the other hand, the candidates who scored high marks (3.0 – 4.0) demonstrated an understanding that using a spring balance repeatedly leads to its weakening. They correctly explained that the spring balances which have been used for a long time exhibit incorrect reading. Furthermore, they recognized that environmental influences and effects of wear and tear can contribute to incorrect reading in the older spring. Extract 2.1 is a sample of the correct responses to the question.

2	The two spring balance produce different
	reading because:
	The old spring balance undergoes
	elastic Fatigue which cause it ~~th~~ to
	Fail to ~~retd~~ return to its initial lenth
	when Force is removed. So the new balance
	will provide accurate measurement.

Extract 2.1: A sample of a correct response to question 2.

The candidates who scored low marks (0.0 – 1.5) gave incorrect responses to the question. They failed to recognize that a spring balance which has been used for a long time experiences a decrease in its restoring force and elasticity resulting in incorrect reading. Some of them confused the concepts of errors analysis with elasticity of spring balance. For example, one of the candidates incorrectly explained the reasons for wrong readings of the old spring as *precision is a situation whereby the new reading is different from the actual reading. The old reading is different from the new reading* and *accuracy is the situation such that the reading is the same with the actual reading*. Other candidates explained how to reduce random and systematic errors during experimentation instead of explaining the reasons for different readings when using the new and old spring balance.

Moreover, other candidates gave explanations based on the concepts of density and pressure rather than addressing the elasticity of spring balance. For instance, one of them explained that the *new spring balance has correct reading due to high density and pressure while the old spring balance is affected by low density and pressure*. The other candidates explained the concepts of temperature and electricity instead of elasticity of a new and old spring. For example, one of the candidates explained that *old spring does not require electricity, new spring is highly sensitive temperature while old spring is not sensitive temperature*. Extract 2.2 is a sample of the incorrect responses from one of the candidates.


2 The reason of getting difference reading
It may be caused by.
(i) Poor Maintainance of a spring balance before the conduction of the experiment
(ii) poor fixation of the spring balance during the experiment.
(iii) Inadequate skills of using spring balance to the experimenter.

Extract 2.1: A sample of a correct response to question 2

In Extract 2.1, the candidate listed the causes of improper laboratory management and organization instead of giving reason for the difference in reading when using old and new spring balance.

2.1.3 Question 3: Mechanics

This question was asked as follows: *A passenger in the train noticed that the brake was applied when it was moving with a velocity of* $72\ \text{km/hr}$. *After passing over* $200\ \text{m}$, *its velocity reduces to* $36\ \text{km/hr}$ *at the same rate of retardation. How much distance will it go before brought to rest?*

The question was attempted by 338 (100%) candidates. Figure 3 summarizes the candidates' performance in this question.

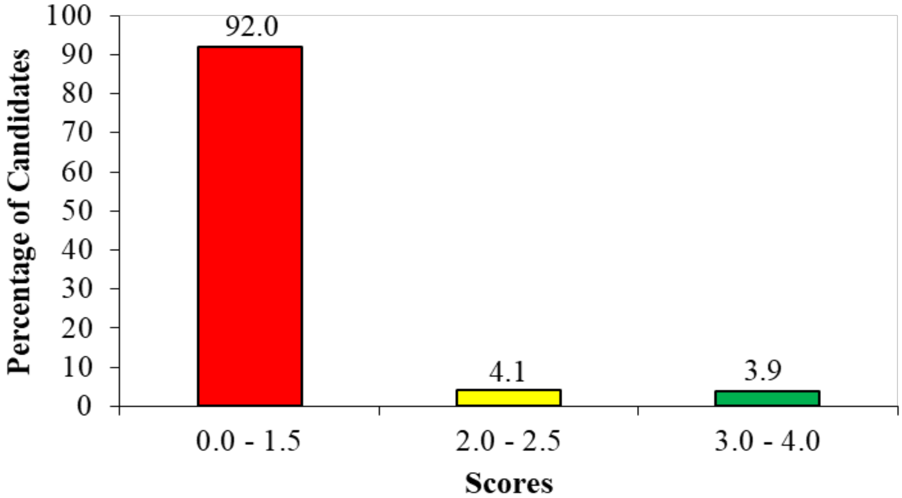


Figure 3: *Candidates' Performance in Question 3*

The data in Figure 3 shows that the overall performance was weak as only 8.0 per cent of the candidates scored from 2.0 to 4.0 marks, and the majority (92.0%) of the candidates scored 0.0 to 1.5 marks.

Further analysis indicates that the candidates who scored low marks (0.0 – 1.5) had insufficient knowledge of the tested concepts, leading to incorrect responses to the question. Most of them failed to establish the relationship between the concepts of velocity and the rate of retardation of a train which is crucial for calculating the distance covered by a train before coming to a stop. For example, one of the candidates wrote that *distance covered is equal to velocity multiplied by time taken* $(d = v \times t)$. Similarly, others wrongly calculated distance by manipulating initial velocity and final velocity as *distance covered by a train* $(d_2 = \frac{d_1 v_1}{v_2})$. It was also noted that some of the candidates employed inappropriate concepts and formulas to determine the distance covered by a train. They introduced the concepts like *linear momentum* ($m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$) and *projectile motion* ($R = u_o \sin\theta \times t$; $T = \frac{2v_o \sin\theta}{g}$) instead of Newton's third equation of linear motion ($V^2 - V_0^2 = 2aS$) which would lead them into the formula of acceleration ($a = \frac{V^2 - V_0^2}{2S}$). Moreover, some of them omitted the steps necessary to deduce either acceleration or distance of the train when the break was applied. These candidates seemed to be unaware that the rate of retardation is the same as deceleration of a moving object when brakes are applied. This implies that these candidates lacked some skills of calculating acceleration of a train in straight/linear motion. Extract 3.1 is a sample of incorrect responses of the candidate who scored low marks in this question.

3 soln

Data given:

Velocity of break wire when it was moving = 72km/hr

Velocity reduces to 36km/hr at the same radiation.

Speed, = 200m.

Required.

How much distance will it go before brought to rest?

$$\frac{72\,km/hr \times 36\,km/hr}{200m}$$

= 12.96km/h.

∴ The distance that it will take before brought to rest = 12.96km/h.

Extract 3.1: A sample of an incorrect response to question 3

Extract 3.1 indicates that the candidate applied a wrong formula and procedure to deduce distance covered by a train before it was brought to rest.

Most of the candidates who scored average marks (2.0 – 2.5) correctly wrote Newton's third equation of linear motion and substituted the values of velocities. However, in the step of deducing the rate of retardation/acceleration they did not score any marks.

The candidates who scored high marks (3.0 – 4.0) had enough knowledge of Newton's equations of linear/straight line motion. Therefore, in step one, they correctly applied Newton's third equation of motion ($v^2 - u^2 = 2aS$) to calculate the rate of retardation/acceleration of a train. Moreover, in step two, they were aware that when a brake was applied, the final velocity of the train became zero ($0m/s$). Therefore, they correctly deduced the distance moved by a train before it was brought to rest through the formula $s = \frac{v^2 - u^2}{2a}$. Extract 3.2 is a sample of correct responses from one of the candidates who scored high marks.

3	given, initial velocity (u) = 72km/hr = 20m/s
	final velocity (v) = 36kmhr = 10m/s.
	distance (s) = 200m.
	from third equation of motion
	$v^2 = u^2 + 2as$.
	$10^2 = 20^2 + 2as$.
	$\frac{100 - 400}{2 \times 200} = a$
	$a = -0.75m/s$.
	retardation = 0.75m/s.
	required distance to brought to rest (v) = 0m/s.
	$\frac{v^2 - u^2}{2a} = s$.
	$s = \frac{0^2 - 10^2}{2 \times 0.75} = 66.67m$.
	the car will takes a distance of 66.67m to come to rest

Extract 3.2: A sample of a correct response to question 3

2.1.4 Question 4: Heat

The question was asked as follows: *The College Principal invited a clinical officer to present to the second-year student teachers about qualities of a good thermometric property. What are the four key points will the clinical officer present to students?*

The question was attempted by all 338 candidates, which corresponds to 100 per cent as summarized in Figure 4.

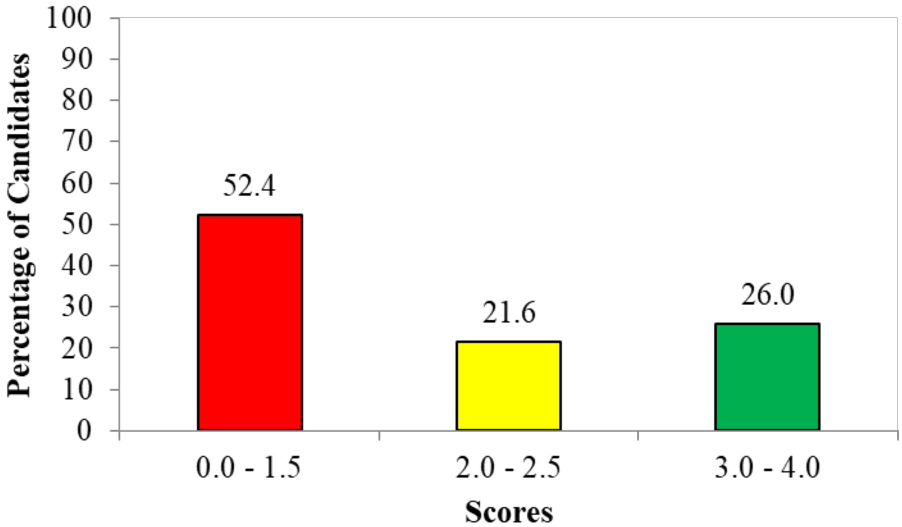


Figure 4: *Candidates' Performance in Question 4*

Figure 4 shows that the candidates' performance in question 4 was average since 47.6 per cent of the candidates scored from 2.0 to 4.0 marks.

The candidates who scored high marks (3.0 – 4.0) correctly explained the four qualities of a good thermometric property. They were aware that the qualities of a thermometric property include good stability, consistence, good sensitivity, wide coverage range of temperature and low thermal conductivity to heat. Extract 4.1 is a sample of the correct responses from one of the candidates.

4	
	(i) Good thermometric property should varies continuosly with temperature.
	(ii) Good thermometric property should remain constant with constant temperature
	(iii) Good thermometric property should be sensitive in small range of temperature
	(iv) Good thermometric property should range over wide range of temperature.

Extract 4.1: A sample of a correct response to question 4

The candidates who scored average marks (2.0 – 2.5) lost some marks because they were not aware of volume expansion of a liquid and solid, pressure change of gas are types of thermometry property. Some of them mixed the qualities of thermometry property with properties of liquid thermometer. Other candidates outlined the reasons for using mercury and alcohol in thermometers instead of explaining the qualities of a good thermometric property. For example, one of the candidates explained that *Mercury is used in thermometers because it has high coefficient of expansion*.

The candidates who scored low marks (0.0 – 1.5) wrote three to four incorrect responses to this question, such as *the expansion of thermometric liquid should be uniform, the boiling point of thermometric liquid should be very high, and the freezing point should be very low*. One of the candidates explained the qualities of thermometric property that *it measures the boiling point of water, it has a glass to show the rise and fall of temperature, it has numbers that help to reading the temperature* and *inside containing liquid for the specific temperature wanted to measure*. Other responses included *should have expansivity power, transparent to be seen easily, adhesive forces and potable*. All these responses indicate the candidates' partial knowledge of the tested concepts. Extract 4.2 is a sample of the incorrect responses from one of the candidates.

4	i) It should be relable.
	ii) It should be measurable
	iii) It should be readable.

Extract 4.2: A sample of an incorrect response to question 4

In Extract 4.2, the candidate incorrectly gave the qualities of a good thermometric property due to lack of understanding of thermometric features and types of thermometer.

2.1.5 Question 5: Mechanics

The question was asked as follows: *"If the distance between two objects is doubled, the gravitational force between them decreases to one fourth." Prove this statement by using Gravitation's equations*.

The question was answered by all 338 (100%) candidates. The overall performance in this question was weak as revealed in Figure 5.

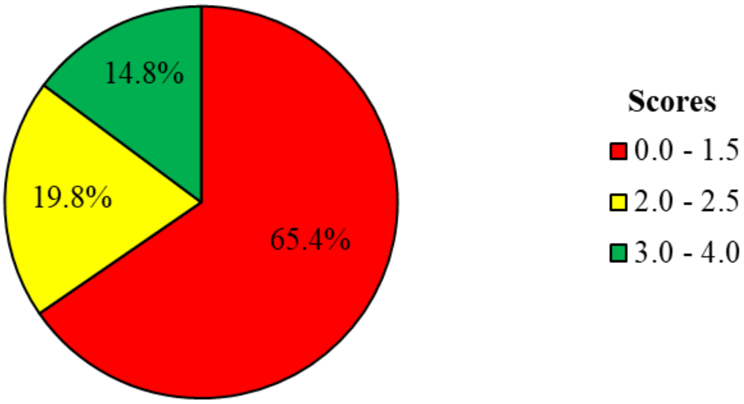


Figure 5: *Candidates' Performance in Question 5*

Figure 5 indicates that the performance of the candidates was weak as more than half of the candidates (65.4%) scored marks ranging from 0.0 to 1.5.

The candidates who scored low marks (0.0 – 1.5) demonstrated lack or partial knowledge of the concept of gravitational motion, specifically the Newton's law of universal gravitation equation ($F = \frac{Gm_1m_2}{r^2}$). These candidates either derived the equation of density of earth instead of deducing Newton's law of universal gravitation which relates masses and distance between them or provided the Kepler's laws instead of Newton's universal gravitational equation. For example, one of the candidates explained that *planets move around the Sun in ellipses, with the Sun at one focus.* Another candidate wrote: *The square of the orbital period of a planet is proportional to the cube of the semimajor axis of the ellipse*. Moreover, some candidates used incorrect gravitational equations to prove the given statement. For instance, one of them presented the equation resembling Kepler's third law as $T^2 = Gr^3$ while others gave the equation that resembles to Newton's law of gravitation as $\left(g - \frac{1}{4}\right) = \frac{GMm}{2r^2}$.

The candidates also wrongly proved the given statement by equating either the centripetal force equation or force of gravity with the Universal gravitational force as $\frac{mv^2}{r} = \frac{GMm}{r^2}$ and $m_1g = \frac{Gm_1m_2}{r^2}$ respectively. These candidates were not aware that comparison of centripetal force equation and universal gravitational force are used to determine the velocity of a satellite in its orbit and radius of an orbit. The equations of force of gravity and universal gravitational force are compared in deducing the equation of density of earth. However, these equations could not help them to prove the given statement using gravitational equation. Extract 5.1 shows an incorrect response to the question.

5	Solution
	Gravitational force (F) $\propto 1/r^2$
	Also,
	Gravitational force (F) $\propto m_1 m_2$
	$F \propto 1/r^2$, if doubled in radius
	$F \propto 1/r^2$, $F \propto 1/4r^2$
	$F = K/r^2 = K/2^2 r^2$
	$F = K/4r^2$ hence proved

Extract 5.1: A sample of an incorrect response to question 5

In Extract 5.1, the candidate used the equation which does not relate to gravitational motion, specifically an expression of Newton's law of universal gravitation equation. He/she also demonstrated poor mastery of mathematical skills.

The candidates who scored average marks (2.0 – 2.5) lost some marks when manipulating the doubled distance between two objects and computation of decreases in gravitational force to one fourth because they gave incomplete procedures for proving the statement mathematically.

On the other hand, the candidates who scored high marks (3.0 – 4.0) had sufficient knowledge about the Newton's law of universal gravitational and its mathematical expression ($F = \frac{GMm}{r^2}$). In addition, they were aware of the effect of gravitational force of a planet of mass m exerted by another planet (or star) of mass M and the distance between them. Therefore, they knew that the product of two masses is proportional to the exerted force and inversely proportional to the square distance between them. The procedure continues by correctly analyzing two equations from the given statement. When force, $F = \frac{GMm}{r^2}$ and when distance is doubled and force reduced to one force, F becomes $F = \frac{GMm}{(2r)^2}$. As result, these candidates correctly manipulated the two equations to obtain the required proof. Extract 5.2 is a sample of responses from a candidate who scored good marks in this question.

5 From lef-

Distance between two object → R.

$$F_1 = \frac{GMm}{R^2} \quad \text{----} \quad (1)$$

$$F_2 = \frac{GMm}{(2R)^2} \quad \text{----} \quad (2)$$

take equatoon (11) devode equ (1)

$$\frac{F_2}{F_1} = \frac{GMm}{(2R)^2} \div \frac{GMM}{R^2}$$

$$\frac{F_2}{F_1} = \frac{GMm}{(2R)^2} \times \frac{R^2}{GMm}$$

$$F_2/F_1 = \frac{R^2}{(2R)^2} = \frac{R^2}{4R^2} = \frac{1}{4}$$

$$F_2/F_1 = 1/4 \quad \therefore \quad F_2 = 1/4\, F_1 \text{ (Proved).}$$

Extract 5.2: A sample of a correct response to question 5

2.1.6 Question 6: Current Electricity

The question was asked as follows: *The radio technician was given a* $5\,\Omega$ *resistor and asked to connect it in series with a parallel combination of other resistors each of* $5\,\Omega$. *For the radio to work, it requires a total resistance of* $6\,\Omega$. *How many resistors are required to be in parallel connection for the radio to work properly?*

The candidates who attempted this question were 338 (100%), and 80.2 per cent failed. Further analysis of the performance is illustrated in Figure 6.

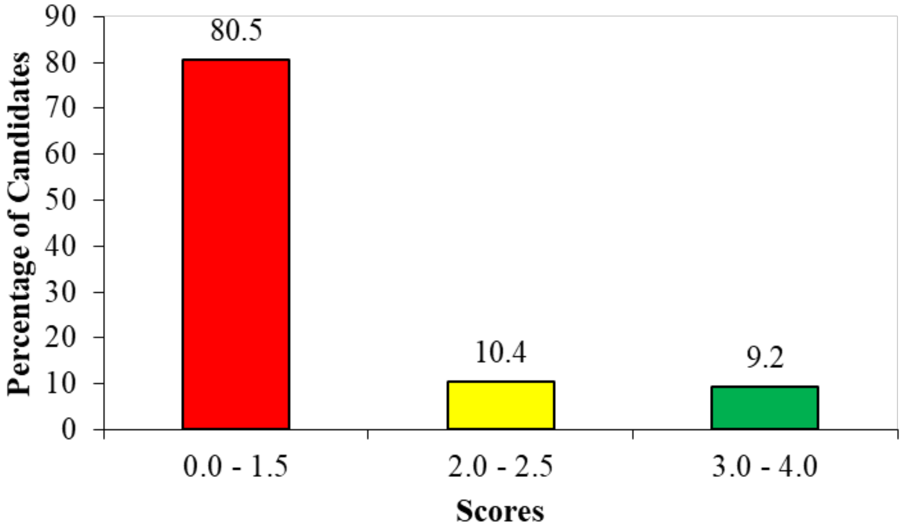


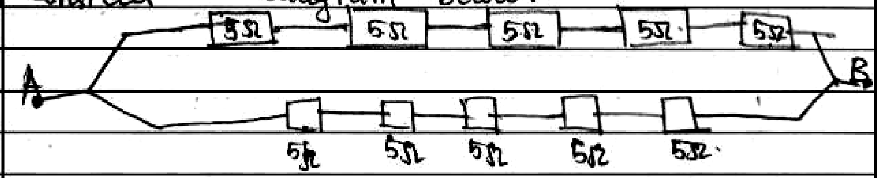
Figure 6: *Candidates' Performance in Question 6*

Figure 6 shows that the performance in the question was weak as more than three quarters of the candidates (80.5%) scored from 0.0 to 1.5 marks.

The analysis of the candidates' performance shows that the candidates who scored low marks (0.0 – 1.5) had insufficient knowledge of the concept of simple electric circuit. They failed to associate the equation for equivalent resistance in situations where multiple resistors are connected either in parallel or series configurations. Some of these candidates incorrectly manipulated mathematical expressions of equivalent resistance for either parallel or series connections. As a result, they were unable to obtain the total number of resistors within the circuit. For example, one candidate mistakenly formulated the equation for equivalent resistors in parallel as: $R_T = 5\Omega + \frac{1}{n_1} + \frac{1}{n_2}$ instead of $\frac{1}{R_p} = \frac{1}{5} + \frac{1}{5} + \frac{1}{5} - - - n\ times = \frac{n}{5}$. The other candidates wrongly wrote as: *equations of total resistance for series* $5\Omega \rightarrow 2.5n$ *in series and* $6\Omega \rightarrow x$ *in parallel*. In a separate instance, a candidate incorrectly applied the concept of heat (thermometry) instead of current electricity (simple electric circuit) as: $R_\theta = \left(\frac{R_T}{R_{Tr}}\right) \times 273.16K$.

Consequently, they failed to determine the number of resistors in parallel connection for a functional radio. Extract 6.1 represents a sample of weak responses from one of the candidates.

6 Consider diagram below:-



The resistors require in the redior to perform in it work properly is 10.

Extract 6.1: A sample of a weak response to question 6

In Extract 6, the candidate provided a circuit of a loop of 10 resistors in parallel. However, he/she obtained a wrong equivalent resistance by counting the number of resistors from the circuit.

On the other hand, the candidates who scored good marks (3.0 – 4.0) had a good understanding of the concepts of simple electric circuit particularly parallel and series arrangement of resistors. Moreover, they demonstrated a clear understanding of the expressions which govern the equivalent resistance in both parallel and series connection. Hence, they correctly deduced the number of resistors required for the radio to work properly. Extract 6.2 shows a sample of good responses to this question.

6 total resistance in series connection

$R_T = R_1 + R_2$.

$R_{eq} = R_{resistance\ in\ series} + R_{parallel}$

$R_s = 5\Omega$

$R_p = ?$

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{n}{R}$

$R_p = \frac{R}{n}$

$R_T = R_s + R_p$.

$6 = 5 + R/n$

$6 - 5 = R/n$.

$n = \frac{R}{6-5}$. ∴ Resistors in parallel combination will be 5 resistors

$n = 5/1$

$n = 5$

Extract 6.2: A sample of a correct response to question 6

2.1.7 Question 7: Electronics

The question was asked as follows: *Scientists have discovered two hypothetical elements, A and B. If element A has energy gap of 3. 0 eV and element B has energy gap of 1.2 eV; which element will be suitable in the manufacturing of semiconductor devices? Justify your answer using energy band diagram.*

The data shows that all 338 (100%) candidates responded to the question. The analysis of their performance is shown in Figure 7.

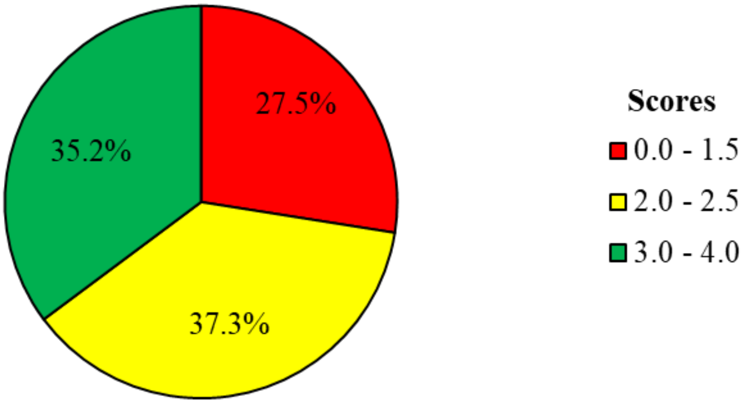
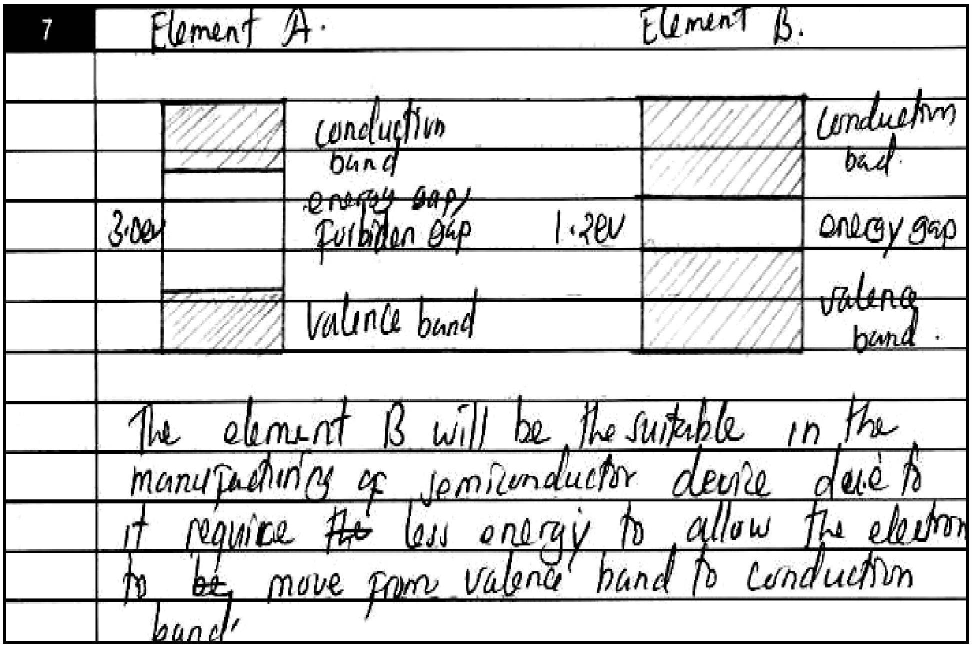


Figure 7: *Candidates' Performance in Question 7*

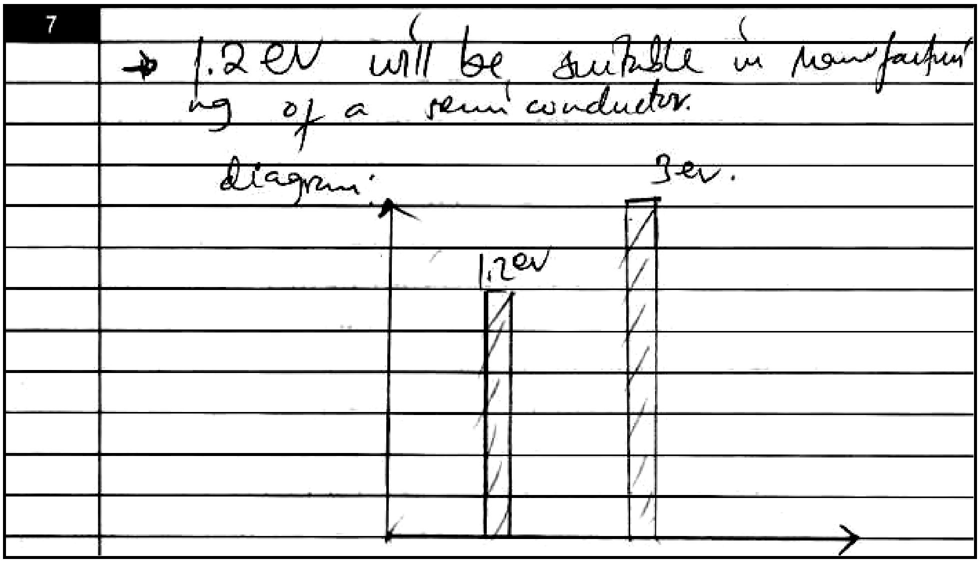
Figure 7 indicates that 72.5 per cent of the candidates scored from 2.0 to 4.0 marks while 27.5 per cent scored from 0.0 to 1.5 marks.

The candidates who scored high marks (3.0 – 4.0) correctly identified the suitable element for manufacturing semiconductor devices from the given values of energy gap 1.2 eV and 3.0 eV. They knew that it is easier for more electrons to leave the valence band and enter the conduction band when the energy gap is 1.2 eV hence increase electric conductivity behavior for semiconductor devices. Moreover, they correctly justified their selection of the element suitable for manufacturing of semiconductor device using a well labeled diagram of energy band. Extract 7.1 is a sample of the correct responses from one of the candidates.



Extract 7.2: A sample of a correct response to question 7

However, candidates who scored low marks (0.0 – 1.5) had insufficient knowledge of the concept of semiconductors. These candidates failed to identify the appropriate element for semiconductor devices and they drew a wrong energy band diagram. For example, one of the candidates drew a logic gate with its truth table while others gave the diagram related to hydrogen lines spectrum rather than depicting energy band diagram. In addition, some of the candidates justified the choice of suitable element for semiconductor devices through incorrect description. For instance, one of the candidates explained that *"due to silicon semiconductor it is easy electron to move from conduction to the valence band because are small layer depletion while the germanium semiconductor it's difficult to move from conduction and valence band because of high space"*. Another candidate explained that *"3.0 eV is suitable because not easy to allow current to pass through it and this can be existing in both properties of conductors and insulators."* Moreover, some of the candidates derived expressions related to the concept of structure of atom instead of the concept of semiconductor. For example, one of the candidates deduced the relationship between energy in eV and the velocity of the electron as: $1eV = K.E$; $eV = \frac{1}{2}mv^2$ *and* $eV \propto v^2$. These candidates were not aware that the amount of energy in eV of semiconductor element is not associated with the speed of electron, it implies the amount of energy (work done) for an electron to move from valence band to the conduction band. Extract 7.2 illustrates a sample of incorrect response from one of the candidates.


7

→ 1.2 eV will be suitable in manufacturing of a semi conductor.

diagram:

Extract 7.1: A sample of an incorrect response to question 7

In Extract 7.1, the candidate drew the histogram showing values of 1.2 eV and 3 eV instead of the energy band diagram which was the required by the question.

2.1.8 Question 8: Planning for Teaching

The question was asked as follows: *You have been employed at Uhai Secondary School which has scarcity of laboratory apparatus and equipment. Unfortunately, you wanted to conduct an experiment to determine acceleration due to gravity to Form Two students. How would you improvise the apparatuses so that you perform such an experiment effectively? Give four points.*

The data shows that all 338 (100%) candidates responded to the question. The analysis of their performance is shown in Figure 8.

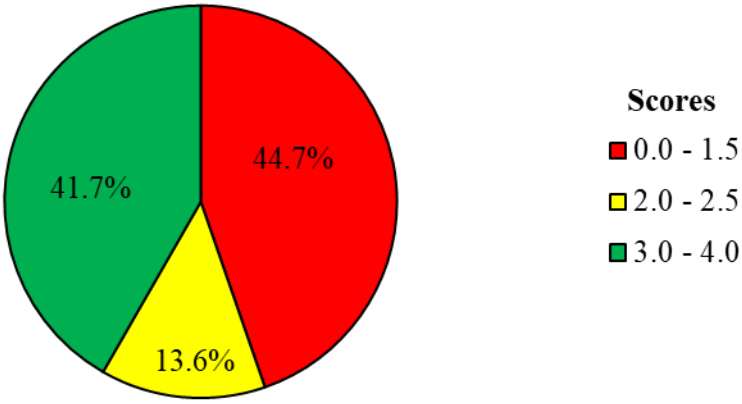


Figure 8: *Candidates' Performance in Question 8*

Figure 8 indicates an average performance in question 8 since more than a half (55.3%) of the candidates scored above the pass marks (2.0 – 4.0).

The candidates who scored high marks (3.0 – 4.0) understood the concept of improvisation in the process of teaching and learning. Thus, they correctly explained how to improvise the apparatuses during an experiment to determine the acceleration due to gravity. Moreover, they were aware that small stones, sticks of the trees, clocks, marked piece of wood and sewing thread collected from school environment can be used instead of sophisticated apparatuses like pendulum bob, retort stand, stopwatches, metre rule and cotton thread respectively. Extract 8.1 is a sample of good responses from one of the candidates.

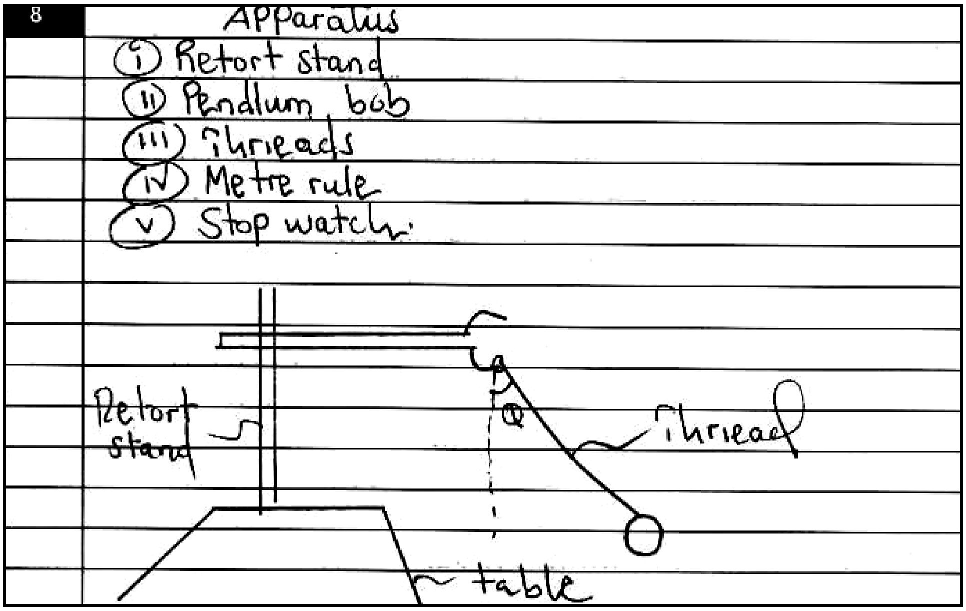
8	(i) I will Collect small stone in shape acting as a pendlum
	bob.
	(ii) I will Collect also the pieces of sticks and Connect them
	acting as the retort stand.
	(iii) I will use my phone to collect data (time) if
	the stopwatch is not available
	(iv) I will Collect and Connect glasses acting as the
	thread.

Extract 8.1: A sample of good response to question 8

The candidates who scored average marks (2.0 – 2.5) correctly explained only two out of four improvised apparatuses used in conducting an experiment to determine acceleration due to gravity. They lost some of the marks because they provided explanation for apparatuses that are not used in conducting such experiment. For example, one of the candidates gave apparatuses such as *to use plastic bottles, foil paper*. Other candidates mentioned *used dry cells and connecting wires* as improvised apparatuses to carry out experiment to determine acceleration due to gravity.

On the other hand, the candidates who scored low marks (0.0 – 1.5) either gave incorrect responses or managed to score a single point. Some of them incorrectly associated the experiment with heat related apparatuses experiment rather than focusing on experiment related to acceleration due to gravity. Example of such responses included mentioning of *thermometer, boiled water, and piece of black clothes*. Furthermore, there was confusion among candidates between the concepts of improvising in teaching and learning aids with laboratory management. For instance, one candidate suggested attributes like *clean the apparatus and lab benches before conducting an experiment, labeling the apparatus and group them according to the nature of the experiment, record and know the number of apparatus before conducting experiment*. Other candidates wrote expressions to determine acceleration due to gravity g, as: $T = 2\pi\sqrt{\frac{l}{g}} \rightarrow T^2 = 4\pi^2.\frac{l}{g} \rightarrow g = \frac{4\pi^2}{T^2}.l$.

Moreover, some candidates listed criteria for conducting physics experiments and steps for improvisation of teaching and learning aids. For example, one of the candidates listed criteria such as *number of apparatus, number of students, time for conducting an experiment and size of the class.* The candidates were supposed to recognize that in order to improvise apparatus for experiment to determine the acceleration due to gravity, they had to consider the *use small stones or any small mass collected from school environment instead of pendulum bob, prepare or collect some sticks of tree or timber pieces to make a retort stand, use clock or staff phones instead of stopwatch, prepare and use marked local metre rule, and prepare and use local thread or sowing thread*. Extract 8.2 is a sample of incorrect responses from one of the candidates.



Extract 8.2: A sample of an incorrect response to question 8

In Extract 8.2, the candidate wrote some of the procedures for writing a physics practical report instead of explaining how to improvise the apparatuses to conduct experiment to determine acceleration due to gravity. He/she listed apparatuses and drew a diagram which was not the requirement of the question.

2.1.9 Question 9: Planning for Teaching

The question stated as follows: *Some of the Physics teachers argued that preparing a lesson plan is too demanding and time wastage activity. Comment on teacher arguments giving four points.*

The question was attempted by all 338 (100%) candidates. Figure 9 illustrates the candidates' performance in this question.

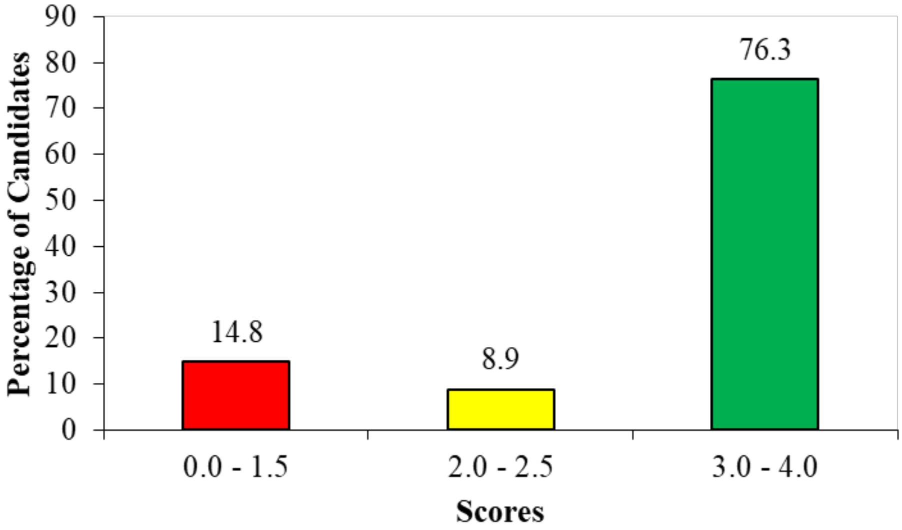


Figure 9: *Candidates' Performance in Question 9*

Figure 9 shows that the candidates' performance in Question 9 was good because more than three quarters of them (85.2%) scored above average marks (2.0 – 4.0).

The candidates who scored high marks (3.0 – 4.0) were aware that a lesson plan helps a teacher to plan the strategies to be used in the lesson delivery, and enable the preparation of teaching materials and series of learning activities for the lesson. They correctly supported the given argument by explaining the importance of a teacher to prepare a lesson plan as before classroom session. They described the advantages of a lesson plan as *to enable lesson objectives being achieved, it regulates teachers' speed of teaching and manage time, to help teachers to be consistent and confident*. Thus, they gave correct responses. Extract 9.1 is a sample of the correct responses to the question.

9	Preparing a lesson plan is not wastage activity
	because:
	i/ A lesson plan help a teacher to teach systematic
	ically
	ii/ A lesson plan help a teacher to manage and
	balance of time when teaching
	iii/ A lesson plan help in increasing confidence
	to a teacher
	iv/ A lesson plan help a teacher to understand which s
	tage the students could not understand well the le
	sson

Extract 9.1: A sample of a correct response in question 9

The candidates who scored average marks (2.0 – 2.5) had insufficient knowledge about the advantages of a lesson plan in teaching and learning process as they supported the argument about a lesson plan and correctly explained two out of four points regarding the preparation of a lesson plan before teaching.

However, some candidates scored low marks (0 – 1.5). Those who scored zero were not aware of the roles of the lesson plan for teachers. Those who scored from 1 to 1.5 marks gave incorrect responses mixed with the correct ones. For example, one of the candidates perceived the preparation of a lesson plan as time consuming and stated that *it uses much time to prepare, it needs skilled teacher to prepare, it causes teacher to teach slowly and costly it needs much books*. Another candidate explained that *it involves much time in construction, it requires syllabus and scheme of work in finding teaching and learning activities*. This candidate failed to understand that a lesson plan to teachers act as a guide during the deliverance of a lesson in the classroom. Other candidates explained that *is prepared at beginning of the term and has the several columns*. These candidates were not aware that a lesson plan is prepared daily before classroom session and covers the plan of a single lesson unlike a scheme of work which covers the plan of the whole term.

Furthermore, other candidates regarded lesson plan as a log book which has a record of taught topics and sub topics in a particular period of time. These candidates explained that *it helps an academic teacher to identify a number* *of topics covered by preparation of terminal examinations*. They candidates confused a lesson plan with a log book. Extract 9.2 is a sample of the correct responses to the question.

9

i). because it cover large area of learning
ii). Mostly physics are base on practicle and theory.
iii). It is difficult to prepare.
iv). It contain many thing and in other school there one physics teacher he/she teach from form one to form four.

Extract 9.2: A sample of an incorrect response to question 9

In Extract 9.2, the candidate provided some advantages and disadvantages of construction of multiple-choice items instead of the importance of a lesson plan in teaching and learning process.

2.1.10 Question 10: Physics Laboratory Management

The question was asked as follows: *Form Three students were given a task of conducting an experiment to verify Ohm's law. You have decided to use observation schedule to record their participation during experiment. What four key points would you record for students' assessment?*

The question was attempted by 338 (100%) candidates, and their performance is summarized in Figure 10.

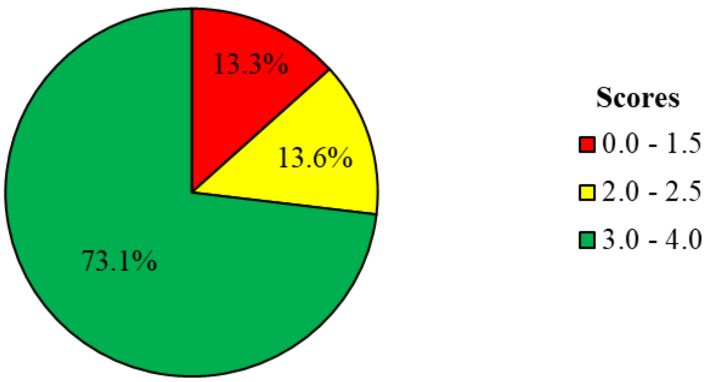


Figure 10: *Candidates' Performance in Question 10*

Figure 10 shows that 86.7 per cent of the candidates passed the question by scoring from 2.0 to 4.0 marks. This indicates a good performance.

The candidates who scored high marks (3.0 – 4.0) were equipped with the knowledge about preparation and conduction of physics practical. Therefore, they correctly stated the key points to be considered when assessing students during an experiment to verify Ohm’s law. Extract 10.1 is a sample of the correct responses from one of the candidates.

10

(i) Ways of assembling the apparatus.
They are able to assembly the required apparatus?

(ii) The way they Conduct experiment Independently

(iii) The way they Present and Organize data.

(iv) The way they Analyze and give Conclusion on presented data.

Extract 10.1: A sample of a correct response to question 10

The candidates who scored average marks (2.0 - 2.5) demonstrated partial understanding of the uses of observational schedule to assess students’ participation when conducting an experiment. They gave two out of four key points about students’ participation that could be recorded in the observational schedule. Their key points included incorrect responses which made them lose some marks. For example, one of the candidates gave types of assessment as *formative assessment and placement*. The other candidates wrote procedures of conducting experiments such as *define the purpose and scope of observation learning schedule and collecting data*.

On the other hand, the candidates who scored low marks (0.0 - 1.5) had insufficient knowledge about the preparation and conduction of physics practical. Hence, they provided one out of four correct points that could be recorded in the observational schedule and consequently lost some marks.

On the other hand, some candidates scored zero because they confused between the preparation and conduction of physics practical with the concept of current electricity particularly Ohm’s law. Consequently, they gave wrong answers like *resistance of a conductor in ohms, current that pass through a conductor, and voltage potential difference of a source*.

Another group of candidates listed factors affecting resistance of a conductor such as *cross-section area, length of the wire, and nature of the wire*. Some candidates gave the expression of Ohm's law as $V \propto I \rightarrow V = kI \rightarrow V = IR$ and the list of apparatuses used to conduct experiment such as; *resistance box, switch, ammeter, voltmeter, dry cell.* Moreover, there were some candidates who listed assessment tools such as test, portfolio, interview and questionnaire instead of key points such as handling of apparatus/equipment, assembling apparatus, data collection and data presentation. Extract 10.2 is a sample of incorrect responses from one of the candidates.

10	
	i) Test.
	i) Ratio schedule.
	ii) Variable schedules
	iii) Ratio interval schedule.
	iv) Variable interval schedules.

Extract 10.2: A sample of an incorrect response to question 10

In Extract 10.2 the candidate provided scales of educational measurement instead of a list of students' activities that could be recorded in observation schedule.

2.1.11 Question 11: Atomic Physics

This question had two parts which were asked as follows:

(a) *Scientists at Tanzania Atomic Energy Agency bombarded the stable and naturally occurring nuclide of Cobalt-59 with neutrons. Explain this process basing on neutron-activation.*

(b) *An employee in the nuclear plant project has identified a radioactive element to have an initial count rate of 2400 counts per minute on a scale meter. After 30 hours the count was observed to fall to 300 counts per minute;*

(i) Determine the half-life of the element.

(ii) If the initial number of atoms in another sample is 6×10^{20}*, how many atoms will have decayed in 50 hours?*

A total of 338 (100%) candidates attempted this question. The analysis of the candidates' performance in this question is shown in Figure 11.

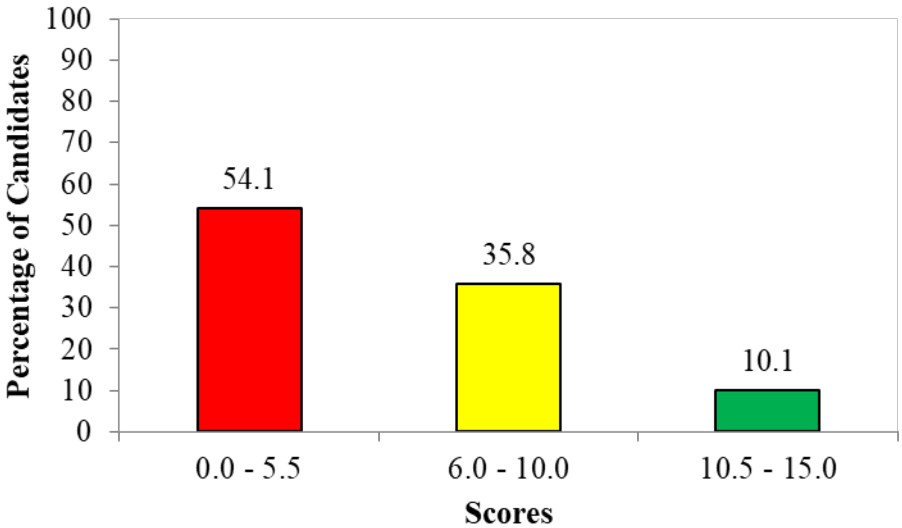


Figure 11: *Candidates' Performance in Question 11*

Figure 11 illustrates that the performance in this question was average since about a half of the candidates (45.9%) scored from 6.0 to 15.0 marks. Further analysis shows that, there was no candidate who scored all 15 marks allocated to this question.

The candidates who scored high marks (10.5 – 15.0) were competent in atomic physics concepts specifically in the area of radioactivity. Thus, in part (a), these candidates correctly explained the process of bombardment of nuclide of Colbat-59 with neutrons basing on neutron-activation. Additionally, they formulated a balanced nuclear reaction equation which helped them to explain the neutron activation process. Similarly, in part (b) the candidates correctly applied the appropriate formula to determine half-life of the element and number of atoms decayed in 50 hours. Extract 11.1 is an example of the correct responses.

11

(a) Neutronactivation is the kind of the method of the artificial radioactivity at which the stable nucleus of an atom is bombarded by using the neutron. When the neutron enter into the nuclide of the cobalt-59 it makes the nucleus to be unstable and hence it can start to emit radiations.

(b) Data given

Initial Counterrate (N_0) = 2400 counts per minute

Time taken (t) = 30 hour

Final counte rate (N) = 300 counts per minutes

Half life ($T_{\frac{1}{2}}$) = ?

Soln

(i) From

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T_{\frac{1}{2}}}$$

$$\frac{300 \text{ counts/minutes}}{2400 \text{ counts/minutes}} = \left(\frac{1}{2}\right)^{\frac{30 \text{ hour}}{T_{\frac{1}{2}}}}$$

$$\frac{300}{2400} = \left(\frac{1}{2}\right)^{30/T_{\frac{1}{2}}}$$

$$\frac{3}{24} = \left(\frac{1}{2}\right)^{30/T_{\frac{1}{2}}}$$

$$\frac{1}{8} = \left(\frac{1}{2}\right)^{30/T_{\frac{1}{2}}}$$

11 Cont.

$$2^{-3} = 2^{-\frac{30}{T_{\frac{1}{2}}}}$$

$$-3 = \frac{-30}{T_{\frac{1}{2}}}$$

$$T_{\frac{1}{2}} = \frac{30}{3}$$

$$T_{\frac{1}{2}} = 10 \text{ hours}$$

∴ The half life is 10 hours

(ii) For $N_o = 6 \times 10^{20}$ as the sample $\Delta N = ?$

From

$$\frac{N}{N_o} = \left(\frac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$$

$$N = N_o\left(\frac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$$

$$N = 6 \times 10^{20} \times \left(\frac{1}{2}\right)^{\frac{50 \text{ hours}}{10 \text{ hours}}}$$

$$N = 6 \times 10^{20} \times \left(\frac{1}{2}\right)^{5}$$

$$N = 6 \times 10^{20} \times \frac{1}{32}$$

$$N = 1.875 \times 10^{19}$$

But the atom decayed (ΔN) = Original sample (N_0) minus the sample left/remained (N)

ie $\Delta N = N_0 - N$

$$\Delta N = 6 \times 10^{20} - 1.875 \times 10^{19}$$

$$\Delta N = 5.81 \times 10^{20}$$

∴ The number of atoms decayed is 5.81×10^{20}

Extract 11.1: A sample of an incorrect response to question 11

The candidates who scored average marks (6.5 – 10.0) obtained most of the marks in part (b) but not (a). They demonstrated partial knowledge of Neutron activation process of nuclide of Cobalt-59. Therefore, they lost most of the marks allocated in that part. For example, one candidate wrongly explained neutron activation as *the process of neutron activation it* *involves the nuclear fission and fusion*. Another candidate explained that *process of neutron is the difference of mass number and atomic number.*

The candidates who scored low marks (0.0 - 5.5) either skipped part (a) or gave incorrect explanation of the Neutron activation process of nuclide of Cobalt-59. Majority of the candidates scored no marks at all in part (a) while in part (b) most of them scored some marks because they wrote correct equation of half-life. However, many candidates struggled with the necessary mathematical manipulation for either determining element's half-life or number of atoms decayed. The responses given by these candidates lacked clarity which could attract full marks.

On the other hand, the candidates who scored zero (0) demonstrated lack of knowledge about the radioactivity concept. For example, in part (a) some of the candidates described the structure of an atom instead of neutron activation process. Their responses included statements such as *the presence of neutrons and protons within the nucleus to counteract repulsion forces, in contrast to outer most shell electrons.* Moreover, these was an instance of a candidates asserting that, *the process included high voltage power*.

In part (b), majority of the candidates encountered challenges in applying appropriate formula of half-life and radioactive decay equation. This led to erroneous calculation of element's half-life and number of atoms decayed in 50 hours. For example, some candidates incorrectly wrote half-life as; $t_{1/2} = \left(\frac{N_{o1}}{N_{o2}}\right)t$ while others wrote *initial count rate over final count rate*. In addition, there were some candidates who derived irrelevant formulas to half-life. For instance, one candidate wrote; $2400 \rightarrow 1\min$, $30\,count \rightarrow 30\,hours$ and $\frac{N}{N_0} = \frac{1}{2}tn$ instead of $\mathrm{N_f} = \frac{\mathrm{N_i}}{2^{\mathrm{n}}}$. Extract 11.1 presents a sample of incorrect responses from one of the candidates who attempted the question.

11 a). The bombardment of stable and naturally occuring nuclide of Cobalt 59 with neutrons will lead to the following.
The binding energy of the new formed nuclide will be lower and the nuclide will be unstable.
This is because some of the energy ~~during~~ is lost during bombarding separating the protons and neutrons in the nuclide.

b) i) To determine the half-life of the element.
Since, half life involves the disintegration of an element into halves to form new element

$2400 \xrightarrow{1^{st}} 1200 \xrightarrow{2^{nd}} 600 \xrightarrow{3^{rd}} 300$.

Thus, the half-life of the element is 3. after 30 hours.

Half life of the element = 3.

Extract 11.1: A sample of an incorrect response to question 11

In Extract 11.1, the candidate explained binding energy instead of Neutron activation process in part (a), and in part (b) he/she wrote a sequence of numbers, hence ended up with a wrong value of half-life of the element.

2.1.12 Question 12: Waves

This question was asked as follows: *In determining the beat frequency of a guitar string and turning fork, two student teachers were assigned to strike a guitar string and sound a turning fork by hitting it on a rubber band. If the tension of the string was 129.6 N and the beat frequency obtained when the string and the turning fork sounded was 10 beats per second, calculate the frequency of turning fork if the tension on the string is raised to 160 N.*

The question was attempted by all 338 (100%) candidates, of whom 94.6 per cent failed. Further analysis of the candidates' performance is shown in Table 2.

Table 2: Distribution of the Candidates' Scores in Question 12

Scores	Description	Per centage of Candidates
0.0 - 5.5	Weak	94.6
6.0 - 10.0	Average	1.8
10.5 - 15.0	Good	3.6

Table 2 shows that the candidates' performance in question 12 was weak since 94.6 per cent scored below the average marks (0.0 to 5.5). Further analysis reveals that only 5.4 per cent of the candidates passed.

The candidates who scored low marks (0.0 – 5.5) demonstrated lack or partial knowledge of the sound waves concepts. These candidates either applied incorrect formula or lacked mathematical skills to calculate the frequency of turning fork. For example, one of the candidates incorrectly wrote: $Tension = beats \times frequency$. Another candidate wrote: $\frac{T_1}{f_1} = \frac{T_2}{f_2}$ instead of $\mathrm{f_n} = \frac{\mathrm{n}}{2\mathrm{l}}\sqrt{\frac{\mathrm{T}}{\mu}}$ to calculate the frequency of turning fork. Most of the candidates struggled to derive the relation between frequency f and tension T of the string. This relationship would have enabled them to arrive at the ultimate expression, $\mathrm{f_1} = \sqrt{\frac{\mathrm{T_1}}{\mathrm{T_2}}} \times \mathrm{f_2}$ which could have facilitated them to calculate the frequency of turning fork if the tension on the string is raised to 160 N. Consequently, they determined the frequency of string using improper relation $f \propto T$ and $T_1 f_1 = T_2 f_2 \rightarrow f_1 = \frac{T_2 f_2}{T_1}$. These candidates were not aware that frequency *(f)* in the string is direct proportional to square root of the tension *(*$\sqrt{T}$).

Moreover, some candidates confused the concept of beat frequency with elasticity found in properties of matter and restoring force in simple harmonic motion. For example, one of the candidates derived the expression of relating frequency and tension of the string as; $T \propto e \rightarrow T = ke \rightarrow T = m\omega e \rightarrow T = 2\pi fme$. Extract 12.1 shows a sample of incorrect responses from one of the candidates.

12	Data given
	Tension of spring (T) = 129.6 N
	Beat frequency (FB) = 10 beats per second
	Frequency of turning fork = ?
	The tension on the string is raised to 160N.
	From
	$\frac{V}{\lambda} = \frac{\lambda F}{\lambda}$
	Frequency = V/λ
	Beat frequency FB) = Frequency string – Frequency of turning fork.
	Tension = Mg
	Tension string = M.g ⊖1
	Tension increased to 160N
	$T_{string} = 2\pi\sqrt{L/g}$ ⊖1

Extract 12.1: A sample of an incorrect response to question 12

In Extract 12.1, the candidate applied the expression relating three terms to describe the wave motion (frequency f, wavelength λ and wave velocity v) and periodic time T in simple pendulum experiment instead of $f_1 = \sqrt{\frac{T_1}{T_2}} \times f_2$ which could be used to calculate the frequency of turning fork.

The candidates who scored average marks (6.5 – 10.0) lost some marks in substitution of the given values of tensions and beat frequency. Some of them gave incomplete procedures for deriving the formula to calculate frequency of turning fork.

On the other hand, the candidates who scored high marks (10.5 – 15.0) had sufficient knowledge about the sound waves, especially beat frequency of a string and turning fork. In addition, they were aware of the appropriate formula to calculate turning fork according to the given tension. Therefore, they properly followed the procedures for deriving the expression which has clear relationship of frequency *f* of turning and tension T of the string. Extract 12.2 is a sample of correct responses.

12	Solution.
	Data given
	Beat frequency $(Bf) = 10$ beat/Sec.
	First Tension $(T_1) = 129.6N$
	Second Tension $(T_2) = 160\ N$.
	Required to calculate the frequency of turning forks
	$(F) = ?$
	From frequency of string
	$f = \frac{V}{2L}$. but $v = \sqrt{\frac{T}{\mu}}$.
	$\cancel{f} = \sqrt{T/m}$
	$f = \frac{V}{2L}\sqrt{\frac{T}{m/L}}$.
	Then
	$f_1 = \frac{V}{2L}\sqrt{\frac{T_1}{m/L}}$ — (i)
	$f_2 = \frac{V}{2L}\sqrt{\frac{T_2}{m/L}}$ — (ii)
	$f_1 = \frac{V}{2L}\sqrt{\frac{129.6N}{m/L}}$ — (i)
	$f_2 = \frac{V}{2L}\sqrt{\frac{160N}{m/L}}$ — (ii)
	Beat frequency
	$Bf = f_2 - f_1$ if $f_2 > f_1$.
12 Cont.	
	Frequency of String at tension 129.6N is 90.09 Sec^{-1}
	Frequency after rising tension of string 160N is obtained to be 100.09 Sec^{-1}.

Extract 12.2: A sample of a correct response to question 12

2.1.13 Question 13: Teaching

The question asked as follows: *During the block teaching practice, the academic master appointed you to present a sample of a lesson notes on "global warming and greenhouse" for the period of 80 minutes to your fellow student teachers before actual teaching. Prepare a lesson notes for the topic given using five points.*

The question was attempted by all 338 (100%) candidates, of which 79.6 per cent passed, as shown in Figure 12.

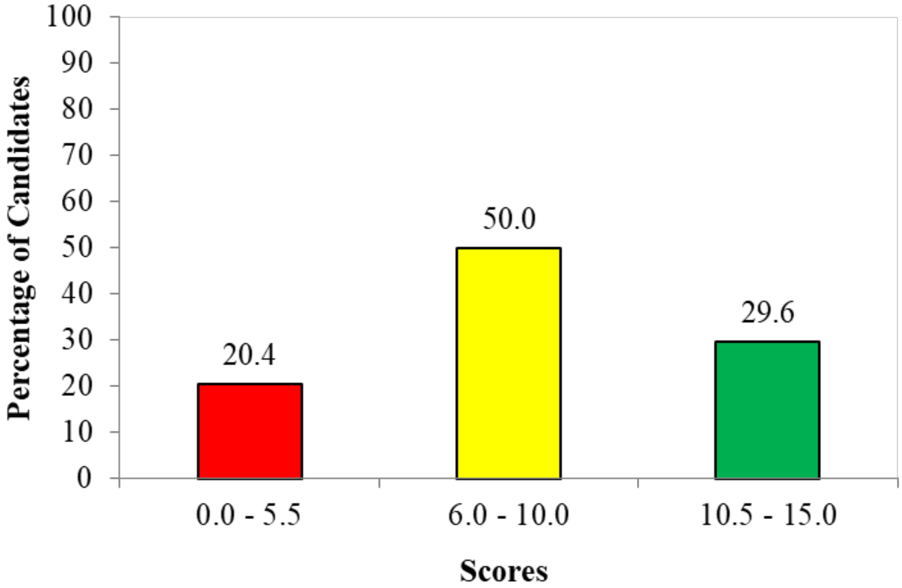


Figure 12: *Candidates' Performance in Question 13*

Figure 13 shows that the performance in this question was good since 79.6 per cent of the candidates scored above an average mark (6.0 - 15.0).

The candidates who scored high marks (10.5 – 15.0) correctly prepared the lesson notes on the topic of global warming and greenhouse. They demonstrated good mastery of the given topic because they gave correct descriptions about sources of green house, definition of global warming and greenhouse effect. In addition, they correctly highlighted the effects of global warming and ways to control global warming. Extract 13.1 is a sample of the correct responses from one of the candidates.

13

Global warming is the increase of the avarage temperature on the Surface of the earth. Green house effect is the Process in which the emission of radiation by atmosphere warms the earth Surface. Example of gases which cause green house effect are carbon dioxide, Sulphur dioxide, Burning of foisil fuels, mining of Coal and oil. ~~Green~~

The following are the effect of global warming to the atmospher

Increase in ~~the~~ temperature in the earth Surface, due to presence of global warming, the earth layer can be destructed therefore Sun rays come directly to the earth Surface and led to increase the atmospheric temperature

Rise Sea level, due to presence of global warming, ~~it~~ led to the increase of temperature in the atmosphere, this can cause melting of ice due to this can cause to increase level of water to ocean

Led to Low Production in agriculture activities due to increase in temperature in earth Surface it can led drought to the Surfce of the earth this can accelerate low Prodution in agriculture sector

Led to loss of biodiversity, due to global warming effect can cause loss of water this situation can accelerate small organism failure to get foods in order to

13 Cont.	
	live due to this can ~~cause~~ led to disappea
	rence of Small organism to the environment.
	Also led to deasertification, due
	to increase in temperature to the atmosphe
	re different ~~a~~ plants can disappeare due to
	lack of water due to this Situation can
	accelerate of deasertification to the earth
	Surfaces
	Also led to cancer to the human,
	due to presence of global warming effect
	~~to~~ led to the occurence of diseases like cancer
	this can caused by Sunlight from the
	earth.
	Generally, Global warming is very
	dangerouse to human being, therefore in
	order to removal this Problems to the
	Country, the government and societies
	can cooparate in order to make different
	ways to Sorve it. for example, to avoid
	deffforestation, bush fire, also Shifting
	Cultivation, and to educate societies about
	the importance of environmental conservation
	and involving in afforestation.

Extract 13.1: A sample of a correct response to question 13

The candidates who scored average marks (6.0 – 10.0) either explained two to three points or gave some unclear descriptions about global warming and greenhouse effect. They lost some marks because they were not aware of the sources of greenhouse gases and ways to control global warming.

On the other hand, the candidates who scored low marks (0.0 – 5.5) gave incorrect responses in all five points about global warming and greenhouse effect. A number of these candidates inaccurately interpreted global warming notes, mistakenly perceiving them as general steps for preparing notes. They outlined these steps as *introduction of the lesson*, *main body*, *summary and reference*. Other candidates incorrectly listed the stages of a lesson plan including; *introduction*, *knowledge*, *reinforcement*, *reflection* and *consolidation*. Moreover, some candidates confused the preparation of lesson notes on global warming with the steps for conducting group discussion in the classroom. One candidate outlined these steps as *preparing work or task*, *form a group of five students*, *distribute the task*, *each group marking discussion, teacher to give correction*. They were also candidates who wrote curriculum material instead of notes on global warming and greenhouse effect. For instance, one of the candidates listed *syllabus*, *scheme of work*, *lesson plan*. Extract 13.2 is a sample of incorrect responses from one of the candidates.

13 Cont.

lesson notes must be Main body: this is another Characteristics of lesson notes who head teacher we seen must have seen main body the lesson notes' In this Subtopic topic' lesson notes must be have Main body of the global warming and green house effect.' so any lesson ~~pla~~ notes we apparted to any person inorder to Chuote must have seen that this lesson notes in main body have Contain whow many time so good lesson notes must be had Main body

lesson notes must have Summary of the lesson; this is another Characteristic of good lesson notes because when any teacher prepared the lesson notes of any topic must he have Considered the Summary of the lesson inorder to Summarize same important point who Conducted in the lesson so must be ~~Good~~ Considered the Summary in the lesson notes inorder to be good lesson notes in whole process of teaching and learning.

lesson notes must have references: Another Characteristic of lesson notes which have Considered in any prepared of lesson notes inorder to be Good in conducted in Classroom so must he Consider the references which have the lesson will going to make Conclusion in whole process teaching and learning so inorder to teacher to make the lesson note was good Among of the Characteristic of references.

Extract 13.2: A sample of an incorrect response to question 13

In Extract 13.2, the candidate explained the characteristics of good notes instead of writing lesson notes on global warming and greenhouse effect as per the requirements of the question.

2.1.14 Question 14: Fundamentals of Teaching and Learning Physics

This question was asked as follows: *Suppose you have been invited by the District Education Officer to orient the newly employed teachers on the application of principles of teaching and learning Physics, what would be your explanations on the following principles?*

(a) A learning environment should be supportive, productive and safe.

(b) Students learn better from simple to complex.

This question was attempted by 100 per cent of the candidates, and 86.4 per cent passed. Further analysis of the candidates' performance is shown in Figure 13.

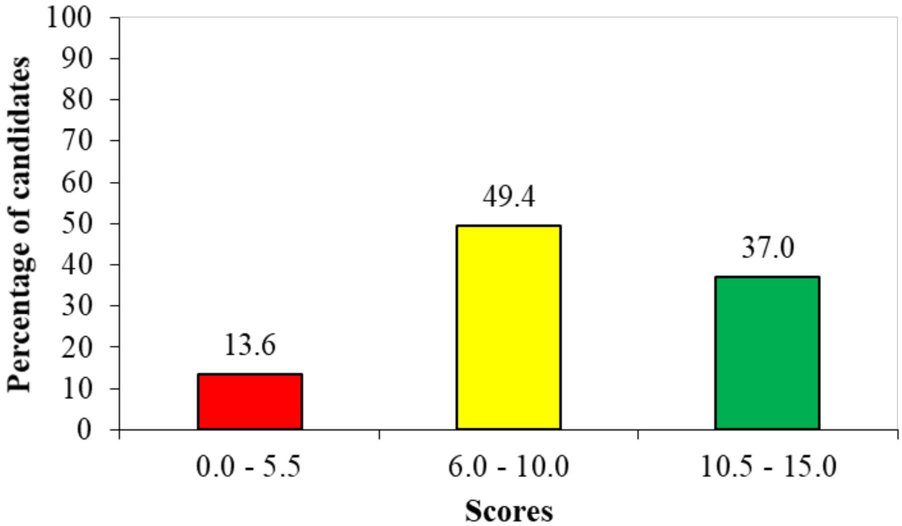


Figure 13: *Candidates' Performance in Question 14*

Figure 13 indicates the candidates' good performance in question 14. It shows that 86.4 per cent scored from 6.0 to 15.0 marks.

The analysis of the candidates' responses shows that the candidates who scored high mark (10.5 – 15.0) were managed to explain precisely the application of each of the given two principles of teaching and learning physics. They were aware that students learn better various physics concepts from simple ideas to complex ones, real to imaginary, whole to parts and known to unknown. They knew that topics in physics syllabus and text books are arranged basing on the principle of "simple subject matter to complex." The candidates' responses imply that, they had understood the topic of Fundamentals of Teaching and Learning Physics. Extract 14.1 shows a sample response from a candidate with good performance.

14 @ The following are the ways on how to apply a principle of teaching and learning physics which states that "A learnining environment should be supportive, productive and safe".

A teacher should ensure the availability of teaching and learning materials such as text books, supplementary materials, teachers guide, manual books. as well as other textual and non textual materials.

A teacher should ensure all the harmful apparatus and chemicals are stored in the fumes chamber so as to avoid contact with the students.

A teacher has to ensure the Fire extinguishers are there in class and laboratories as well as they are well and proper functioning so as to fight with fire if it happen suddenly.

A teacher has to ensure all classes are clean and laboratory rules are there and obeyed., this is done due to be safe in and out side of the laboratory.

A teacher has to use relevance and appropriate teaching methods and strategies while teaching a certain part in the subject matter.

A teacher should encourage active learning and enhances memory of the students so as to produce goods students with the high ability in creativity and innovation.

14 Cont. (b) The following are the ways on how to apply a principle of teaching and learning physics which state that "students learn better from Simple to Complex".

A teacher should start with know concepts to unknown concept, this means that a physics teachers haveto teach their studens from what they know to what they are supposed to know.

A physics teacher should start from whole to part, this means that a ~~phy~~ teacher has to generalize ideas and finally go straight to specific concept so as to avoid confusion to the students.

A teacher should start from real life situations to imaginary situations, this means from concrete to abstract, this is done in ord to simplify a learning process

A teacher should start to teach from simple or easy Ideas to complex or hard or difficult concepts this is also done in order to avoid confusion to the students and simplify learning process

Extract 14.1: A sample of a correct response to question 14

In contrast, the candidates who scored low marks (0.0 – 5.5) lacked knowledge on the principles of teaching and learning physics. They failed to explain the principles of "*learning environment should be supportive'* and "*students learn better from simple to complex"*. Most of them provided irrelevant explanations which do not reflect principles of teaching and learning physics. For example, one of the candidates wrote: *"teaching theory and practically of physics in real life situation, teaching by using question and answer"* and another candidate wrote: "*application of principle of teaching and learning materials of physics should depend on the teacher for arranging well according to the strategies and methods needed for teaching and learning process.*

Moreover, some candidates explained the concepts of laws and principles of physics instead of principles of teaching and learning physics. One of the candidates explained that *teaching creates in theoretically and practically of the subject, teaching and learning principles and law of physics, during teaching and learning process a teacher should teach the laws of Newton's and Bernoulli's principle practically.* Extract 14.2 shows one of the incorrect responses to the question.

14	(a) Means the learning process require the environment which enable
	learners to interact with them when they are doing or performing
	Various learning activities. Example: Learners who study science subject
	a laboratory should be a safe place for the learners to conduct Various
	experiment without causing any danger.

Extract 14.2: A sample of an incorrect response to question 14

In Extract 14.2; the candidate provided responses based on the topic of teaching and the concept of conducting physics practical instead of principles of teaching and learning Physics.

2.2 Physics 2 (Actual Practical)

The Physics actual practical paper consisted of three questions from three topics of *Mechanics*, *Heat* and *Current Electricity*. Question 1 carried 20 marks, while questions 2 and 3 carried 15 marks each, making a total of 50 marks. The candidates were required to answer all questions. The pass mark in question 1 was 8.0 marks while that of questions 2 and 3 was 6.0 marks. The analysis of the candidates' performance in each question is as follows:

2.2.1 Question 1: Mechanics

The question was as follows: *Suppose you are given an assignment to determine the gravitational pull strength of your school area so that you can be able to determine the weight of objects and you are given the following materials: metre rule, retort stand, stopwatch, inextensible string, pendulum bob and two wooden pads. Conduct the experiment through the following procedures and answer the questions that follow.*

Procedures:

(a) Fix one end of an inextensible string on the retort stand. Tie a pendulum bob to the other end as shown in Figure 1.

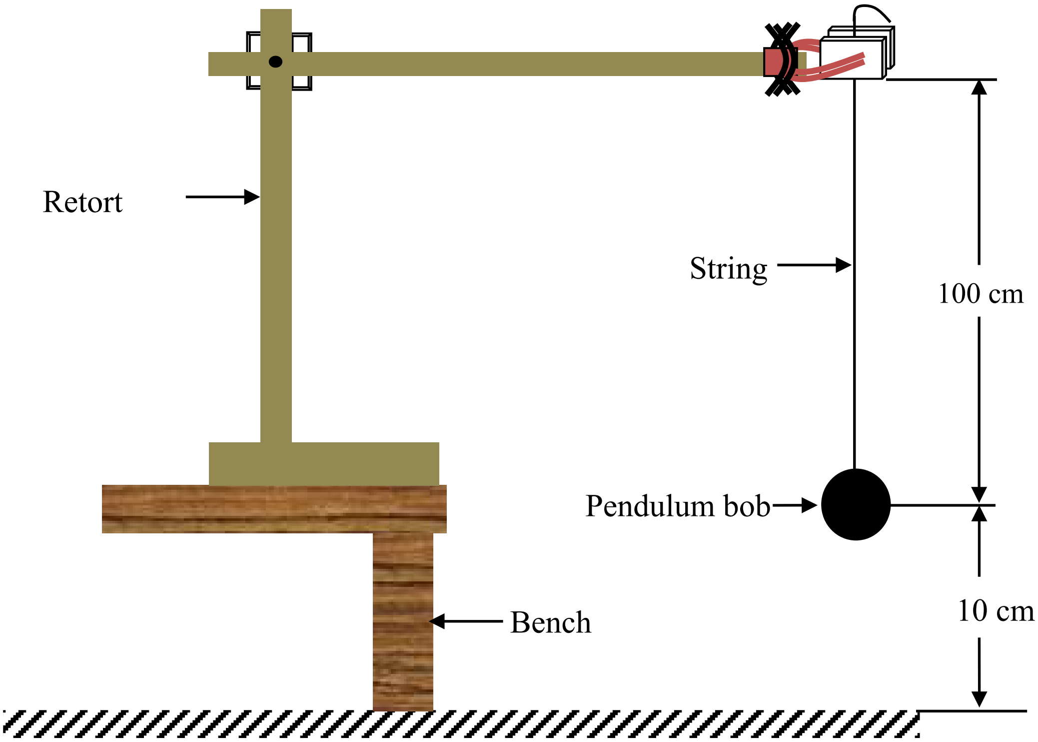


Figure 1

(b) *Measure the height, (h) = 10 cm from the ground to the centre of mass of the bob.*

(c) *Slightly displace the bob and release to let it oscillate freely and record the time for 20 complete oscillations.*

(d) *Repeat procedures in 1(b) to (d) for values of h = 20, 30, 40, 50, 60, 70 and 80 cm.*

Questions

(i) *Tabulate the results including the corresponding values of periodic time.*

(ii) *Plot a graph of h (m) against T^2 (sec^2).*

(iii) *Find the intercept of your graph.*

(iv) *Determine the slope S of your graph. What does it imply?*

(v) *What is the value of gravitational pull at your center?*

(vi) *Suppose the amplitude of vibration diminishes due to increased air resistance, will the periodic time for 20 complete oscillations be different? Briefly explain.*

The question was attempted by all 338 (100%) candidates, out of whom 69.8 per cent passed. Figure 14 summarizes the candidates' performance in this question.

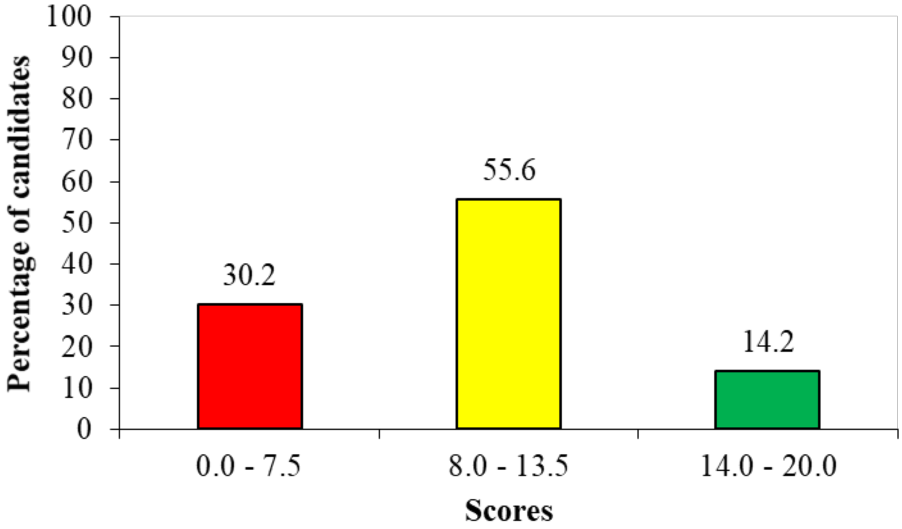


Figure 14: *Candidates' Performance in Question 1*

Figure 14 reveals that the candidates' performance in question 1 was average because 69.8 per cent of the candidates scored 8.0 to 20.0 marks.

Further analysis shows that the candidates who scored high marks (14 - 20) had sufficient knowledge about determination of gravitational pull using simple pendulum experiment. These candidates demonstrated adequate competence in assembling apparatuses as well as recoding correct data of height (h) from the ground and time (t) for 20 oscillations period. The candidates correctly drew a graph of h (m) against $T^2(s^2)$ using proper scales. In addition, they deduced the formula $h = -\frac{gT^2}{4\pi^2} + H$ from $T = 2\pi\sqrt{\frac{l}{g}}$. Also, they correctly identified h intercept, determined the slope S from the graph and found the gravitational pull g in acceptable SI units. Moreover, they correctly explained the effect of reducing amplitude to the periodic time of oscillation. Extract 15.1 shows the correct responses from one of the candidates.

1 Q7.

i). Table of result.

h (m)	t (sec)	T (sec)	T^2 (sec^2)
0.1	40	2	4.00
0.2	37.94	1.897	3.60
0.3	35.78	1.789	3.20
0.4	33.46	1.673	2.80
0.5	30.98	1.549	2.40
0.6	28.28	1.414	2.00
0.7	25.38	1.269.	1.60
0.8	21.9.	1.095.	1.20

ii) Consider to the graph paper.

iii). From the graph the intercept (h-intercept) is 1.1m.

iv). $\text{Slope } (S) = \dfrac{\Delta h\,(m)}{\Delta T^2\,(sec^2)}$.

$$S = \frac{(0.96 - 0.32)\,m}{(3.12 - 0.8)\,sec^2}.$$

$$= 0.25\,m/sec^2.$$

v). From the period.

$$T = 2\pi\sqrt{\frac{H-h}{g}}.$$

Where by,

1 Cont.

v) H – length from the retort stand to the ground,

h – length from the ground to the center of the bob,

Hence,

$$T = 2\pi\sqrt{\frac{H-h}{g}}$$

$$T^2 = 4\pi^2 \frac{H-h}{g}$$

$$T^2 = \frac{4\pi^2 H}{g} - \frac{4\pi^2 h}{g}$$

$$\frac{4\pi^2 h}{g} = -T^2 + \frac{4\pi^2 H}{g}$$

$$h = -\frac{g}{4\pi^2} T^2 + \frac{4\pi^2}{g} H$$

$$y = -S\,T^2 + c$$

where $-S$ = slope.

Then, Slope $S = g/4\pi^2$.

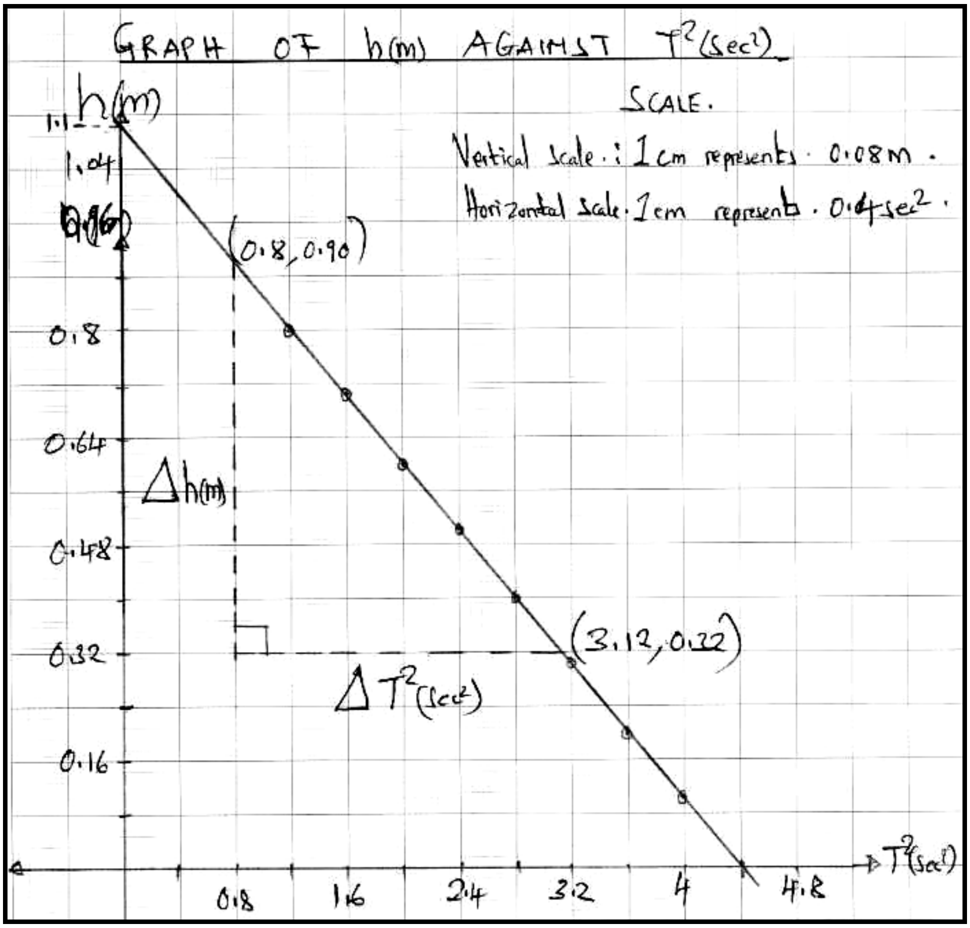
where g = gravitational pull,

$$g = 4\pi^2 S$$

$$= 4\pi^2 \times 0.25\ m/s^2$$

$$= 9.869\ m/sec^2$$

$\therefore$ The value of gravitational pull is $9.869\ m/sec^2$.



Extract 15.1: A sample of a correct response to question 1 of Paper 2A

The candidates with average scores (8.0 – 13.5) provided incorrect responses in some parts of the question. Some of these candidates collected appropriate data; tabulated the results; and plotted the graph correctly but failed to draw the best line of a graph because of incorrect transfer of data points from the table of values. Others chose an incorrect scale which was rough to observe accurate points plotted on a graph. In addition, some of the candidates calculated correctly the slope 'S' but wrote incorrect units. Some of these candidates failed to provide the implication of the slope S of the graph. For example, one of the candidates incorrectly wrote; *the slope (S) implies the original length of the thread used*. Another candidate explained that *it implies that the height from the ground to the of a bob changes per second square.* Their responses indicate that they were not aware that slope S mean rate of retardation ($-0.288\,ms^{-2}$).

However, some of the candidates who scored low marks (0.0 - 7.5) did not collect the data properly due to the failure of setting the apparatuses as indicated in the diagram. In data collection, some of them failed to convert centimeter (cm) into metres (m). They just used raw data in the table of results and plotted a graph using cm in instead m. They drew the graphs without indicating the title, axes, scales, best line and slope. Some of the candidates lacked knowledge of how to determine the slope of the graph and thus failed to provide the correct answers to other parts of the question. For example, some candidates did not draw the graph which was a necessary step to compute the slope, instead they just used the data collected from the experiment to determine the slope, contrary to the requirement of the question.

Other candidates provided incorrect explanation regarding the effect of reducing amplitudes to periodic time of the bob. For instance, one candidate wrote *yes, it can differ because air resistance course amplitudes reduce periodic time*. Another candidate explained that *the number of periodic time for 20 complete oscillation will be different because the acceleration will be maximum* and the other added that, *periodic time will be different because the air resistance disturb the direction of bob*. These candidates were supposed to realise that the period of oscillation T will remain constant because the periods depend on the length *l* of the pendulum bob and not on the amplitude of oscillation. Extract 15.2 is a sample of incorrect responses.

1

i) TABLE OF RESULTS

height, h (cm)	10	20	30	40	50	60	70	80
time for 20osc, t, sec	1·2	1.14	1.08	0.98	0.9	0.8	0.7	0.58
periodic time, T (sec)	0.06	0.057	0.054	0.049	0.045	0.040	0.035	0.029
square periodic time, T^2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

iii) intercept of the graph will cut at 100 value.

Extract 15.2: A sample of an incorrect response to question 1 of Paper 2A

In Extract 15.2 the candidate gathered incorrect data and he/she did not draw the graphs based on the collected data to obtain a slope S and intercept.

2.2.2 Question 2: Heat

This question was as follows: *In the heating experiment you observed that, when substances made of the same material are exposed at the same initial temperature and then allowed to cool, their rate of cooling differs depending on various factors. Then, you decide to carry out an experiment to investigate the rate of cooling.*

If you are provided with the following apparatuses and materials: A calorimeter with jacket and stirrer, thermometer, hot water (to be fetched from heat source) and stop watch, perform the experiment through the given procedures and answer the questions that follow.

Procedures:

(a) *Weigh and determine the mass of an empty calorimeter (without its outer jacket)*

(b) *Half fill* $\left(\frac{1}{2}\right)$ *the calorimeter with hot water about 90 °C, and place the calorimeter in its jacket. Place the lid with stirrer and finally insert the thermometer. Wait for the temperature of the water to reach 85 °C.*

(c) *Observe and record the temperature of the contents for every 2 minutes as it cools from 85 °C to 50 °C. Remove the calorimeter from the jacket and measure the mass of calorimeter with water but without its outer jacket.*

(d) *Repeat the procedures in 2 (b) and (c) with the calorimeter about three quarter* $\left(\frac{3}{4}\right)$ *full of water.*

Questions

(i) *Tabulate the results for both half and three quarter full including time and temperature for each case.*

(ii) *Plot the cooling curves for both half and three quarter full in the same frame of axes.*

(iii) *Use the two curves to obtain the ratio* $\frac{1}{2}\text{ full} : \frac{3}{4}\text{ full}$ *of the times taken for both to cool from 85 °C to 60 °C.*

(iv) *What conclusion can you draw on the ratio obtained in 2 (iii)?*

(v) *Using your graph, comment how a quantity of a body/substance affects its rate of cooling?*

The question was attempted by all 338 (100%) candidates, of which 32.9 per cent scored from 6.0 to 10.0 marks and 12.7 per cent scored from 10.5 to 15.0 marks. The candidates' performance in this question is illustrated in Figure 15.

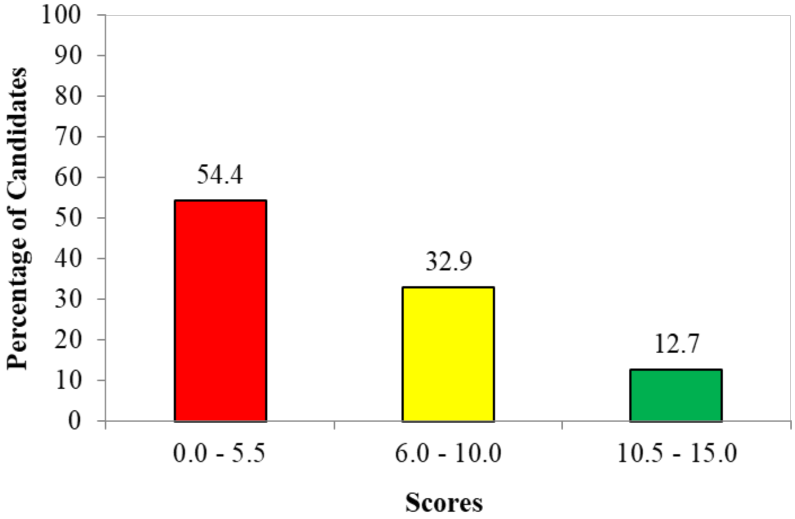


Figure 15: *Candidates' Performance on Question 2*

Figure 15 shows that the candidates' performance in question 2 was average since about a half (45.6%) of the candidates scored average and above (6.0 – 15.0) marks.

The candidates who scored high marks (10.5 – 15.0) in this question demonstrated the necessary skills for conducting the experiment on heat transfer by convection, particularly the concept of rate of cooling in liquids. The analysis indicates that these candidates had sufficient knowledge of Newton's law of cooling. They correctly collected data for half fill $\left(\frac{1}{2}\right)$ and $\left(\frac{3}{4}\right)$ calorimeter, plotted curves in the same axis and correctly determined the time taken to cool both liquids from 85 °C to 60 °C. Furthermore, the candidates provided a clear conclusion regarding the ratio of time to cool from 85 °C to 60 °C and recommended that the larger the quantity of substance at a given temperature the less the rate of cooling. Extract 15.1 is a sample of correct responses to this question from one of the candidates.

2

(i) Table of Results for ½

θ°c	t (min)
85	0
79	2
72	4
69	6
64	8
62	10
60	12
56	14
54	16
52	18
50	20

Table of results for ¾

θ°c	time (min)
85	0
82	2
77	4
75	6
72	8
69	10
67	12
64	14
60	16
57	18
55	20
53	22

2 Cont.

(ii) Ratio of times for ½ and ¾ (85° → 60°c)

then

for ½ of calorimeter

– time used = 12 min

for ¾ of calorimeter

- time used = 16 min

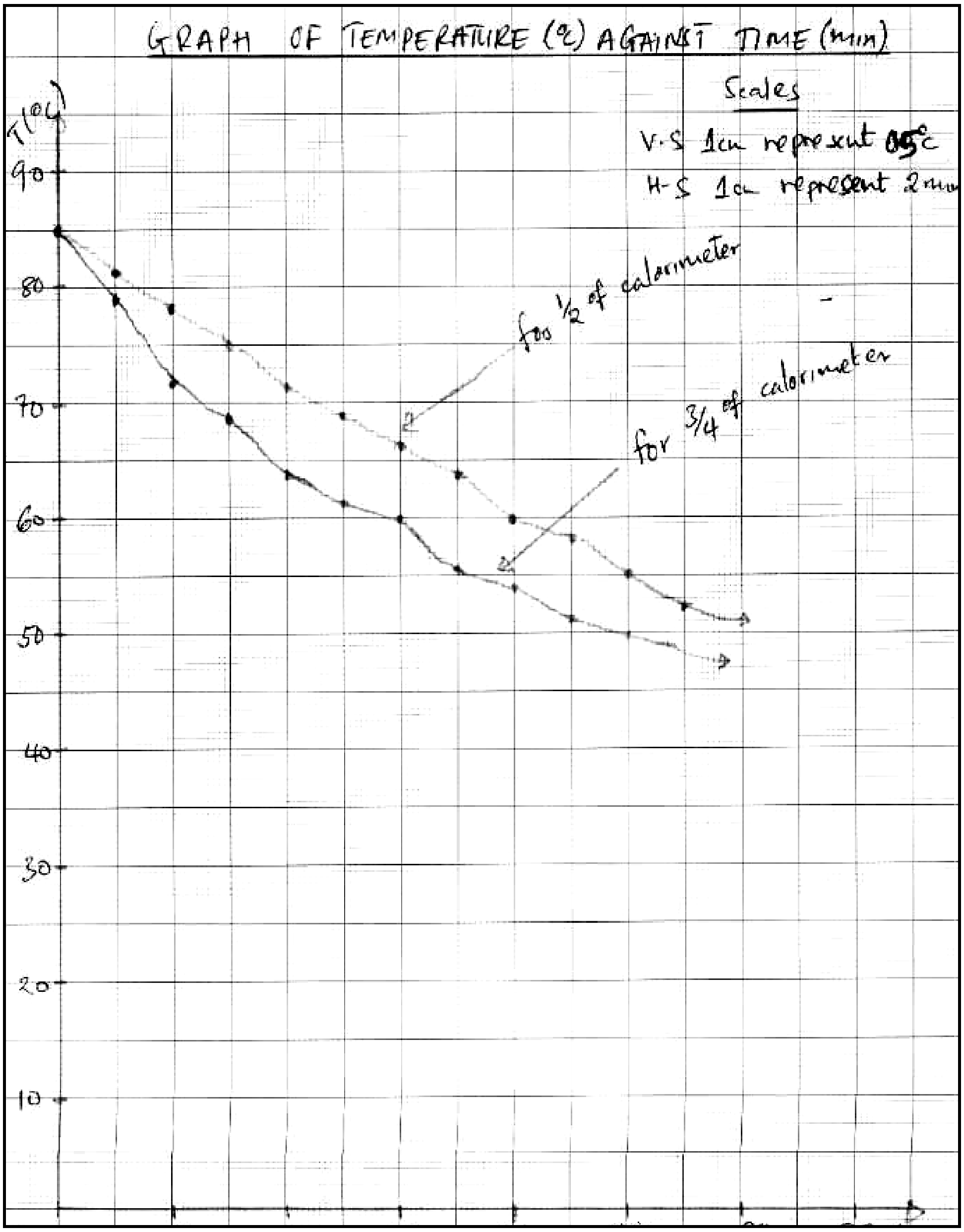
∴

Ratio $= \frac{12}{16} = 0.75$

Ratio of time was 0.75

(iv) The calorimeter with ¾ of water, its rate of cooling was low as compared to the calorimeter with ½ of water, hence, in small amount of liquid or water, the rate of cooling is so high.

(v) Yes, there is effect of quantity of substance as we have done experiment and it shows, in the calorimeter with high amount of water (the rate of cooling is too low/slow compare to the calorimeter with few amount of water.



Extract 16.1**:** A sample of a correct response to question 2 of Paper 2A

However, the candidates who scored average marks (6.0 – 10.0) had limited ability to effectively organize the given apparatuses and analyse the rate of cooling under Newton's law of cooling. Those candidates measured inaccurately the mass of calorimeter when it is half full and when it is two third full of water. Additionally, some of them had problems with reading a stopwatch when recording temperature after every 2 minutes. However, they got some marks on procedures of plotting curve and provided

insightful comments in part (iv) of the question.
The candidates who scored low marks (0.0 – 5.5), including 12.1 per cent who scored zero, demonstrated lack of knowledge about the concepts of thermal convection particularly Newton's law of cooling. Most of them failed to collect the appropriate data and chose a wrong scale to plot the cooling curve in part (ii) of the question. They also lacked mathematical skills necessary to calculate the ratio of cooling time from 85 °C to 60 °C. As an example, one candidate wrote: *the ratio between* $\frac{1}{2}$ *full and* $\frac{3}{4}$ *full at the time taken is almost the same because it has close range.* Another candidate wrote: *the ratio of the two water* $= \left(\frac{1/2}{3/4} \right) = 2$. In addition, some candidates failed to draw conclusion regarding the ratio of time taken to cool liquids accordingly. For instance, one candidate concluded as *the ratio shows that the time taken to cool the water in the calorimeter has no significant difference therefore the rate of cooling of temperature is always the same*. Another candidate stated that *ratio is the rate of the cooling of body is direct proportional to surrounding temperature.*
collected wrong data values and attempted to plot a graph without showing. They should have concluded that the $1/2$ full filled calorimeter would cool more easily than the $3/4$ full filled calorimeter.

Furthermore, they did not comment on the effect of the quantity of a substance to the rate of cooling. For example, one candidate commented that *when time increases the rate of cooling decreases.* Another candidate commented that *quantity of a body will increase in the calorimeter leads to lose the temperature in the surrounding slow*. Their responses indicate they were unaware that a larger quantity of substance at a particular temperature results in a slower rate of cooling. Extract 16.2 presents a sample of the incorrect responses.

2

a) The Mass of an empty Calorimeter = 39.2g.

i) TABLE OF RESULTS:

θ °C ½	θ °C ¾	Time
85 85	85	0
81 77	81	2
77 71	77	4
73 66	73	6
66 58	66	8
58 54	58	10
55 52	55	12
50 50	50	14

iii) from the graph the temperature when Decrease the time also Increases.

Extract 16.2: A sample of an incorrect response to question 3 Physics 2A

In Extract 16.2, the candidates provided a wrong table of values, and consequently failed to draw the graphs on the same axis.

2.2.3 Question 3: Current Electricity

The question was as follows: *You were assigned to install electricity to a new secondary school building. The district electric department provided you with two standard resistors labeled R_1 and R_2 each having 1 Ω, four standard resistors (2 Ω, 3 Ω, 4 Ω and 5 Ω), switch (K), voltmeter (V), ammeter (A) and connecting wires. Design a circuit having two loads labeled R_1 and R_2 connected in such a way that, the voltage drop across the two loads is the same. Following the procedures provided, perform an experiment and then answer the questions that follow.*

Procedures:

(a) Complete a design by connecting a switch and two dry cells provided.

(b) Close the switch, K and quickly record the reading on the ammeter and voltmeter.

(c) Replace R_2 with R_o = 0 Ω and quickly record simultaneously the reading on the ammeter and voltmeter.

(d) Repeat procedure 3 (c) for R_o = 2 Ω, 3 Ω, 4Ω and 5 Ω.

Questions

(i) *Tabulate your results as shown in the following table:*

R_o (Ω)	0	1	2	3	4	5
P.d (V)						
I (A)						

(ii) *Draw a well labeled diagram for the experimental set-up.*

(iii) *Evaluate the validity of the Ohm's law in this experiment.*

(iv) *Deduce mathematical relation that can be used to evaluate the equivalent resistance (R_{eq}) when R_o = 10 Ω.*

(v) *Plot a graph of P.d (V) against I (A) and then comment on the numerical values of slope and intercept.*

The question was attempted by all 338 (100%) candidates, but 90.5 per cent of them failed. Further analysis of the candidates' performance is shown in Table 3.

Table 3: Distribution of the Candidates' Scores in Question 2

Scores	Description	Per centage of Candidates
0.0 - 5.5	Weak	90.5
6.0 - 10.0	Average	9.2
10.5 - 15.0	Good	0.3

Table 3 indicates the candidates' weak performance in question 3. It shows that 90.5 per cent scored below the average marks (0.0 to 5.5) and only 9.5 per cent scored above the pass marks (6.0 to 15.0).

The candidates who scored low marks (0.0 – 5.5) were incompetent in connecting simple electric circuit. These candidates failed to record data from either ammeter or voltmeter which led them to tabulate the results with incorrect data. For example, one of the candidates drew a table of values with only one column of current (I) readings and ignored the column of voltage (V). Moreover, the candidates failed to plot graph due to the missed data. Other candidates collected and tabulated the wrong data, and plotted inappropriate graph of P.d (V) against I (A). For example, one of the candidates plotted an incorrect graph by using the following data; *value of V (1.6, 1.3, 1.0, 0.89, 0.8, and 0.65) and their corresponding value of I were (0.7.0.5,0.4, 0.32, 0.3, and 0.25) respectively.* In these data, the value of voltage is directly proportional to current I which gave a positive slope instead of negative slope according to the set-up of the experiment.

In addition, they incorrectly sketched a diagram for the experimental circuit and they demonstrated lack of skills to manipulate the mathematical relation that is used to evaluate the equivalent resistance. For instance, one candidate derived as; $E = I\left(R_o + r + R_e\right) \rightarrow R_e = \frac{E - 10I - Ir}{I}$ instead of $R_e = \frac{10R_1}{10 + R_1}$.

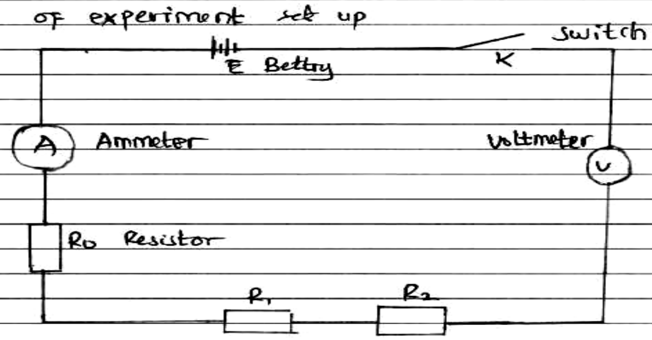
Furthermore, they rewrote the procedures of the question instead of answering the question items. The candidates also wrongly evaluated the validity of Ohm's law in part (ii) of the question. One of the candidates stated that *Validity of Ohm's law can be applied at constant temperature and other physical factors*. Another candidate explained that *the validity of Ohm's law is because the amount of current uses in a conductor was determined by the change of resistance*, and another one wrote; the *validity of Ohm's law is the resistance is increased, the length of the wire the cross-section areas decrease*. The candidates were supposed to realize that according to the data and graph, the experiment does not obey Ohm's law. They failed to give reasonable comment either on slope or intercept in part (v) of the question. They failed to recognize that the voltage drop across the two loads is the same if the connection is parallel. Extract 17.1 is a sample of incorrect responses from one of the candidates.

3 The aim of this experment is to verfy Ohm's law

i Table of result

R_o (Ω)	0	1	2	3	4	5
P.d (V)	0.00	1.50	2.0	2.30	2.40	2.50
I (A)	3.0	1.5	1.0	0.78	0.6	0.5

ii Diagram of experiment set up



Extract 17.1: A sample of an incorrect response to question 3 of Physics 2A

In extract 17.1, the candidate prepared an incorrect table of results and drew wrong electric circuit. Moreover, R_1 and R_1 were supposed to be in parallel with voltmeter. He/she also wrongly included R_o in the circuit.

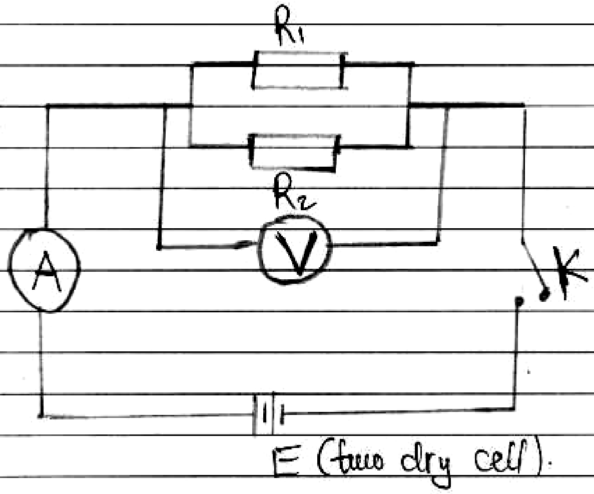
The candidates with average scores (6.0 – 10.0) provided correct responses to some parts of the question. Some of these candidates collected appropriate data, tabulated the results, and plotted the graph correctly. Most of these candidates failed in parts (ii), (iv) and (v) of the question. They were not able to assess the validity of Ohm's law on the bases of the experiment. Others failed to deduce mathematical relation of equivalent resistance (R_e). Furthermore, they failed to comment on the numerical slope value and intercept from the graph of P.d (V) against I (A). For example, one of the candidates commented that *the numerical value of the slope and intercept shows the current passing is direct proportional to the potential difference.* Another candidate wrote; *the slope imply the standard resistor* R_1 *and* $R_1 = 1$ *and the* $y-$ *and* $x-$ *intercepts imply the graph is passing exactly across the original.* The other candidate stated that *numerical slope will be equal to the value of* R_o *and for intercept will be equal to the value of equivalent resistance* R_{eq}. They were supposed to comment that, slope represents internal resistance of the two cells and the y- intercept represents the emf of the two dry cells.

The candidates who scored high marks (10.5 – 15.0) had sufficient knowledge of the concepts of Current electricity, especially the simple electrical circuit. They properly connected an electric circuit, which enabled them to collect the exact data values of voltage (V) and current (I). These candidates had good skills in drawing the graph of voltage (V) against current (I) and on calculating the slope (S). The candidates also correctly identified the physical meaning of a slope of as internal resistance r of the two cells. Extract 17.2 displays an example of good responses from one of the candidates.

3	
3	(i) Table of results.

$R_o (\Omega)$	0	1	2	3	4	5.
P.d (V)			1.6	1.7	1.8	1.8
I (A)	2		1.9	1.8	1.7	1.6

ii)



3 Cont.

iv) $\frac{V}{R_{eq}} = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

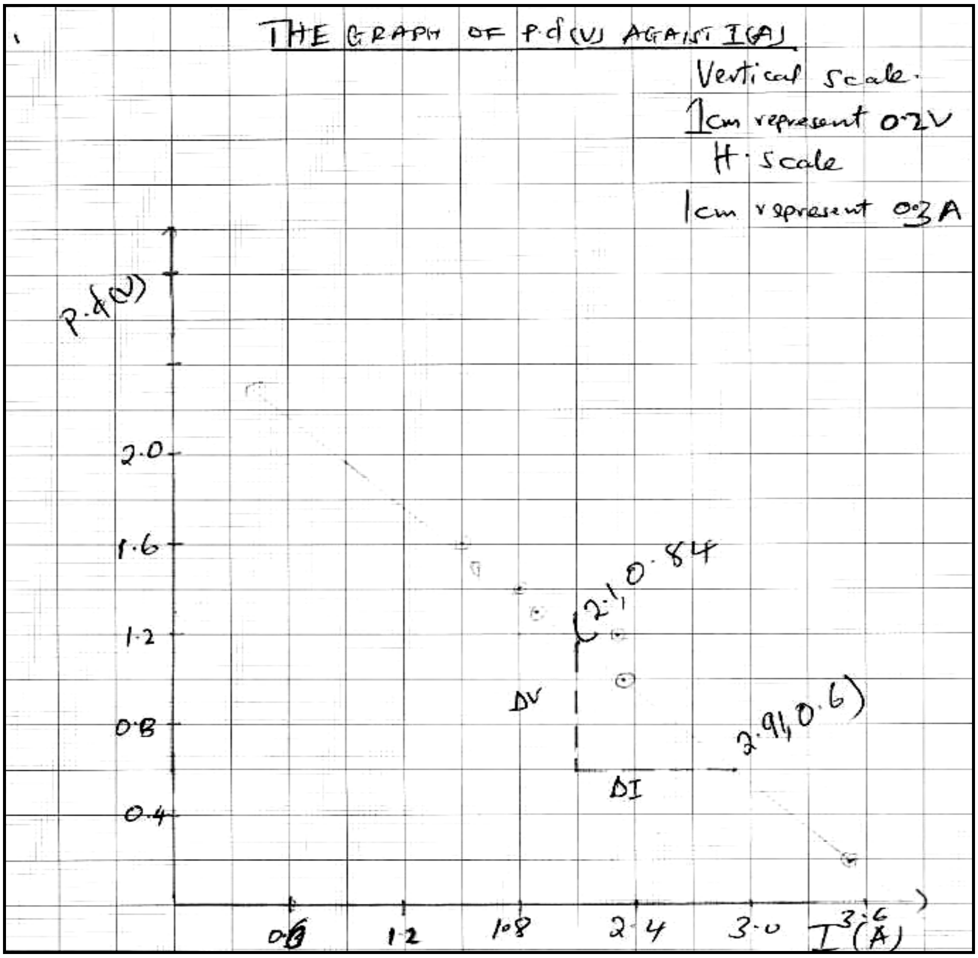
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{eq}} = \frac{R_2 + R_1}{R_1 \times R_2}.$$

By resprocal

$$R_{eq} = \frac{R_1 \times R_2}{R_1 \ R_2}.$$

$$R_{eq} = \left(\frac{R_2 R_1}{R_1 + R_2}\right)$$



Extract 17.2: A sample of good response to question 3 of Physics 2A.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH TOPIC

The Physics examination covered a total of 12 topics. These topics were *Measurements, Properties of Matter, Mechanics*, *Heat, Current Electricity, Electronics*, *Planning for Teaching, Physics Laboratory Management, Atomic Physics*, *Waves, Teaching* and *Fundamental of Teaching and Learning Physics.*

The analysis of the candidates' responses in each topic in Physics 1 indicates good performance in the topics of *Physics Laboratory Management* (86.7%), *Fundamental of Teaching and Learning Physics* (86.4%), *Teaching* (79.6%), *Electronics* (72.5%) and *Planning for Teaching* (70.3%). On the other hand, average performance was observed in the topics of *Properties of Matter* (63.9%), *Heat* (47.6%), *Atomic Physics* (45.9%) and *Measurements* (42.6%). Moreover, the topics of *Mechanics* (21.3%), *Current Electricity* (24.5%) and *Waves* (5.4%) had weak performance (See Appendix I).

Further analysis reveals that the topic of *Fundamental of Teaching and Learning Physics* and *Teaching* have maintained good performance in 2022 and 2023. The performance in the topics of *Physics Laboratory Management* and *Electronics* has improved from average and weak performance in 2022 to good performance in 2023. Furthermore, the performance in the topics of *Heat* and *Measurements* has improved from weak in 2022 to average performance in 2023. However, the performance in the topics of *Mechanics*, *Current Electricity* and *Waves* has continued to be weak in 2022 and 2023 (See appendix III).

On the other hand, the analysis in Physics 2 (Actual Practical Paper) revealed that, the topics of *Mechanics* and *Heat* have average performance while the topic of *Current Electricity* was weakly performed (See appendix II).

4.0 CONCLUSION

In general, the candidates' performance in Physics was good as 96.93 per cent of the candidates passed the examination. The good performance was due to the candidates' ability to identify the task of the questions, skills on the subject matter, good mathematical skills and correct application of the theories and principles in interpreting scientific observation. They were able to explain and elaborate the points using appropriate Physics principles and theories.

On the other hand, the reasons for weak performance included lack of knowledge of the concepts in the questions, inability to express and deduce formulas and misinterpretation of some Physics principles and theories.

5.0 RECOMMENDATIONS

For future improvement of the candidates' performance in Physics examination, tutors are advised to:

(a) use demonstration method in teaching the concepts of motion of bodies sliding on horizontal plane, connection of simple electric circuit and velocity of sound in air using turning fork. This will help learners to determine the distance of moving bodies on horizontal plane and to derive equivalent resistance for multiple resistors in parallel or series in electrical circuit, and relationship between frequency and tension of the string;

(b) emphasize learning by doing through conducting various experiments in the topics of *Current Electricity* and *Waves*. The experiment should base on the concepts of Ohm's law and velocity of sound in air using turning fork. This will help the candidates to acquire skills about connections of multiple resistors and determination of beat frequency;

(c) apply deductive inquiry method in teaching and learning processes in the topics of *Mechanics, Current electricity* and *Waves,* especially the subtopic of *Gravitation*, *Simple Electric Circuit* and *Sound Waves*. The method helps learners to develop competencies and skills of derivation of formula of Newton's law of universal gravitation, equivalent resistance and beat frequency.

(d) use questions and answer, group discussion and presentation methods when teaching the topic of *Mechanics*, *Current Electricity* and *Waves* specifically the concepts of gravitation, simple electric circuit and sound waves respectively as it will enhance learners to share knowledge and skills.

(e) develop student teachers' attitude of reading different textbooks and reference books in order to promote their knowledge of different concepts, theories and laws of Physics.

Appendix I

Summary of the Candidates' Performance in each Topic in 731/1 Physics 1

No.	Topic	Question Number	Performance in each question (%)	Average performance per topic (%)	Remarks
1.	Physics Laboratory Management	10	86.7	86.7	Good
2.	Fundamentals of Teaching and Learning Physics	14	86.4	86.4	Good
3.	Teaching	13	79.6	79.6	Good
4.	Electronics	7	72.5	72.5	Good
5.	Planning for Teaching	8	55.3	70.3	Good
		9	85.2		
6.	Properties of Matter	2	63.9	63.9	Average
7.	Heat	4	47.6	47.6	Average
8.	Atomic Physics	11	45.9	45.9	Average
9.	Measurement	1	42.6	42.6	Average
10.	Mechanics	3	8.0	21.3	Weak
		5	34.6		
11.	Current Electricity	6	19.5	19.5	Weak
12.	Waves	12	5.4	5.4	Weak

Appendix II

Summary of the Candidates' Performance in each Topic in 731/2A Physics 2A (Actual Practical)

No.	Topic	Question Number	Performance in each question (%)	Average performance per topic (%)	Remarks
1.	Mechanics	1	69.8	69.8	Average
2.	Heat	2	45.6	45.6	Average
3.	Current Electricity	3	9.5	9.5	Weak

Appendix III

Comparison of the Candidates' Performance in each Topic in 731 Physics DSEE between 2022 and 2023

No.	Topic	2022			2023		
		Question Number	Average performance per topic (%)	Remarks	Question Number	Average performance per topic (%)	Remarks
1.	Physics Laboratory Management	8 &9	48.8	Average	10	86.7	Good
2.	Fundamentals of Teaching and Learning Physics	10	90.8	Good	14	86.4	Good
3.	Teaching	14	88.8	Good	13	79.6	Good
4.	Electronics	7	18.6	Weak	7	72.5	Good
5.	Planning for Teaching	-	-	-	8 &9	70.3	Good
6.	Properties of Matter	2	61.4	Average	2	63.9	Average
7.	Heat	11	7.7	Weak	4	47.6	Average
8.	Atomic Physics	5	61.7	Average	11	45.9	Average
9.	Measurement	1	12.6	Weak	1	42.6	Average
10.	Mechanics	3 &4	9.6	Weak	3 &5	21.3	Weak
11.	Current Electricity	12	3.9	Weak	6	19.5	Weak
12.	Waves	6	22.1	Weak	12	5.4	Weak