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) 2022

PHYSICS

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731 PHYSICS

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FOREWORD

The National Examinations Council of Tanzania (NECTA) is pleased to issue this report on the Items Response Analysis of the Performance of Candidates for Diploma in Secondary Education Examination (DSEE) 2022 for Physics subject. The report aims at giving feedback to stakeholders about the performance of candidates and the extent to which the instructional objectives were met.

The Diploma in Secondary Education Examination is a summative evaluation which among other things shows the effectiveness of the education system in general and Diploma in Secondary Education in particular. Essentially, responses to examination questions are strong indicators of what the education system was able to offer to the students in the Diploma in Education Course.

The report analyses the performance of the candidates and the reasons behind their good or poor performance in each question. For those who scored high marks, the factors include adequate knowledge on various concepts of the subject, ability to identify the task of the questions, good mathematical skills, English language proficiency and possession of good drawing skills, and correct application of the principles and laws of interpreting scientific observations. For those who demonstrated poor performance, their responses exhibited a lack of those qualities.

The feedback provided in this analysis will enable educational administrators, college managers, tutors, student-teachers and other stakeholders to identify proper measures to improve candidates' performance in future examinations administered by the Council.

The Council would like to express sincere appreciation to all who played a role in the preparation of this report.

Athumani S. Amasi
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report analyses the candidates' responses in Physics subject for the candidates who sat for DSEE in May 2022. It delivers feedback to educational stakeholders on the strengths and weaknesses of the candidates' performance.

The DSEE 2022 Physics examination paper covered the 2009 academic and pedagogy syllabus which was set based on the 2021 Physics revised Examination Format. The examination comprised of two papers; Physics 1 which is a theory paper and Physics 2 which is a practical paper.

The Physics 1 consisted of sections A and B with a total of fourteen (14) questions. Section A consisted of ten (10) short-answer questions, out of which seven (7) questions assessed the academic content and three (3) questions assessed pedagogical content, each carrying 4 marks. Sections B had four (4) structured questions, out of which two (2) questions assessed academic and two (2) pedagogical contents. The questions were set from different topics. Each question carried 15 marks. The candidates were required to answer all questions from both sections A and B.

On the other hand, Physics 2 consisted of three actual practical equivalent alternative papers A, B and C, with three (3) questions. Question 1 was set from the topic of *Mechanics* and carried 20 marks while question 2 and 3 was set from the topics of *Heat* and *Current Electricity* respectively. Each question carried 15 marks. The candidates were required to attempt all questions.

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

The candidates' performance on each question has been classified into three categories which are good, average and weak. Good performance ranges from 70 to 100 per cent, average from 40 to 69 per cent and weak from 0 to 39 per cent. Green, Yellow and Red colours are respectively used in charts or graphs to represent these categories.

A total of 1,708 candidates sat for 731 Physics examination in 2022. Among them, 1612 (96.18%) passed the examination while 96 (3.82%) failed. The candidates' performance in this year has increased by 1.23 per cent compared to that of 2021 in which 94.95 per cent of the candidates passed. The analysis of the candidates' performance in 2022 as compared to that of 2021 and 2020 is shown in Table 1.

Table 1: The Percentage of Performance of Candidates in Terms of Grades from 2020 to 2022 in Physics Subject

Year	Sat	Number of Candidates and Percentage						
		Passed	Grades				
			A	B	C	D	F
2022	1,708	1,612	0	17	519	1,076	64
		96.18%	0.0%	1.00%	30.39%	63.00%	3.75%
2021	382	357	0	1	110	246	25
		94.95%	0.0%	0.27%	29.26%	65.42%	5.05%
2020	344	342	0	16	172	152	2
		99.42%	0.0%	4.68%	50.29%	44.4%	0.58%

The table indicates that majority of the candidates scored grade C and D for three consecutive years. Besides, in all three years no one scored A. Nevertheless, the number of candidates sitting for Physics paper has been increasing from 2020 to 2022. The table also reveals that the performance of the candidates was inconsistent.

Lastly, this report makes a conclusion and recommendations on how 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 presents an analysis of each question. It provides an overview of what the candidates were required to do, the general performance and the possible reasons for the observed performance. Samples of extracts showing the candidates' responses have been used in appropriate sections to support the information provided.

731/1 Physics 1 (Theory)

Physics paper 1 tested 12 topics which are *Measurements*, *Properties of Matter*, *Mechanics, Atomic Physics, Waves*, *Electronics, Physics Laboratory Management*, *Fundamentals of Teaching and Learning Physics, Heat, Current Electricity*, *Assessment in Physics* and *Teaching*. The Physics 1 examination paper had a total of 14 questions. Question 1 to 10 carried 4 marks each and question 11 to 14 carried 15 marks each. The analysis of candidates' performance in each question is as follows:

2.1.1 Question 1: Measurements

This question required the candidates to refer a simple pendulum experiment in determining the acceleration due to gravity to: (a) obtain the relationship of physical quantities involved in that experiment by using dimensional knowledge and (b) give two reasons that made students to commit systematic errors while conducting that experiment.

A total of 1,708 (100%) candidates attempted this question and their scores were as follows: 87.4 per cent scored from 0.0 to 1.5 marks, 6.7 per cent scored from 2.0 to 2.5 marks while 5.9 per cent scored from 3.0 to 4.0 marks. The general performance of the candidates in this question was weak as 87.4 per cent scored from 0.0 to 1.5 marks out of 4.0 marks. Figure 1 summarises the performance of the candidates in this question.

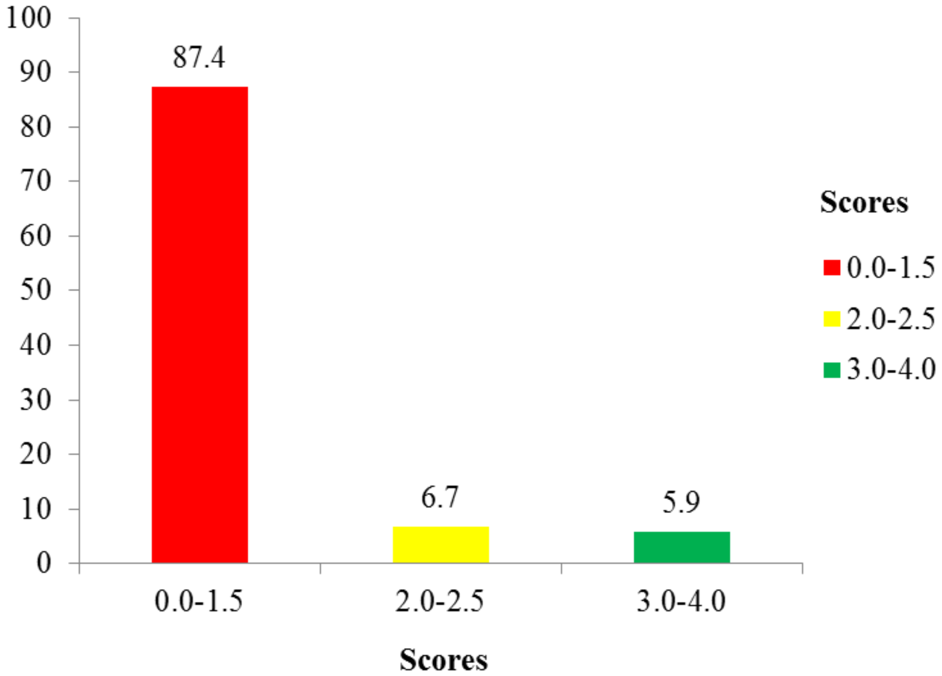


Figure 1: *The Candidates' Performance in Question 1*

The data analysis reveals that the candidates with low scores (0.0 - 1.5) had limited knowledge about the concept of measurements, especially in dimensional analysis. In part (a) of the question, the candidates failed to establish the relationship between the period of oscillation, the length of the pendulum and the acceleration due to gravity. Most of them failed to give the factors that determine the period of oscillation in a simple pendulum experiment, which could enable them to obtain their relationship.

Some of the candidates outlined irrelevant concepts contrary to the need of the question. For example, one of the candidates wrote: *"they should add or subtract fundamental physical quantities which are the same; they should know that each term on every side should be the same in order for the equation to be dimensionally correct"*. This candidate misinterpreted the question by introducing the principle or laws of dimensional homogeneity, instead of using the knowledge of dimensional analysis to investigate the relationship of the parameters used in the simple pendulum experiment. They were supposed to know that a Simple pendulum is a point mass body suspended by a weightless thread or string from a rigid support about which it is free to oscillate. They were also expected to recognize that the main aim of this simple pendulum experiment is to investigate the relationship between the time period of a simple pendulum (oscillation) and the effective length (total length) of the simple pendulum. Similarly, these candidates were expected to know that the period of oscillation T, depends on the: length of the pendulum, L and the acceleration due to gravity, g.

In part (b), the candidates failed to give reasons that contributed to the students to commit systematic errors while conducting the experiment named in part (a). Since most of them failed to identify the parameters used in part (a), they failed also to give the correct responses in part (b). For example, one of the candidates wrote: *"(i) because of the availability of the constants within a physical relation" and (ii) "because of the availability of the dimension*". All these statements were incorrect reasons. This candidate was supposed to know that the systematic errors which might be committed by the students during the simple pendulum experiment include: incorrect design or calibration of instrument; limitations of the method used for measurement; incorrect reading or interpretation of the instrument; and lack of accuracy of the formula being used.

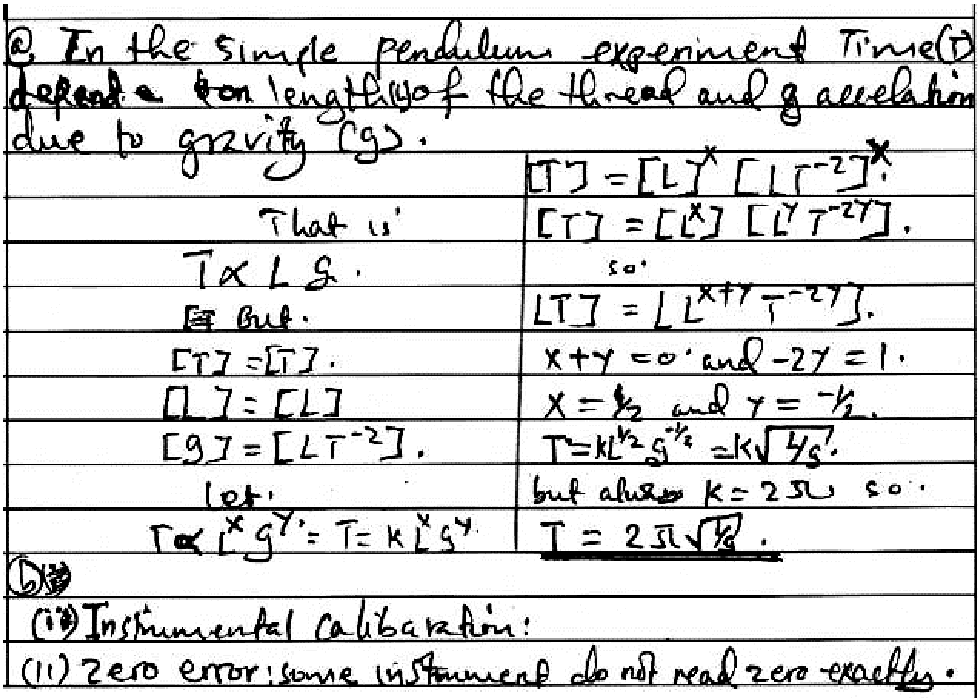
Extract 1.1 represents a sample of weak responses from one of the candidates.

a i)	By derivation / deriving formulae.
ii)	By recapulating the forgotten formulae.
iii)	By checking correctness / consistency of the formulae.
iv)	By converting one system of unit to another
v)	By finding the constants.
b) i	Increase in wind speed which can cause air resistance.
ii)	Failure of student to start the stopwatch in a time when
	the bob starts to oscillate. and this can cause time reaction.

Extract 1.1: A sample of a candidate's weak responses to question 1.

Extract 1.1 shows the responses of the candidate who provided the uses of dimensions in part (a) instead of identifying the parameters used to obtain the relationship between the period of oscillation, length of the pendulum and acceleration due to gravity. The candidate also failed to give reasons that could cause the students to commit systematic errors in simple pendulum experiment.

On the contrary, the candidates who scored high marks (3.0 - 4.0) had sufficient knowledge on the concept of dimensional analysis. These candidates presented precisely the factors governing the period of oscillation in simple pendulum experiment. They wrote correctly the factors as *length of the pendulum* and *the acceleration due to gravity*. They wrote accurately the dimensions of each term involved in the formulation of the relationship of the identified physical quantities. They also gave reasons that caused students to commit systematic errors while conducting such experiment. Extract 1.2 is a sample of correct responses from one of the candidates in question 1.



(a) In the simple pendulum experiment Time(T) depend on length(L) of the thread and g accelation due to gravity (g).

That is:
$T \propto L\, g$.
But:
$[T] = [T]$.
$[L] = [L]$
$[g] = [LT^{-2}]$.
let:
$T \propto L^x g^y$: $T = k L^x g^y$.

$[T] = [L]^x [LT^{-2}]^y$.
$[T] = [L^x][L^y T^{-2y}]$.
so:
$[T] = [L^{x+y} T^{-2y}]$.
$x + y = 0$ and $-2y = 1$.
$x = \frac{1}{2}$ and $y = -\frac{1}{2}$.
$T = kL^{1/2} g^{-1/2} = k\sqrt{L/g}$.
but always $k = 2\pi$ so:
$T = 2\pi\sqrt{L/g}$.

(b)
(i) Instrumental calibration:
(ii) zero error: some instrument do not read zero exactly.

Extract 1.2: A sample of correct response to question 1.

In extract 1.2, the candidate applied correctly the concept of dimensional analysis and wrote the correct dimensions of each term involved in the formula. He/she stated properly the possible sources of systematic errors.

2.1.2 Question 2: Properties of Matter

This question required the candidates to: (a) briefly explain how is the pressure of a gas affected when its volume is reduced to half at constant temperature as the pressure of the gas varies inversely proportional to temperature and (b) briefly justify the statement based on the temperature variation that “water exist in more than one form of matter”.

The question was attempted by 1,708 (100%) candidates out of whom 38.6 per cent scored from 0.0 to 1.5 marks, 29.5 per cent scored from 2.0 to 2.5 marks and 31.9 per cent scored from 3.0 to 4.0 marks. This means that the candidates’ performance in this question was average as 61.4 per cent scored from 2.0 to 4.0 marks. Figure 2 illustrates the performance of the candidates in this question.

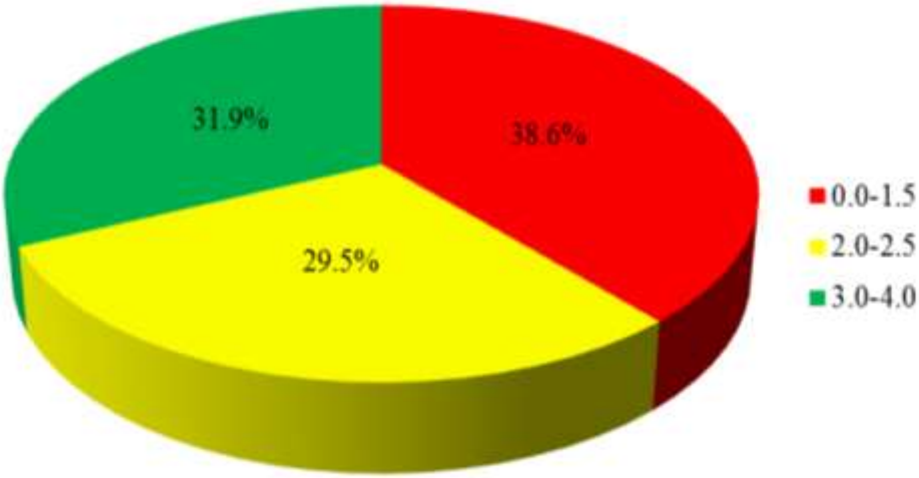
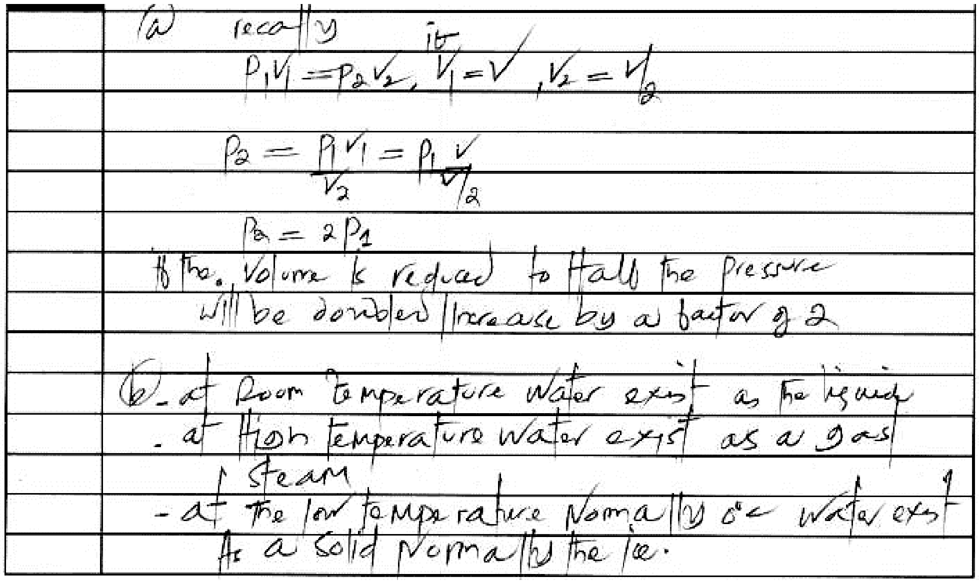


Figure 2: *Candidates' Performance in Question 2*

The candidates who scored above 1.5 marks answered correctly this question. They had adequate knowledge about the topic of *Properties of Matter,* particularly the kinetic theory of the gases. These candidates were familiar with the gas laws, specifically Boyles' law. They recognized that when pressure of a gas is inversely proportional to the volume at constant temperature, Boyles' law is applied. By reducing the volume by half at constant temperature, the number of molecules per unit volume increases. Therefore, more molecules collide with the wall per second and hence the pressure of a gas will be doubled.

They also understood that the factor which determines the states of matter is its temperature. When the temperature of ice (solid state at 0 ºC) is moderately raised, it changes into water (liquid state). Continuous heating changes the water into steam (gaseous state at 100 ºC). This means that ice is the solid state of water, moderate temperature turns water into liquid state and steam is the gaseous state of water. Extract 2.1 exhibits a sample of good responses from a candidate.


(a) recall Boyle's law

$P_1V_1 = P_2V_2$, $V_1 = V$, $V_2 = V/2$

$P_2 = \frac{P_1V_1}{V_2} = P_1 \frac{V}{V/2}$

$P_2 = 2P_1$

If the volume is reduced to half the pressure will be doubled/increase by a factor of 2

(b) - at Room temperature water exist as the liquid
- at High temperature water exist as a gas/steam
- at the low temperature Normally 0°C water exist As a solid Normally the ice.

Extract 2.1: A sample of a candidate's good responses to question 2.

In Extract 2.1, the candidate explained correctly all parts of the question.

On the other hand, further analysis indicates that the candidates who scored low marks lacked knowledge of the Boyles' law and the states of matter. For example, in part (b), on the assertion that water can exist in more than one form depending on temperature variation. One of the candidates wrote that: *"Because of triple point"*. This candidate had to some extent the knowledge of states of matter but he/she did not show how the states of water change with temperature change as per the demand of the question. This candidate did not comprehend that the triple point occurs where the solid, liquid, and gas transition curves meet. The triple point is the only condition in which all three phases coexist, and is unique for every material. Water reaches its triple point at just above the freezing (0.01° C) and at a pressure of 0.006 atm.

Another observed difficult that faced the candidates was that they had poor English language writing skills and little knowledge about the kinetic theory of gases. For example, one of the candidates wrote: in part (a), *"When the volume reduce the pressure its increase and the volume increase the pressure decrease"*. In part (b), *"Water can exist in the three states in liquid when there is not temperature and in ice when there is not temperature and it can exist in a gas"*. This implies that some candidates were hindered by some language barriers in responding to various examination questions. Extract 2.2 is a sample of incorrect responses from one of the candidates.

(a) (i) The pressure tends to Increase when the volume Increase

(ii) The pressure tend to decrease when the volume reduced or the volume decrease.

(b). Water can boil at 360°c but Water can free at 100°c.

→ Water can exist at Fixed point when the temperature was rise up by boiling.

→ Water can exist at stream point when the temperature was falling down by freezing.

Extract 2.2: A sample of incorrect responses to question 2.

In extract 2.2, the candidate wrote a relation which does not exist in nature in the concept of Gas laws in part (a) (i) of his/her response. In part (b), the candidate lacked knowledge about the boiling and the freezing points of water and, hence, she/he failed to justify the states of water with respect to temperature variation.

2.1.3 Question 3: Mechanics

This question required the candidates to: (a) give the two necessary conditions that enable a satellite to be stationary in space and (b) calculate the orbital radius of the satellite if it takes a period of one day to go around its orbit and it rotates at the same speed as that of the moon.

A total of 1,708 (100%) candidates attempted this question. The analysis of candidates' performance shows that the performance was weak as summarized in Figure 3.

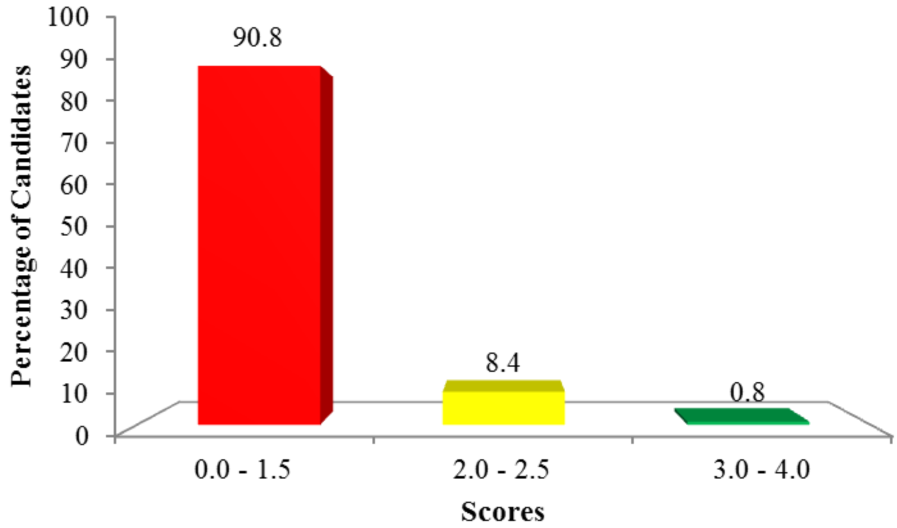


Figure 3: *Candidates' Performance in Question 3*

The statistical data in Figure 3 shows that 90.8 per cent of the candidates scored from 0.0 to 1.5 marks, 8.4 per cent scored from 2.0 to 2.5 marks and 0.8 per cent scored 3.0 to 4.0 marks.

Generally, the analysis reveals that 90.8 per cent of the candidates scored low marks. This is an indicator that they either skipped or gave incorrect answers to most of the parts of the question. These candidates had limited knowledge on the topic of Mechanics, particularly the parking orbit as applied in gravitation. Most of them gave incorrect conditions for a satellite to be stationary in space in part (a). For example, one of the candidates explained as, *"Consider the centrifugal force and the centripetal force"*. Another candidate stated that *"When acceleration due to gravity is zero"*. These candidates did not realize that centrifugal force is the outward push that we experience in a circular motion, so it cannot keep the satellite in its rotating orbit while centripetal force is the pull towards the center in a circular motion, thus it can keep the satellite in its orbit. Similarly, acceleration due to gravity is zero when the force F = 0 which occurs at the centre of the earth. Some of the necessary conditions for a satellite to be stationary in space are: *the time period of a satellite should be the same as that of earth about its own axis such as 24 hours. Another one could be: the sense of rotation of the satellite should be the same as that of the earth about its own axis such as anticlockwise direction from west to east*.

In part (b) of the question, the majority of the candidates failed to deduce the orbital radius of the satellite whose period was one day while rotating at the same speed as that of the moon. Some of them utilized the concept of finding the period of the satellite instead of applying Kepler's third law of planetary motion and hence they failed to get the correct value. Others used the balancing forces of gravitational force and the centripetal force but failed to obtain the relationship between the square of the period and cube of the orbital radius of the satellite. Extract 3.1 is a sample of incorrect responses of the candidate who scored low marks in this question.

(a) Two necessary conditions should you to eacble a catellite to be stationary in space.
i) Parking orbirt
ii) orbirt velocity

(b)
Data
T = 1 day
R = ?
From
[illegible]
$T = \frac{2\pi R}{V}$

$R = \frac{TV}{2\pi}$

$R = \frac{1 \times 24 \times 60 \times 60 \times V}{2 \times \pi}$

$V = \frac{2\pi R}{T}$

$V = \frac{2\pi \times 3800 \times 10^3}{22 \times 24 \times 60 \times 60} = 98$ [illegible] m/s

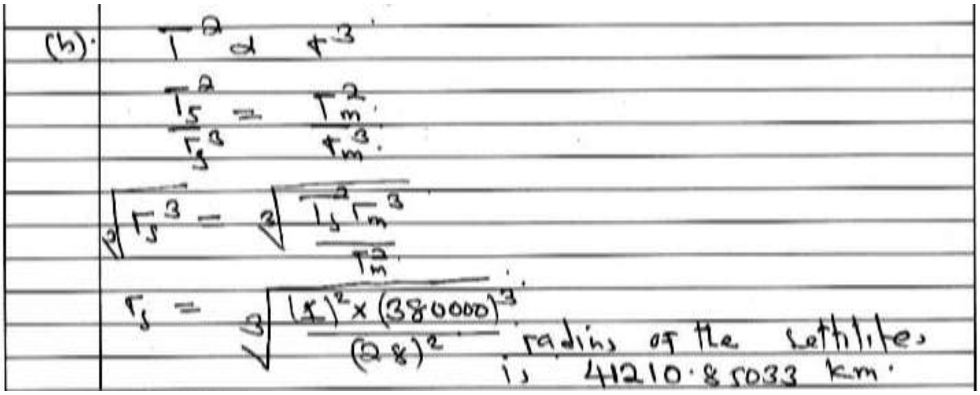
R = 13[illegible]535 m

∴ The radius orbital of the satellite is 1356535 m.

Extract 3.1: A sample of a candidate's incorrect responses to question 3.

In extract 3.1, the candidate failed to give the necessary conditions for a satellite to be stationary in space. Instead he/she mentioned the type of the orbit for it to be placed. He/she also used the formula for the period of the satellite instead of applying Kepler's third law of planetary motion.

Conversely, those who scored high marks responded correctly to most parts of the question. They provided the necessary conditions for a satellite to be stationary in space correctly. They also applied a correct formula for Kepler's third law of planetary motion to compute the orbital radius of the satellite placed in a parking orbit. Extract 3.2 is a sample of a correct response from one of the candidates who performed well.



Extract 3:2: A sample of a part of candidate's good response to question 3

In extract 3.2, the candidate applied correctly Kepler's third law of planetary motion in part (b) to calculate the radius of the satellite in a parking orbit.

2.1.4 Question 4: Mechanics

This question required the candidates to use a sketched diagram to analyze the interchange between kinetic and potential energies of the particle that is in Simple Harmonic motion.

A total of 1,708 (100%) candidates attempted this question. The overall performance of the candidates was weak as 90.1 per cent of them scored from 0.0 to 1.5 marks. A summary of the candidates' performance in this question is shown in Figure 4.

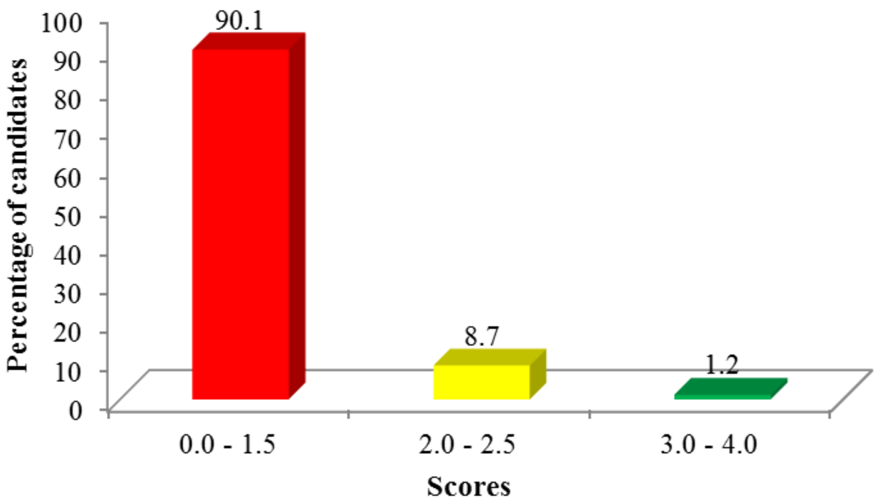
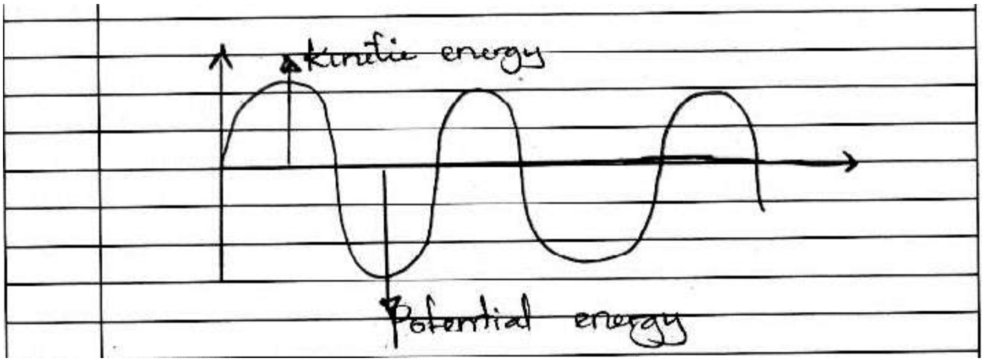


Figure 4: The *Candidates' Performance in Question 4*

Figure 4 shows that 90.1 per cent of the candidates scored from 0.0 to 1.5 marks; 8.7 per cent scored from 2.0 to 2.5 marks and 1.2 per cent scored from 3.0 to 4.0 marks.

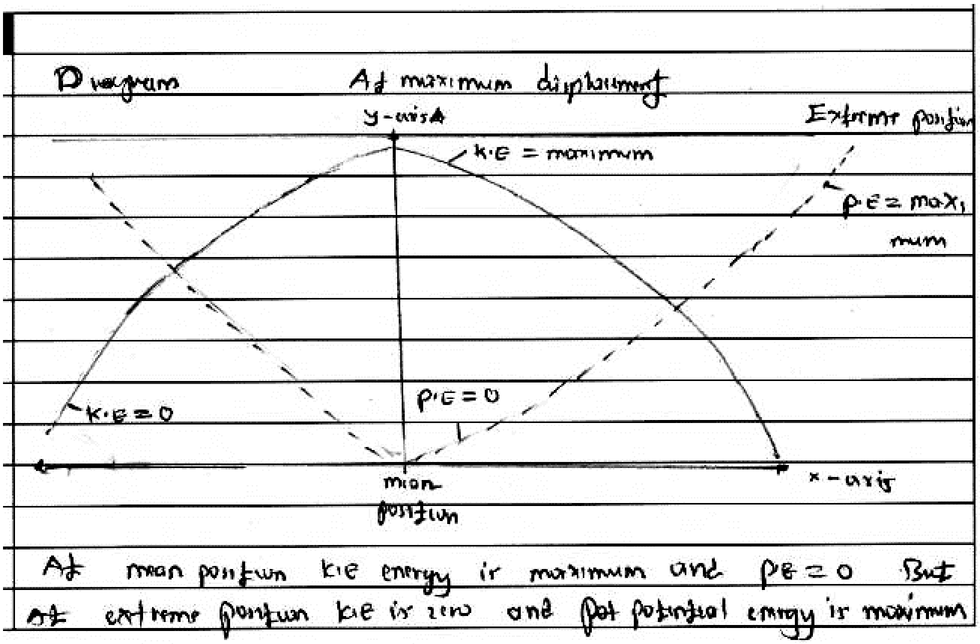
Further analysis of the candidates' performance indicates that weak performance was caused by reasons such as: inadequate knowledge about the interchange between kinetic and potential energies of a particle that is simple harmonic motion, poor drawing and interpretation skills and failure to understand the requirement of the question. Most of the candidates failed to draw the diagram appropriately and explained their diagrams partially. Extract 4.1 is a sample of incorrect responses from one of the candidates.



Extract 4.1: A sample of candidate's weak response to question 4.

In Extract 4.1, the candidate drew a wrong diagram for the kinetic and potential interchange of energies of a particle that is in simple harmonic motion without any detailed explanations and thus missed any mark.

However, some of the candidates who scored high marks (3.0 – 4.0) had adequate knowledge and drawing skills related to mechanics, simple harmonic motion in particular. These candidates drew neat and well labelled sketches. They also managed to interpret and provide proper descriptions on the sketched diagrams. Extract 4.2 is a sample of correct responses from one of the candidates.



Extract 4.2: A sample of a candidate's correct response to question 4.

In extract 4.2, the candidate drew an appropriate diagram of the interchange between kinetic and potential energies of a particle executing simple harmonic motion. He/she also made correct labelling and stated brief explanation about the diagram.

2.1.5 Question 5: Atomic Physics

This question required the candidates to describe the applications of radioactivity in daily life to first year student teachers.

The question was attempted by 1,708 (100%) candidates. The overall performance of candidates was average since 61.7 per cent scored from 2.0 to 4.0 marks. A summary of the candidates' performance in this question is shown in Figure 5.

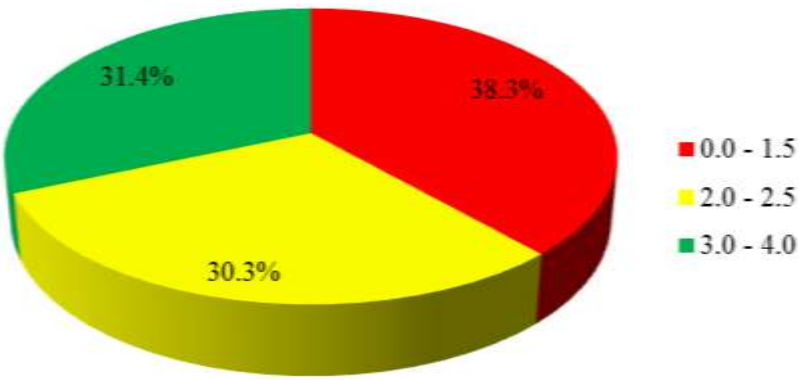
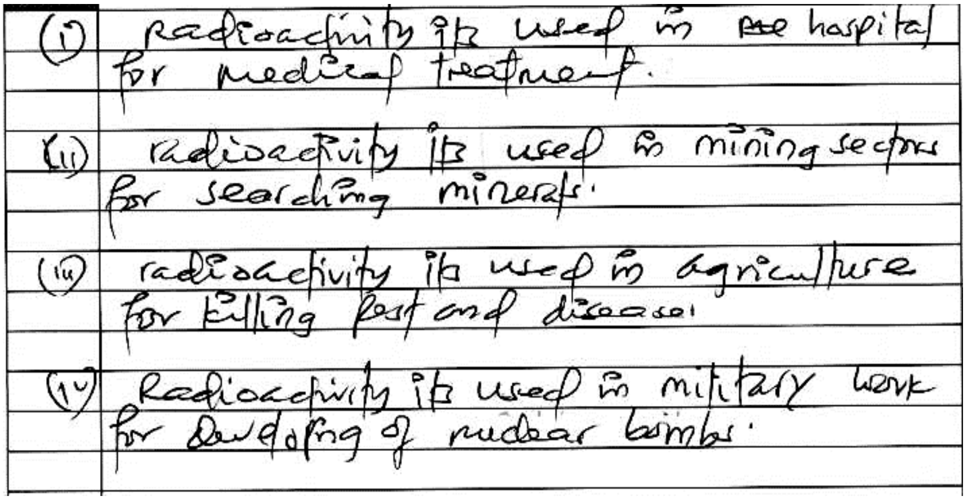


Figure 5: *The Candidates' Performance in Question 5*

Figure 5 shows that among the candidates who attempted the question, 654 (38.3%) scored low marks from 0.0 to 1.5, while 517 (30.3%) scored from 2.0 to 2.5 marks and 537 (31.4%) scored from 3.0 to 4.0 marks.

The data analysis reveals that the candidates with average scores provided relevant and irrelevant responses to the question. Some of the candidates' responses partially explained the applications of radioactivity in daily life.

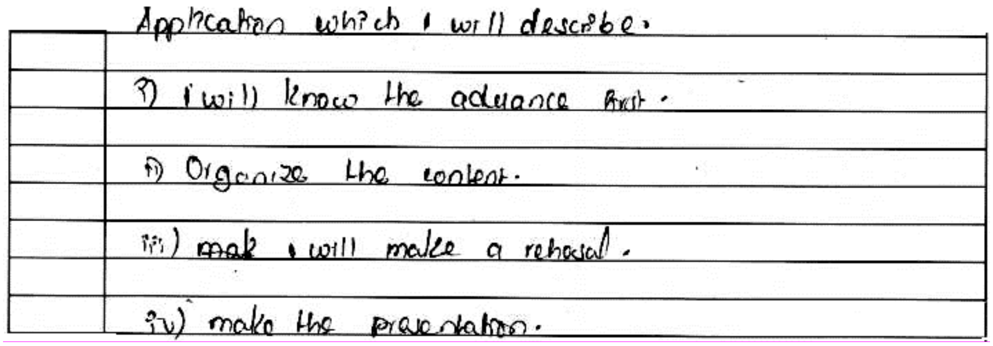
On the other hand, the candidates who scored good marks (31.4%) were conversant with the applications of radioactivity in daily life. Some of the responses given by these candidates were as follows: Diseases such as cancer are cured by radiotherapy, radioisotopes are used as fuel for atomic energy reactors and they are also used to determine the age of the rock by using a carbon 14. These candidates understood the applications of radioactivity in daily life. Extract 5.1 is a sample of correct responses from one of the candidates.



(i) radioactivity its used in hospital for medical treatment.
(ii) radioactivity its used in mining sectors for searching minerals.
(iii) radioactivity its used in agriculture for killing pest and diseases
(iv) Radioactivity its used in military work for developing of nuclear bombs.

Extract 5.1: A sample of candidate's good responses to question 5.

On the contrary, 654 (38.3%) candidates who scored low marks had unsatisfactory knowledge about the applications of radioactivity in daily life. Some of them provided inappropriate responses to this question. For example, one of the candidates responded that; *"radioactivity is used in transmission of waves in radio"; "help to acquire networks in our homes"*. This candidate confused various topics. For instance, transmission of waves is a concept from the topic of waves and not from atomic Physics. *"Help to acquire networks in our homes"* is a concept of telecommunications and is not related to *Atomic Physics*. Extract 5.2 shows a sample of incorrect responses.



Application which I will describe.

i) I will know the advance first.

ii) Organize the content.

iii) mak I will make a rehosal.

iv) make the presentation.

Extract 5.2: A sample of a candidate's weak responses to question 5.

In Extract 5.2, the candidate failed to identify the requirement of the question. He/she outlines the steps to follow in making a presentation instead of describing the applications of radioactivity in daily life.

2.1.6 Question 6: Waves

The question required the candidates to use slinky coil spring to explain the propagation behaviour of transverse and longitudinal waves.

It was attempted by 1,708 (100%) candidates. In general, the performance was weak as shown in Figure 6.

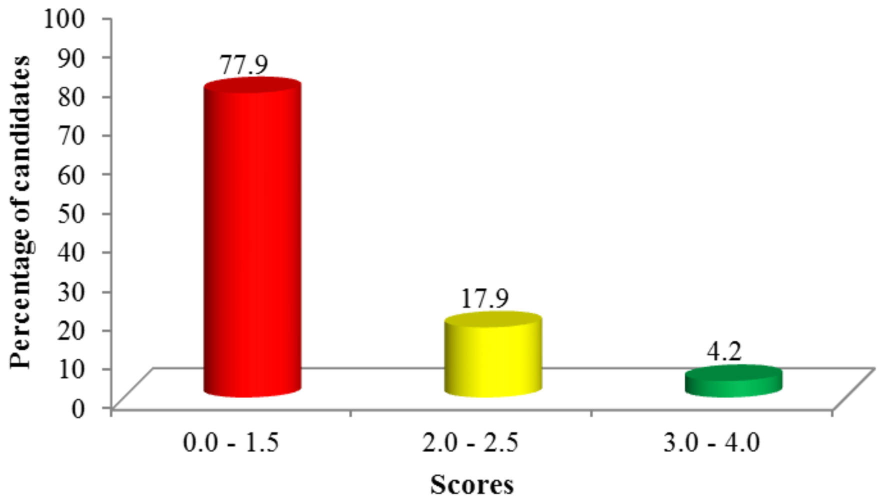
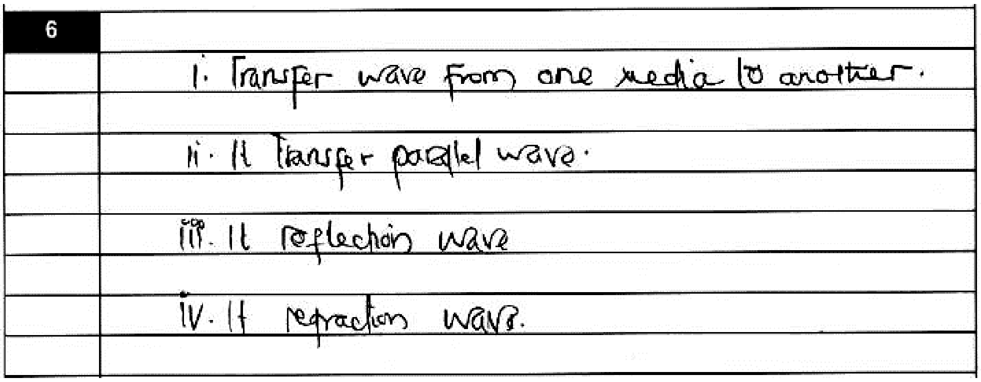


Figure 6: *The Candidates' Performance in Question 6*

Figure 6 shows that 1330 (77.9%) candidates scored from 0.0 to 1.5 marks; 310 (17.9%) scored from 2.0 to 2.5 marks; and 68 (4.2%) scored from 3.0 to 4.0.

In this question, the candidates' responses showed that those who scored marks below average failed in most or all parts of the question. These candidates failed to explain the propagation behaviour of the transverse and longitudinal waves by using a slinky coil spring. According to the requirement of the question, the candidates were supposed to explain how they can use the slinky coil spring to produce both transverse and longitudinal waves. To the contrary, some of the candidates defined transverse and longitudinal waves without showing how the slinky coil spring can be used to produce such types of mechanical waves. Others mentioned some of their characteristics. For example, one of the candidates wrote: *"Transverse waves are waves which oscillate perpendicular/at right angle to the direction of propagation of the wave"*. *"Longitudinal waves are waves which oscillate parallel to the direction of propagation of the wave"*. This candidate defined correctly the two types of mechanical waves but failed to demonstrate or explain how the slinky coil spring can be used to produce the waves. Extract 6.1 represents one of the candidate's weak responses in this question.


6

i. Transfer wave from one media to another.

ii. It transfer parallel wave.

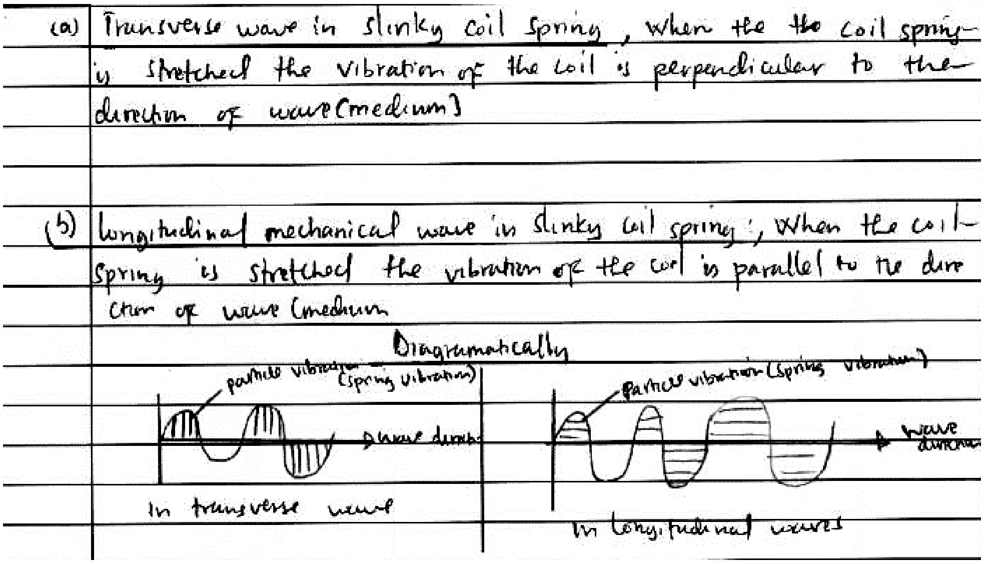
iii. It reflection wave

iv. It refraction wave.

Extract 6.1: A sample of incorrect responses to question 6.

In Extract 6.1, the candidate wrote some of the properties of mechanical waves instead of describing how a slinky coil spring can be used to produce transverse and longitudinal waves.

Despite the weak performance of most of candidates in this question, some of them scored high marks. The candidates who scored high marks (4.2%) explained correctly the propagation behaviour of transverse and longitudinal waves by showing how a slinky coil spring can be used. Generally, their responses denote that they had sufficient content knowledge about the mode of vibrations of mechanical waves and the way they are produced. Extract 6.2 shows a sample of good responses from one of the candidates.


(a) Transverse wave in slinky coil spring, when the the coil spring is stretched the vibration of the coil is perpendicular to the direction of wave (medium)

(b) longitudinal mechanical wave in slinky coil spring; When the coil spring is stretched the vibration of the coil is parallel to the direction of wave (medium

Extract 6.2: A sample of a candidate's correct responses to question 6.

In extract 6.2, the candidate used a slinky coil spring to explain correctly the propagation behaviour of transverse and longitudinal mechanical waves.

2.1.7 Question 7: Electronics

In this question, the candidates were required to draw a truth table for a room of three doors and associated three switches A, B and C which turned on light when one enters the room through any door and presses the associated switch. On leaving the room through any door and pressing the associated switch, the light goes off. Candidates had to assume that the light is off when A = B = C = 0.

A total of 1,708 (100%) candidates attempted the question. The overall performance of the candidates in this question was weak as summarized in Figure 7.

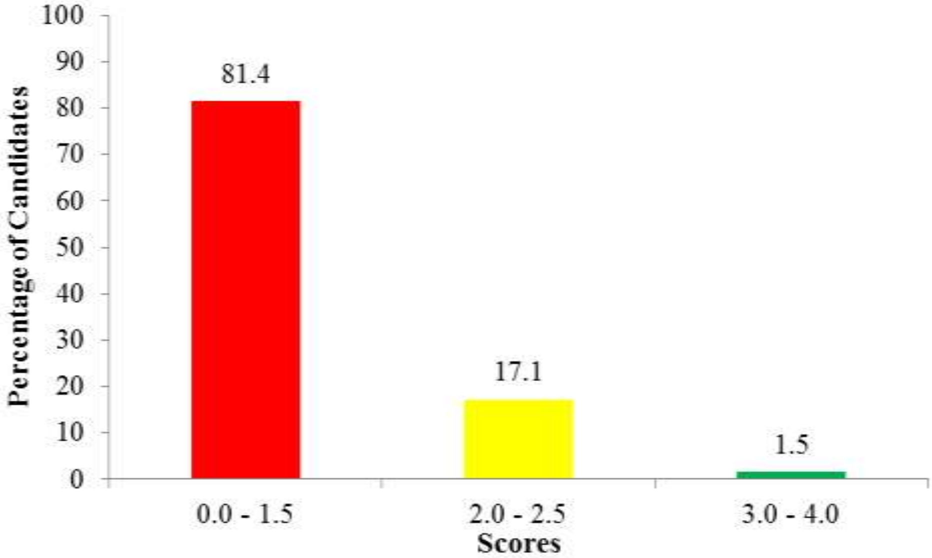
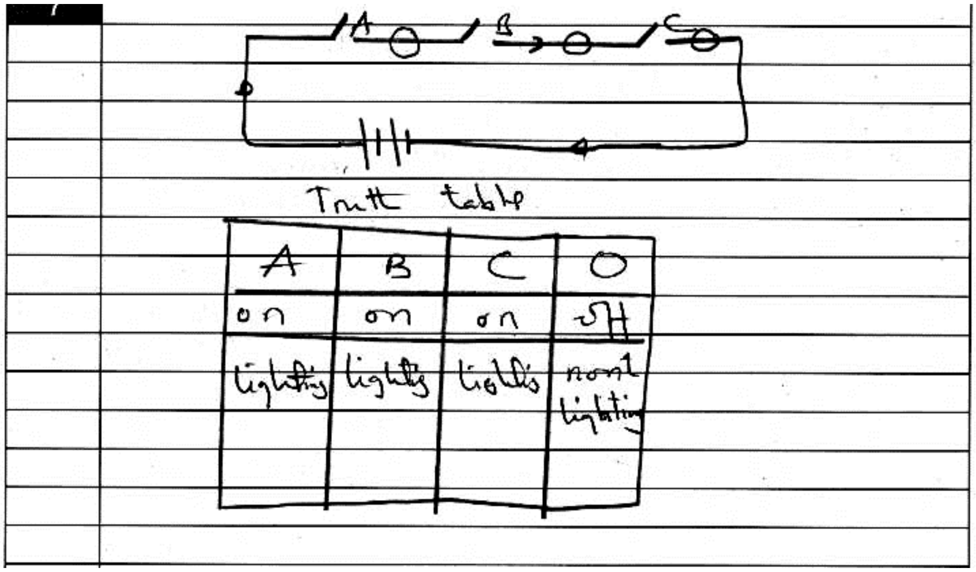


Figure 7: *The Candidates' Performance in Question 7*

Figure 7 indicates that 81.4 per cent of the candidates scored 0.0 to 1.5 marks, 17.1 per cent scored 2.0 to 2.5 marks and 1.5 per cent scored 3.0 to 4.0 marks.

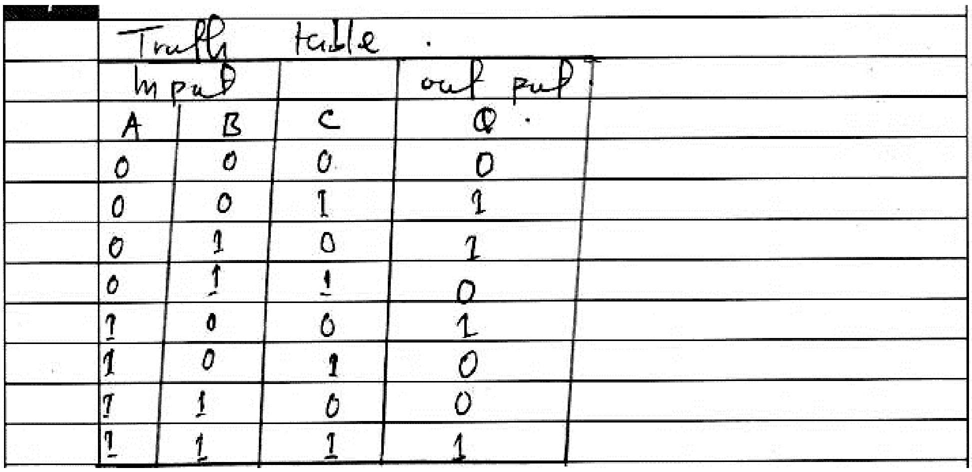
The analysis of the candidates' responses shows that, those who scored low marks had inadequate knowledge of the topics of *Electronics* especially, integrated circuit in the derivation of truth tables for various logic gates. These candidates wrongly interpreted the scenario given in the question. Because of insufficient knowledge of the concept of logic gates, the majority of the candidates (81.4%) failed to identify the number of inputs necessary to give the output and hence they failed to construct the truth table. They were supposed to know that the inputs are the switches A, B and C and they had to prepare a truth table using 0 (low) and 1 (high). Extract 7.1 illustrates a sample of incorrect responses from one of the candidates who attempted this question.



Extract 7.1: A sample of a candidate's incorrect responses to question 7.

In Extract 7.1, the candidate drew an electric like circuit and prepared an incorrect truth table, which means that he/she had insufficient knowledge of the concept of logic gates.

On the other hand, the candidates who scored high marks showed that they had sufficient knowledge about the concept of electronics, specifically construction of truth tables in combinational logic gates. These candidates managed to deduce the number of inputs needed for preparation of a truth table. Extract 7.2 is a sample of weak response from one of the candidates.



Truth table.

Input			out put
A	B	C	Q
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

Extract 7.2: A sample of a candidate's incorrect response to Question 7.

In extract 7.2, the candidate prepared a correct the truth table by identifying the appropriate number of inputs to use.

2.1.8 Question 8: Physics Laboratory Management

This question required the candidates to give four suggestions on how to reduce the running costs of a Physics laboratory.

The question was attempted by 1,708 (100%) candidates. Their performance was average as 53.7 per cent of them scored from 2.0 to 4.0. Figure 8 shows the given information.

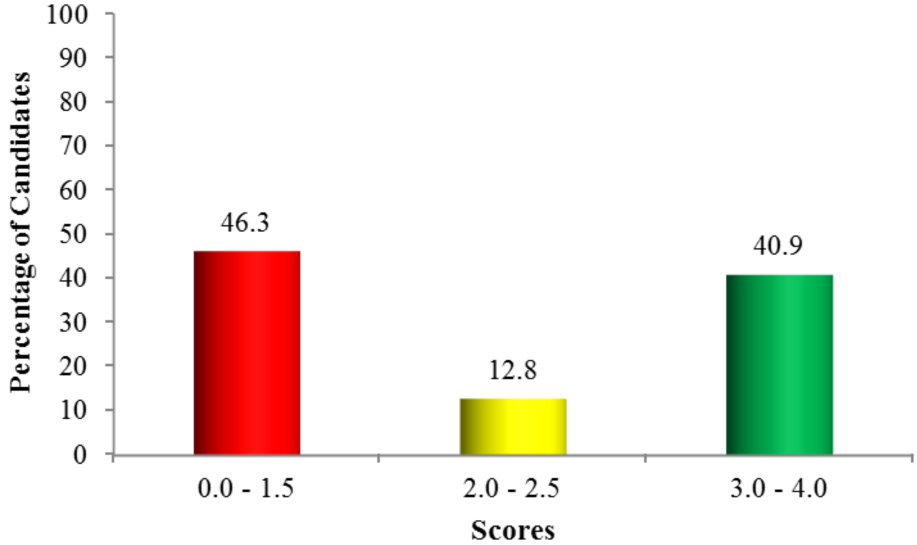


Figure 8: *The Candidates' Performance in Question 8*

Figure 8 shows 46.3 per cent of the candidates who attempted the question; scored from 0.0 to 1.5 marks, 12.8 per cent scored from 2.0 to 2.5 marks; and 40.9 per cent scored from 3.0 to 4.0 marks.

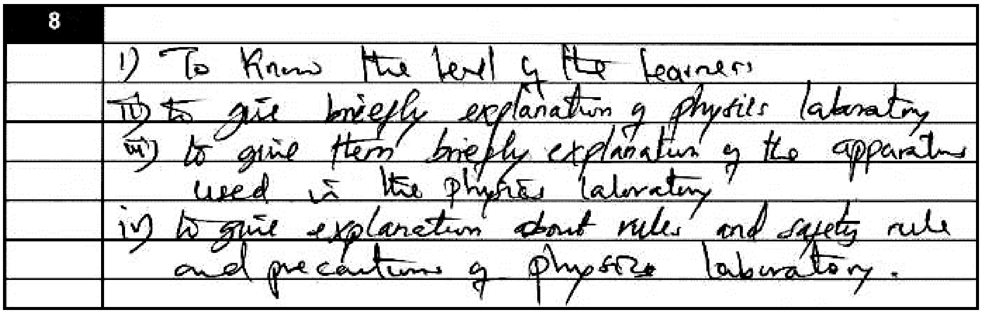
The candidates who scored high marks (3.0 – 4.0) had good knowledge about Physics Laboratory Management, particularly the concept of reduction of running cost of a Physics laboratory. These candidates suggested proper ways of reducing the running costs of a Physics laboratory. Extract 8.1 is a sample of good responses from one of the candidates.

8	i) Proper handling of laboratory apparatus to avoid breakage and malfunction which will need money to ~~by~~ buy new one
	(ii) Order students to follow laboratory rules to avoid accidents like fires and electrical faults
	(iii) Maintaining of laboratory furnitures well so that to reduce cost of buying new one
	iv) Ensuring of safety precautions in the laboratory to avoid unnecessary destructions

Extract 8.1: A sample of a candidate's good responses to question 8.

In Extract 8.1, the candidate suggested appropriate ways to reduce the running cost of a Physics laboratory correctly.

Almost a half of the candidates (46.3%) scored low marks (0.0-1.5). Their weak performance was due to their lack of knowledge about the fundamental ways of reducing the running costs of a Physics laboratory. For example, one of the candidates wrote that: *"record all the activities done in a laboratory, advice new teacher to be careful with the apparatuses, avoid lifting heavy object on the table*". The responses provided by this candidate exhibit his/her lack of knowledge about the topic of Physics Laboratory management. This candidate and others were supposed to know that in order to reduce the running cost of a Physics laboratory, the following should be considered: *keep track of your cost; maintain your equipment; consider equipment upgrades; order the apparatuses and equipment in bulk; train staff in efficiency and consider sharing of available laboratories in your institution*. In addition, the equipment and apparatuses in the laboratory should be carefully handled when conducting experiment to avoid breakage or the need for repairing. Extract 8.2 represents incorrect responses from one of the candidates.



8

i) To know the level of the learners
ii) to give briefly explanation of physics laboratory
iii) to give them briefly explanation of the apparatus used in the physics laboratory
iv) to give explanation about rules and safety rule and precautions of physics laboratory.

Extract 8.2: A sample of a candidate's weak responses to question 8.

In Extract 8.2, the candidate explained about the apparatuses, uses, safety rules and precautions to take when you are in a Physics laboratory instead of suggesting ways of reducing running cost of Physics laboratory.

2.1.9 Question 9: Physics Laboratory Management

The candidates were required to give four reasons why the school Physics laboratory technician preferred to use a mercury thermometer during the preparation for heat experiments.

A total of 1,708 (100%) candidates attempted the question and their overall performance was average as summarized in Figure 9.

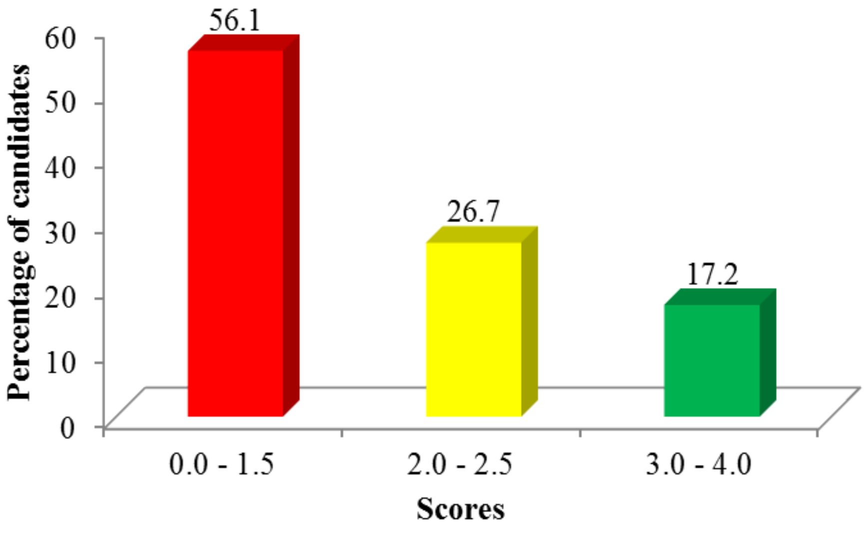


Figure 9: The *Candidates' Performance in Question 9*

Figure 9 indicates that 959 (56.1%) candidates scored from 0.0 to 1.5; 456 (26.7%) scored from 2.0 to 2.5; and 293 (17.2%) scored 3.0 to 4.0 marks. The candidates who scored high marks (3.0-4.0) in this question had the following qualities: they had enough knowledge about the mercury thermometer and understood the requirement of the question. These candidates wrote correct reasons which made the school laboratory technician to prefer using a of mercury thermometer during the preparation for heat experiments. Extract 9.1 is a sample of good responses from one of the candidates.

the school laboratory techniaan preferred to use a mercury thermometer during the heat experiments preparation because:-
i Mercury is an opaque material
ii Mercury is a good conductor of heat
iii Mercury does not wet the glass.
iv Mercury is easy to read than other types of thermometer.

Extract 9.1: A sample of a candidate's correct responses to question 9.

In Extract 9.1, the candidate provided correct reasons why mercury thermometer as preferred to other types of thermometers in the heat experiments.

There were candidates who scored low marks (0.0-1.5), had unsatisfactory knowledge concerning to the merits of mercury thermometer at the expense of other types of thermometers. For, example, one of the candidates wrote: "*It measures the temperature of the 100 ^oC", "the mercury thermometer is easy to obtain" and "it measures temperature coefficient"*. Another candidate wrote: *"it is more portable"*. These responses prove that the candidates lacked knowledge of the concept asked. These candidates were supposed to realize that mercury is a good conductor of heat and hence, it can measure even high temperatures; It gives results quickly – has a fast response time; It expands linearly and less than alcohol and any other liquid; and is more durable than alcohol thermometers and other types because mercury does not evaporate easily. Extract 9.2 is a sample of incorrect responses from one of the candidates in this question.

9 i) Mercury thermometer it work for long time than other thermometer. mercury thermometer designed for different purpose.

ii) Mercury thermometer determine specific temperature at a given time than other thermometer.

iii) Mercury thermometer it is hard compared to other type of thermometer. This mean different thermometer work slower because have soften glass while mercury it is very hard.

iv) Mercury thermometer it determine environmental temperature surrounding compared to other thermometer.

Extract 9.2*:* A sample of the candidate's incorrect responses to question 9.

In extract 9.2, the candidate failed to give reasons to why mercury thermometer is preferable as compared to other types of thermometers during heat experiments.

2.1.10 Question 10: Fundamentals of Teaching and Learning Physics

The candidates were required to justify the following statement in two points: *"Students learn Physics concepts best by doing"*.

The question was attempted by 1,708 (100%) candidates out of whom 9.3 per cent scored from 0.0 to 1.5 marks, 16.9 per cent scored from 2.0 to 2.5 marks and 73.8 percent scored from 3.0 to 4.0 marks. Generally, the candidates' performance in this question was good as 90.7 per cent of them scored 2.0 marks and above. Figure 10 summarises the candidates' performance in this question.

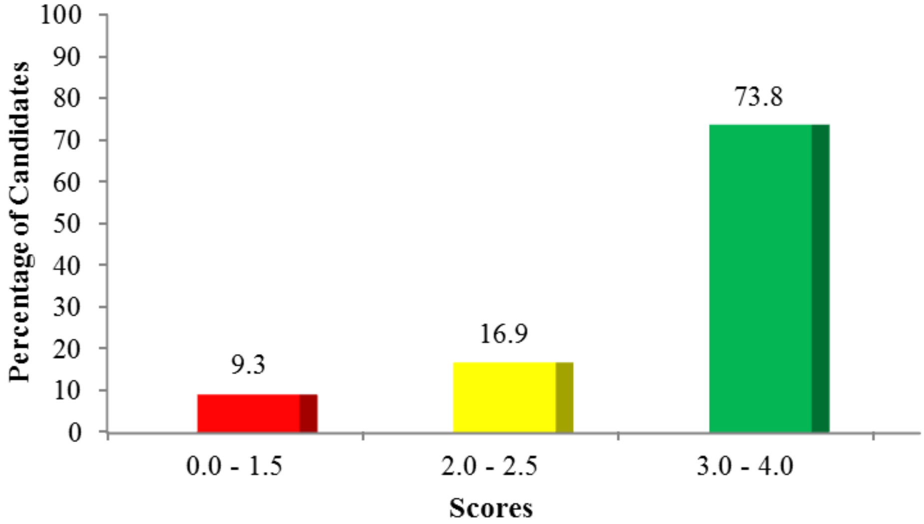
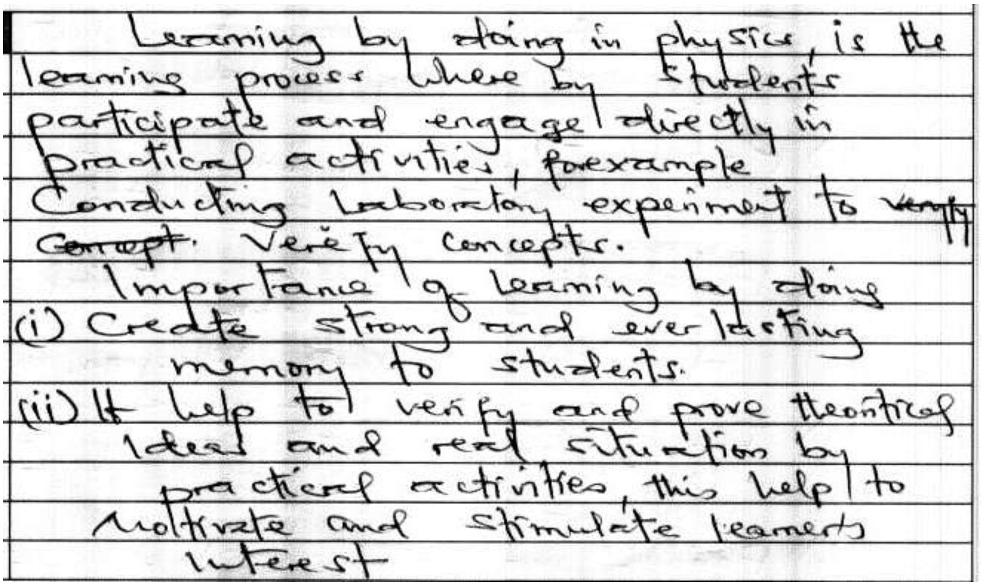


Figure 10: *The Candidates' Performance in Question 10*

The candidates who scored high marks (2.0-4.0) were able to justify that "Students learn Physics concepts best by doing". These candidates were aware that many theories and concepts in physics can be easily understood and registered in mind by making use of laboratory experiments. Therefore, teachers should involve students in preparing apparatuses, connecting the apparatuses, collecting the data, analysis of data and writing reports. In this case learner constructs one's understanding and knowledge, concept or laws.

An example of the candidate who provided one of the correct responses wrote: *"when the teacher is improvising the teaching and learning aids, he/she should involve the students/learners in the process of designing the materials, observing, drawing, measuring, recording and interpreting the product using respective sensory organs"*. This implies that the candidate was competent on the concept of *Fundamentals of Teaching and Learning Physics*. Extract 10.1 is a sample of correct responses from one of the candidates.



Learning by doing in physics, is the learning process where by students participate and engage directly in practical activities, forexample Conducting laboratory experiment to verify Concept. Verify concepts.

Importance of learning by doing

(i) Create strong and ever lasting memory to students.

(ii) It help to verify and prove theoritical ideas and real situation by practical activities, this help to motivate and stimulate learners interest

Extract 10.1: A sample of the candidate's good responses to question 10.

In extract 10.1, the candidate justified correctly the statement that *"Students learn Physics concepts best by doing"*.

It was also noted that the candidates who scored low marks (0.0 - 1.5) failed to justify that students learn Physics best by doing. Most of them provided inappropriate responses which did not suit the demand of the question about the fundamentals of teaching and learning Physics. For example, one of the candidates gave wrong reasons to justify the statement as he/she writes: *"(i) because they create curiosity as they do the task themselves"* and (i) *"because it develops mastering of the concepts and facts about certain topics"*. This candidate wrote the effect or result of learning Physics by doing instead of the activities which make the students to be directly involved in the teaching and learning process, such as performing the experiments and role playing. Extract 10.2 as an incorrect response from one of the candidates.

10	Student learn Physics Concept best by doing
	(i) Assesment: Is a process to gathering Information of the learner, to thesa leaner to decision making when to check her/his performance of the physics Subject.
	(ii) Environment should be Support, when a learner to learning Physics must be environment Support for example enough benchs and table for study of the leaners.

Extract 10.2: A sample of the candidate's incorrect responses to question 10.

In Extract 10.2, the candidate provided responses correcting to the concept of assessment as a tool of measurement and suitable environment instead of the activities that get learners engaged in the teaching - learning process.

2.1.11 Question 11: Heat

This question had two parts: (a) and (b). Part (a) required the candidates to draw lines of heat flow and sketched graphs which show variation of the temperature of the rod along its length when the surface of the rod is (i) unlagged (ii) lagged. In part (b), the candidates were required to deduce the rate of heat flow through a plaster ceiling, measuring 5 m×3 m×15 mm, in contact with 45 mm thick layer of insulating material. If the inside and outside surfaces are at the surrounding air temperature of 15 ºC and 5 ºC respectively, the thermal conductivity of plaster ceiling is 0.60 $Wm^{-1}K^{-1}$ and that of insulating material is 0.040 $Wm^{-1}K^{-1}$.

A total of 1,708 (100%) candidates attempted the question. The general performance of the candidates was weak as 92.3 per cent scored from 0.0–5.5 marks. The performance is summarised in Figure 11.

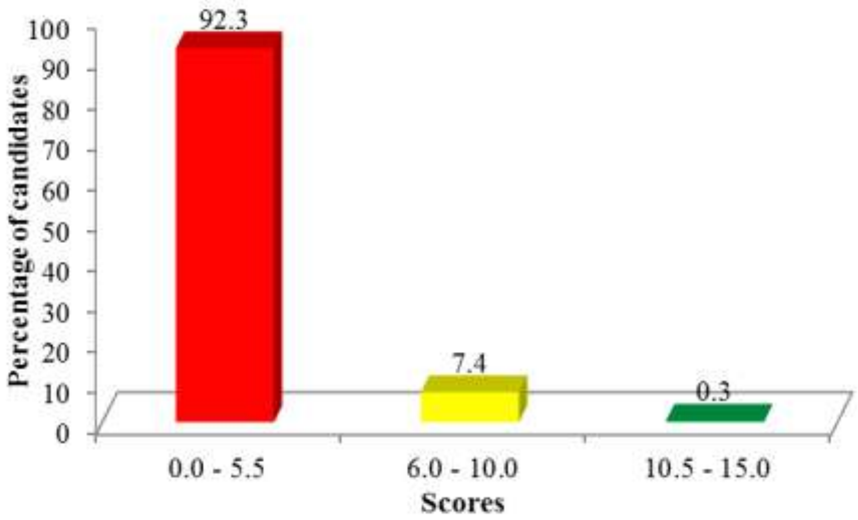
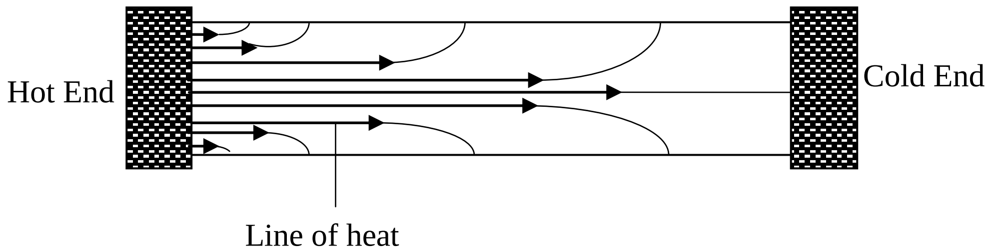


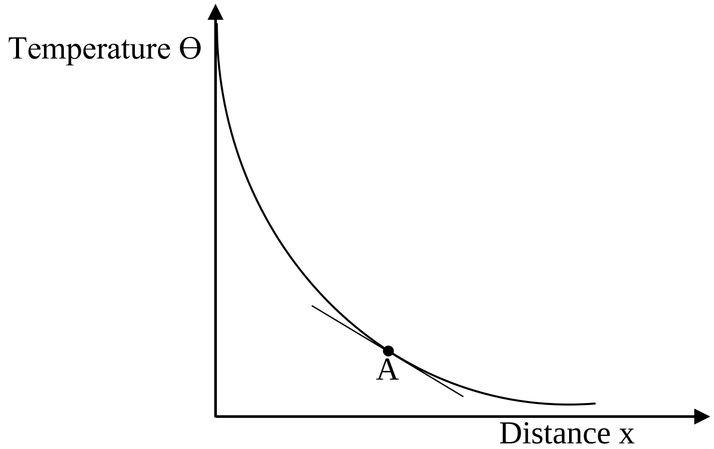
Figure 11: *The Candidates' Performance in Question 11*

Figure 11 indicates that 92.3 per cent scored from 0.0 to 5.5 marks 7.4 per cent scored from 6.0 to 10.0 marks and 0.3 per cent scored from10.5 to 15.0 marks.

The candidates who scored low marks (0.0 - 5.5) had insufficient knowledge and drawing skills regarding to heat flow for both unlagged and lagged material. They provided incorrect responses in most parts of this question. For example, in part (a), some of them failed to draw the lines of heat flow for the unlagged and lagged surface of the rod. Others drew curves without using a rod, the area representing the hot end and that of the cold one and the nature of the direction of heat flow. In part (a) (i), the candidates were supposed to realize that, for the unlagged rod, the quantity of heat passing in a given time through successive cross-sections decreases because of heat loss from the sides of the rod. The lines of heat flow are divergent (deviating) and temperature falls faster near the hotter end. The following diagram illustrates what the candidates were supposed to draw and sketch:

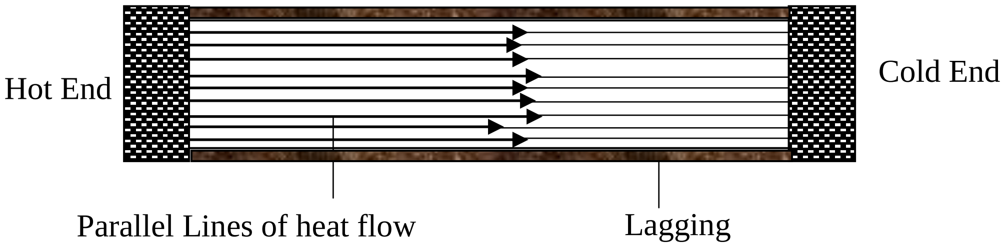


A sketched graph showing the variation of temperature of unlagged rod along its length could be as follows:

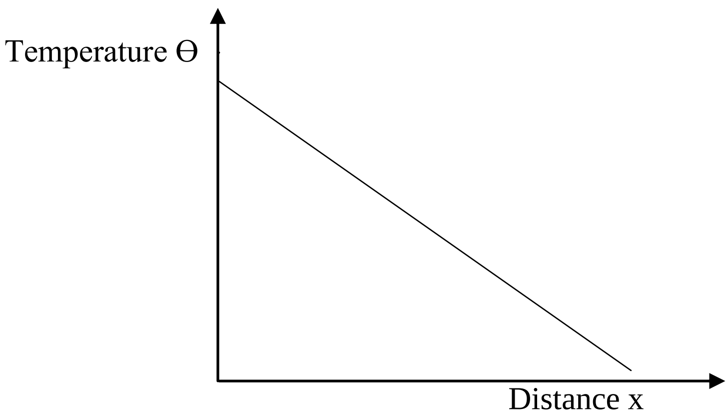


In part (a) (ii), the lines of heat flow for lagged rod and its sketched graph should be as follows:

In a lagged rod whose sides are well wrapped (lagged) with a good insulator, heat loss from sides is negligible and the rate of heat flow is the same all along the rod and the lines of heat flow are parallel.

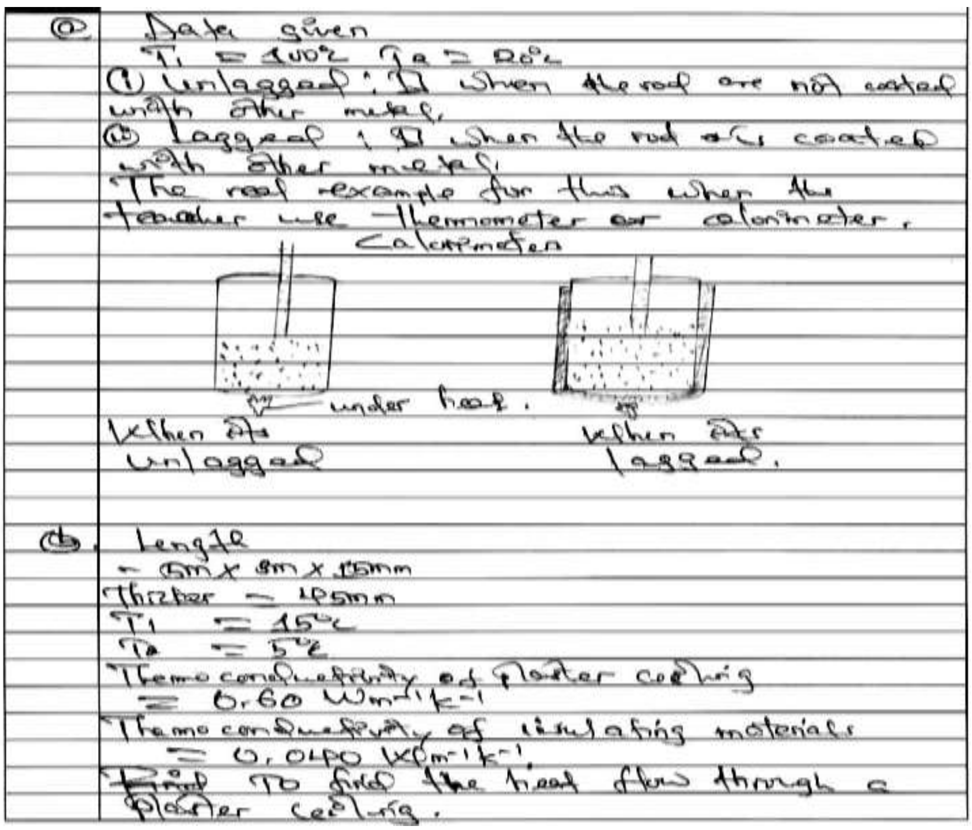


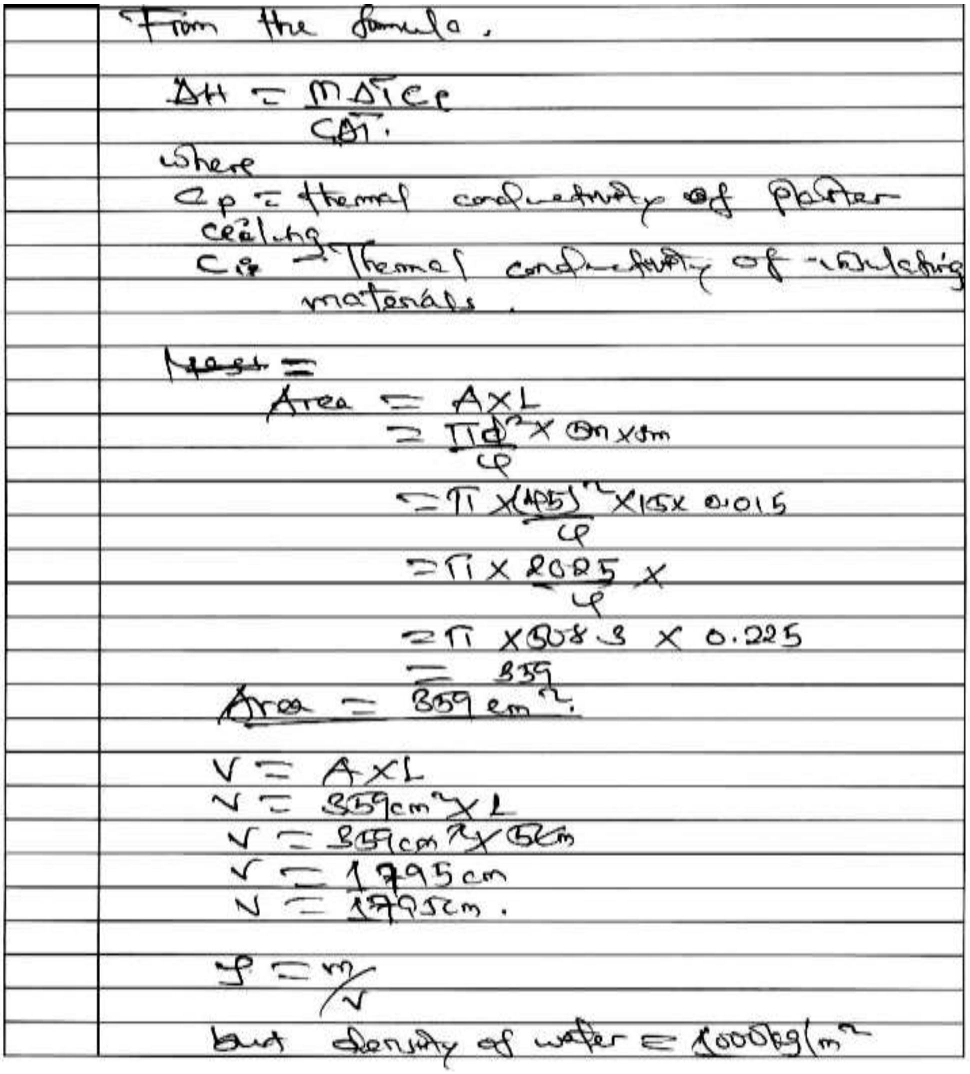
A sketched graph showing the variation of temperature of the lagged rod along its length was supposed to be as follows.



In part (b) of this question, some candidates employed irrelevant concepts and formulae to determine the rate of heat flow through a plaster ceiling.

For example, one of the candidates wrote*: "* $Q = \frac{\alpha}{L}$ *"* which has no physical meaning in Physics subject. Another candidate wrote*: "The rate of heat flow through a ceiling plaster is* $\frac{\Delta H}{\Delta t} = A(\theta_2 - \theta_1)(\rho_1 - \rho 2)$ *"* which does not exist in Physics. This is an indicator that these candidates had limited content knowledge of thermal conduction. The candidates were required to understand that, the rate of heat flow depends on the temperature differences of two surfaces; area of material; thickness of the material; and nature of material. These candidates were supposed to use the following formula in order to be able to calculate the rate of heat flow for both plaster ceiling and insulating material correctly: $\frac{dQ}{dt} = -KA\left(\frac{T_2 - T_1}{L}\right)$; where K is the coefficient of thermal conductivity of a material. Extract 11.1 represents a sample of incorrect responses from one of the candidates who attempted the question.


(a) Data given
$T_1 = 100°C$ $T_2 = 20°C$
(i) Unlagged: It when the rod are not coated with other metal.
(ii) Lagged: It when the rod are coated with other metal.
The real example for this when the teacher use thermometer or calorimeter.
Calorimeter
under heat.
When its unlagged
When its lagged.
(b) Length
= 5m x 8m x 15mm
thicker = 15mm
$T_1 = 15°C$
$T_2 = 5°C$
Thermo conductivity of plaster ceiling
= 0.60 $Wm^{-1}K^{-1}$
Thermo conductivity of insulating materials
= 0.040 $Wm^{-1}K^{-1}$
Find: To find the heat flow through a plaster ceiling.



From the formula.

$\Delta H = \frac{m \Delta T C_p}{C \Delta T}$

where

C_p = thermal conductivity of plaster ceiling

C_i = Thermal conductivity of insulating materials.

Mass =

Area = A x L

$= \frac{\pi d^2}{4} \times$ 8m x 3m

$= \pi \times \frac{(45)^2}{4} \times 15 \times 0.015$

$= \pi \times \frac{2025}{4} \times$

$= \pi \times 508.3 \times 0.225$

= 359

Area = 359 cm^2.

V = A x L

V = 359 cm^2 x L

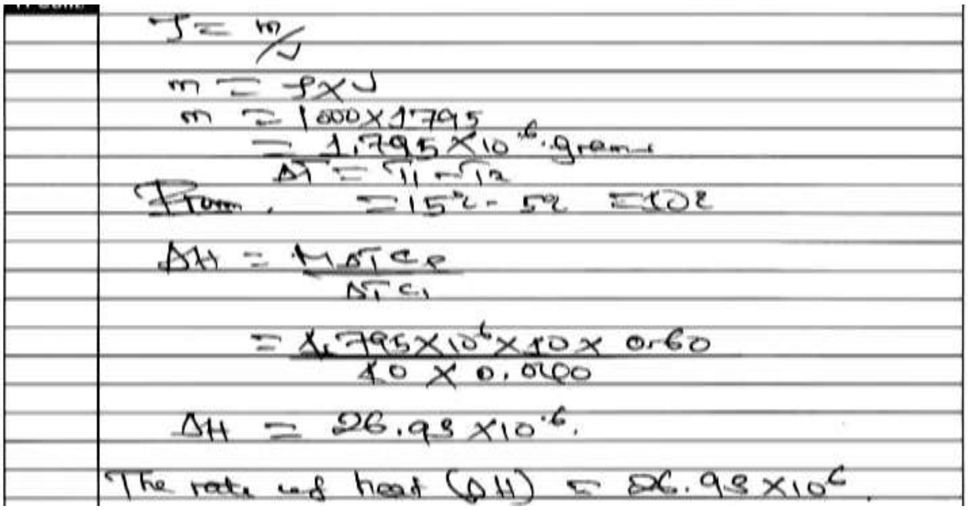
V = 359 cm^2 x 5cm

V = 1795 cm

V = 1795cm.

$\rho = m/V$

but density of water = 1000kg/m^2



$\rho = m/V$

$m = \rho \times V$

m = 1000 x 1795

= 1.795×10^6 grams

$\Delta T = T_1 - T_2$

From. = 15°c - 5°c = 10°c

$\Delta H = \frac{M \Delta T C_p}{\Delta T C_i}$

$= \frac{1.795 \times 10^6 \times 10 \times 0.60}{10 \times 0.040}$

$\Delta H = 26.93 \times 10^6$.

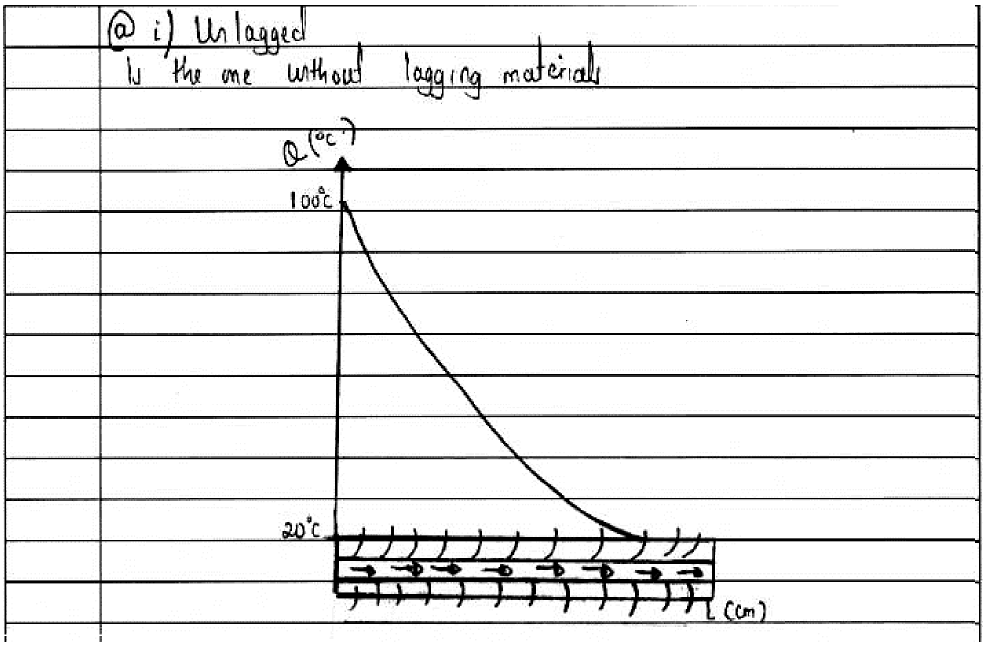
The rate of heat (ΔH) = 26.93×10^6.

Extract 11.1: A sample of a candidate’s incorrect responses to question 11.

In Extract 11.1, the candidate applied irrelevant formula in part (b) and hence ended up with wrong answers.

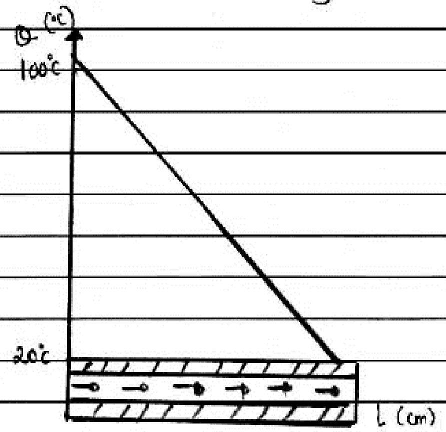
Despite the poor performance of the candidates in this question, there was a small number of candidates (0.3%) who scored good marks (10.5 – 15.0). These showed that they had grasped correctly the concept of heat principally, thermal conductivity of different materials. These candidates were able to draw correctly the lines of heat flow and sketched graphs which show a variation of the temperature of the rod along its length when the surface of the rod is (i) unlagged and (ii) lagged. They also managed to deduce the rate of heat flow through a plaster ceiling.

These candidates wrote correctly the formula for the rate of heat flow in a plaster ceiling and an insulating material then compared the two equations. They finally calculated the temperature at the interface (equilibrium temperature) and use this value to compute the rate of heat flow through the plaster ceiling. Extract 11.2 displays an example of good responses from one of the candidates.



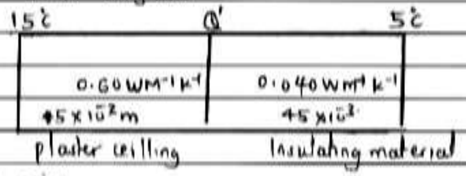
ii) lagged

Is the one which is cotted by lagging materials



b). Solution

With diagram.



Data given

For plaster ceilling

Thermo conductivity $(K_1) = 0.60 Wm^{-1}k^{-1}$

Temperature $(\theta') = 15°c$

The length $(L_1) = 15 \times 10^{-3}m$.

For Insulating materials

Thermo conductivity $(K_2) = 0.04 Wm^{-1}k^{-1}$

Temperature $(\theta') = 15°c$

The length $(L_2) = 45 \times 10^{-3}$.

From

$$\left(\frac{d\theta}{dt}\right)_1 = \left(\frac{d\theta}{dt}\right)_2$$

$$\frac{K_1 A_1 (\theta_2 - \theta_1)}{L_1} = \frac{k_2 A_2 (\theta_2 - \theta_1)}{L_2}$$

but $A_1 = A_2$.

$$\frac{K_1 (\theta_2 - \theta_1)}{L_1} = \frac{K_2 (\theta_2 - \theta_1)}{L_2}$$

$$\frac{0.6 (15 - \theta')}{15 \times 10^{-3}} = \frac{0.04 (\theta' - 5)}{45 \times 10^{-3}}$$

$$\frac{9 - 0.6\theta'}{15 \times 10^{-3}} = \frac{0.04\theta' - 0.2}{45 \times 10^{-3}}$$

11 Cont.

$$0.405 - 2.7\times10^{-2}\theta' = 6\times10^{-4}\theta' - 3\times10^{-3}$$

$$0.405 - 0.027\theta' = 6\times10^{-4}\theta' - 3\times10^{-3}$$

$$0.408 = 0.0276\theta'$$

$$\frac{0.408}{0.0276} = \frac{0.0276\theta}{0.0276}$$

$$\theta' = 14.8^{\circ}C$$

To determine the rate of heat flow a plaster ceilling

From $\frac{d\theta}{dt} = kA\left(\frac{\theta_2 - \theta_1}{L}\right)$

but $A = 15\,m^2$.

$$\frac{d\theta}{dt} = 0.6 \times 15\left(\frac{15 - 14.8}{15\times10^{-3}}\right)$$

$$\frac{d\theta}{dt} = 120\,J/sec.$$

or

$$\frac{d\theta}{dt} = 120\,J/sec.$$

∴ The rate of heat flow through a plaster ceilling is 120 J/sec.

Extract 11.2: A sample of a candidate's good responses to Question 11.

In extract 11.2, the candidate provided correct responses almost to all parts of the question.

2.1.12 Question 12: Current Electricity

In part (a), the candidates were required to derive an expression related to the experiment conducted by Rural Electrical Agency (REA) on the Ohmic conductors and ended up with a conclusion that the resistance of a conductor depends on the two factors. In part (b), they were given an electrical circuit represented in Figure 1 for a staff room lighting and then asked to determine (i) the potential difference (p.d) between A and C and (ii) the amount of current pass through B.

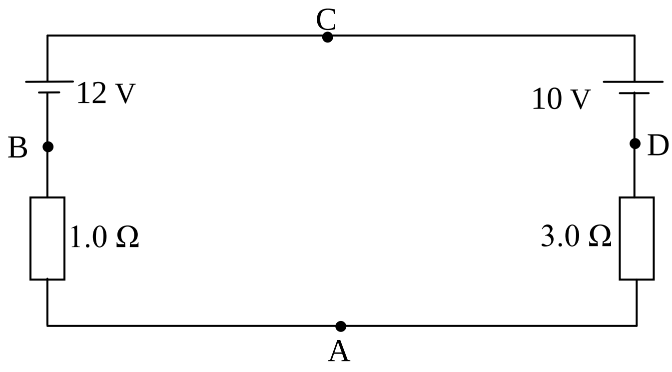


Figure 1

The question was attempted by 1,708 (100.0%) candidates. Through data analysis it was noted that the question had weak performance as 1641 (96.1%) candidates scored 0.0 to 5.5 marks. A summary of the performance is presented in Figure 12.

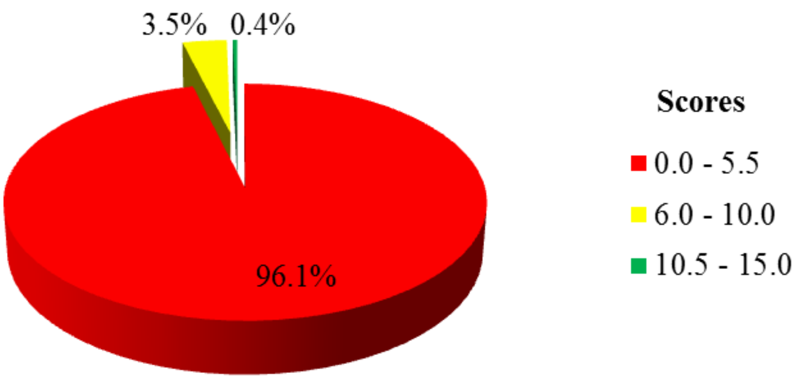
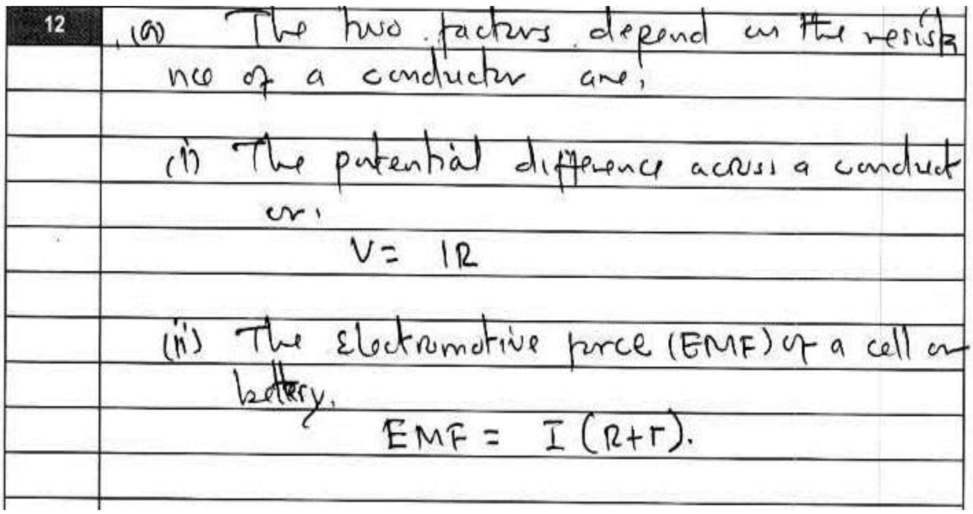


Figure 12: *The Candidates' Performance in Question 12*

Figure 12 shows that 1641(96.1%) candidates scored from 0.0 to 5.5.0 marks, 61 (3.5%) scored from 6.0 to 10.0 marks and 6 (0.4%) scored from 10.5 to 13.0 marks.

Analysis of candidates' responses shows that, candidates with low scores (0.0-5.5) had inadequate knowledge of the topic of *Current Electricity* particularly, the use of electric circuit to determine current, voltage and resistance. In part (a) of the question some candidates failed to identify the factors that affect the resistance of Ohmic conductors. For example, one of

the candidates wrote: *"The resistance of a conductor depends on voltage V, and Current I, that is* $R=\frac{V}{I}$ *".* This candidate utilized the concept of Ohm's law instead of using the fact that, resistance of Ohmic conductors depends on the length L of the conductor and cross-sectional area A, that is $R = \rho\frac{L}{A}$.
In part (b) of this question, most of the candidates failed to determine the potential difference between A and C and the amount of current passing through point B. For example, one of the candidates wrote: *"Ohmic conductors are those conductors that depend on resistance and in series arrangement* $R_T = R_1 + R_2$ *".* This candidate did not understand the demand of the question and lacked both knowledge of the concept of Ohmic conductors and mathematical skills. The candidates were supposed to apply Kirchhoff's voltage law which states *that "In any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop which is also equal to zero"*. They were also supposed to traverse the circuit loops either clockwise or anticlockwise and then formulate the equations. In so doing, they could be able to find the potential difference between A and C and the amount of current passing through B. Extract 12.1 is a sample of one of the candidates who provided incorrect responses in this question.


12 (a) The two factors depend on the resistance of a conductor are;
(i) The potential difference across a conductor;
$V = IR$
(ii) The electromotive force (EMF) of a cell or battery.
$EMF = I(R+r)$.

(b) potential difference p.d btn A and C.

From

parallel eqn.

$R_T = \frac{R_1 R_2}{R_2 + R_1}$

$R_T = \frac{1 * 3}{3 + 1} = 0.75 \Omega$.

From

$V = IR$

but $V = V_1 - V_2$

$V = 12 - 10$

$V = 2v$.

$\frac{V}{R} = \frac{IR}{R_T}$

$I = \frac{2}{0.75 \Omega} A$

$I = 2.66 A$

Extract 12.1: A sample of a candidate's weak responses to question 12.

In Extract 12.1, the candidate did not understand the two factors governing the resistance of Ohmic conductors in part (a). In part (b), he/she applied the concept of Ohm's law instead of using Gustav Kirchhoff's law to determine part (b) (i) and (ii).

In spite of weak performance demonstrated by most of the candidates, 6 (0.4%) candidates scored high marks in this question. These candidates stated correctly the factors affecting the resistance of Ohmic conductors. They also applied Gustav Kirchhoff's voltage law correctly in part (b) to determine the values of the potential difference between A and C and the amount of current passing through point B. Extract 12.2 is a sample of correct responses from one the candidates in this question.

12 a) Resistance depends of the two factor

i/ Resistance of a conductor is inversly proportional to the cross section area.

$$R \propto 1/A \quad ----(i)$$

ii/ Resistance of a conductor is directly proportional to the lenght of conductor.

$$R \propto L \quad ----(ii)$$

Derivations.

Combining equation (i) and (ii)

$$R \propto 1/A \quad --(i)$$

$$R \propto L \quad ---(ii)$$

Then

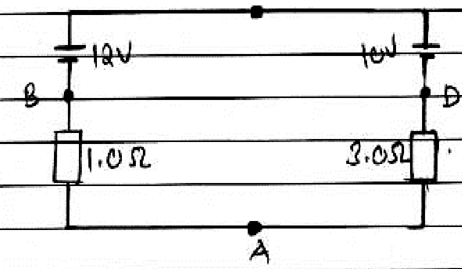
$$R \propto L/A$$

$$R = \frac{KL}{A}$$

but K = Resistivity (ρ)

$$R = \frac{\rho L}{A}.$$

$$\therefore R = \frac{\rho L}{A}$$



Determine

a) i) The potential difference (pd) between A and C.

ii) The amount of current passing throug B.

Solutions

i) The potential different btn A and C.

$$V_{ac} = |\Sigma(emf) - \Sigma IR|$$

$$V_{ac} = |-10 - 3I|$$

but $I = V/R$

Then $I = \frac{12-10}{3+1} = \frac{2}{4} = 0.5$

$I = 0.5\ A.$

Then

$$V_{ac} = |-10 - (3 \times 0.5)|$$

$$V_{ac} = |-10 - 1.5|$$

$$V_{ac} = |-11.5|$$

$$V_{ac} = 11.5\ V$$

12 Cont. ∴ The pottential different (p.d) between A and C is 11.5 V.

Alternative way.

$V_{ac} = |12 - 1I|$

but $I = 0.5$

$V_{ac} = |12 - (1 \times 0.5)|$

$V_{ac} = 12 - 0.5$

∴ $V_{ac} = 11.5$ V.

Extract 12:2: A sample of a candidate's correct responses to question 12.

In extract 12.2, the candidate wrote correctly the two factors affecting the resistance of Ohmic conductors and properly interpreted the electric circuit. Finally, he/she determined appropriately the potential difference between point A and C though she/he failed to state the correct amount of current passing through point B, which he/she had already calculated.

2.1.13 Question 13: Assessment in Physics

This question required the candidates to use a diagram of the moment of force to prepare a comprehensive marking scheme from the following monthly test question*: " A uniform metre rule is pivoted at its centre. If 20 g mass is placed at the 10 cm mark and a 50 g mass at the 40 cm mark from one end of the ruler, at what distance must a second 50 g mass be placed for the system to be in rotational balance?"*

The question was attempted by 1,708 (100.0%) candidates. Data analysis indicates that the question had weak performance as 1508 (88.3%) candidates scored 0.0 to 5.5 marks. The data is summarized in Figure 13.

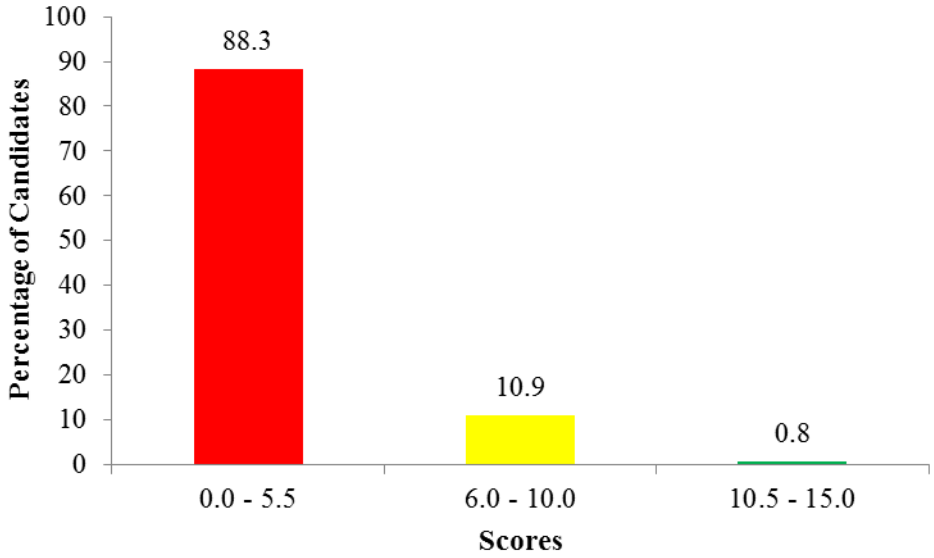


Figure 13: *The Candidates' Performance in Question 13*

The data in Figure 13 portrays that 1,508 (88.3%) candidates scored from 0.0 to 5.5 marks, 187 (10.9%) scored from 6.0 to 10.0 marks and 13 (0.8%) scored from 10.5 to 13.0 marks.

The candidates who scored low marks in this question had unsatisfactory knowledge of the topic of *Forces in Equilibrium*, particularly moment of force. These candidates had limited drawing skills pertaining to a system of rotational balance. They also lacked the skills for preparing a marking scheme for the given question. As well, they failed to distribute marks according to the weight of each piece of work. Likewise, some of the candidates prepared a marking scheme without allocating marks to each respective answer. Others allocated all the marks at the end of the final answer. These candidates were supposed to know that a marking scheme is a plan for allocating marks to students' answers in an examination or model answers for the questions. They were also supposed to understand the question in order to provide correct responses. Extract 13.1 is a sample of incorrect responses from one of the candidates who scored low marks in this question.

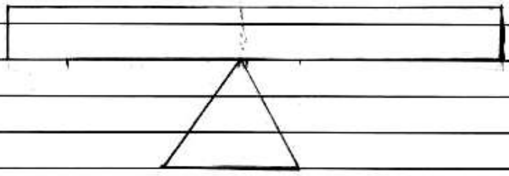
13

Given.

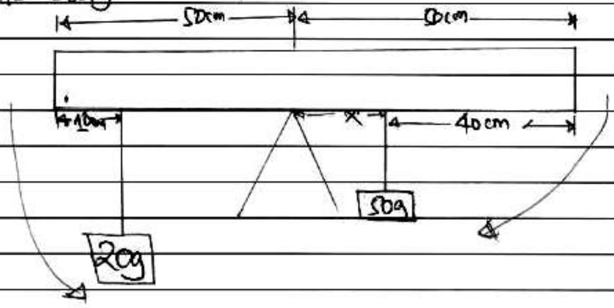
- Metre rule and pivot.
- 20g mass placed at the 10cm mark
- 50g Mass placed at the 40cm mark from one end of a rule.
- Distance of 50g mass be placed to rota for the system to be in rotational balance required?

From Diagrammatic Set up.

length of meter rule is 100cm



The law of Moment of force state that "The anticlowise moment of a body is equal to clockwise moment of the body"



From the law of Moment.

$10 \times 20 = x \times 50$

$200 = 50x$

$\frac{200}{50} = \frac{50x}{50}$

$x = 4$ cm.

∴ The distance is 10 cm, the 50g mass should be placed in order to balance a system (rotational balance). Mass place 10cm from the pivot balanced to the end the Meter ruler

Extract 13.1: A sample of a candidate's incorrect responses to question 13.

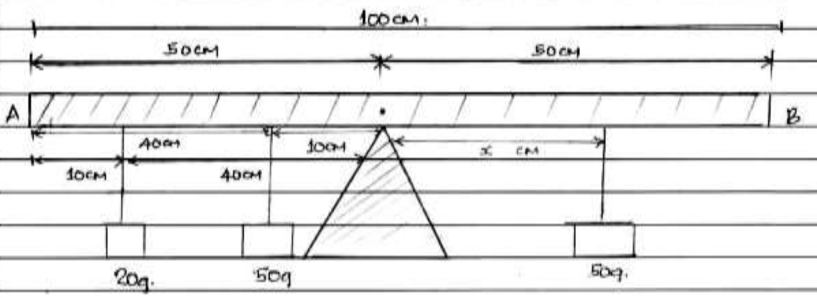
In extract 13.1, the candidate provided incorrect responses to all parts of the question.

On the other hand, the candidates who scored high marks (10.5-15.0) had sufficient knowledge about the *Forces in Equilibrium*, specifically the moment of force. These candidates drew a system of rotational balance by showing the pivot, suspended masses and their corresponding distances from the point of suspension on the metre rule. They recalled the principle of moment for a system of rotational balance and successfully calculated the point/distance at which a second 50 g mass is placed. However, most of them did not allocate the marks to the respective answers and thus missed some important marks. Extract 13.2 is a sample from a candidate who wrote correct responses to most parts of the question.

13

A MARKING SCHEME OF AN EQUILIBRIUM QUESTION.

Consider the diagram below of Moment of force:



Then; We are required to find the distance must a second 50g-Mass be placed for the system to be in rotational bal ante:

Given Mass (M_1) = 20g. let x be the distance for Mass (M_2) = 50g. the system to be in rotational balance;

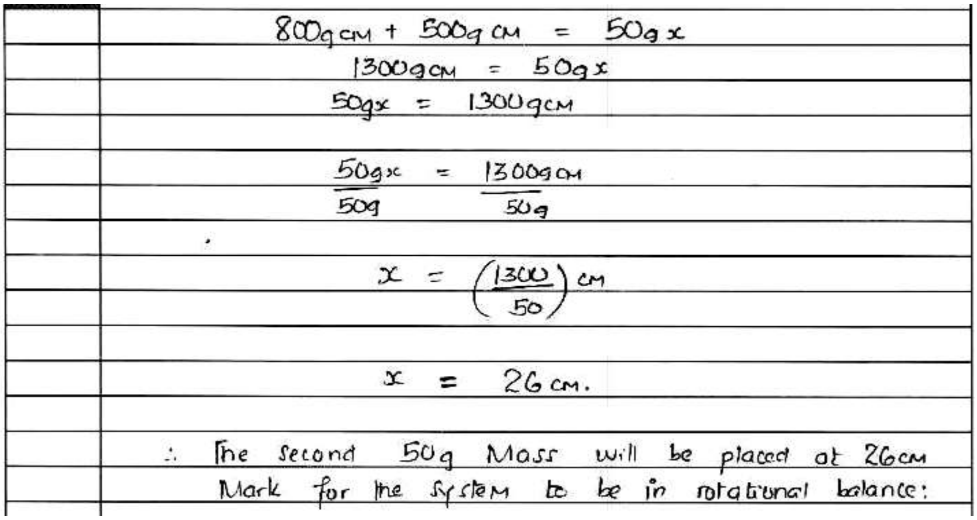
According to the principle of Moments; ~~Clo~~ the sum of Clockwise Moments will be equal to the sum of anticlockwise Moments about any point in a system

∴ Sum of Clockwise = sum of anticlockwise Moments:

by Taking the pivot to be the point of balance of the System; then

$(20g \times 40cm) + (50g \times 10cm) = 50g \times x\,cm$

$800cmg + 500cmg = 50gx$



$800g\,cm + 500g\,cm = 50g\,x$

$1300g\,cm = 50g\,x$

$50g\,x = 1300g\,cm$

$\frac{50g\,x}{50g} = \frac{1300g\,cm}{50g}$

$x = \left(\frac{1300}{50}\right) cm$

$x = 26\,cm.$

∴ The second 50g Mass will be placed at 26cm Mark for the system to be in rotational balance:

Extract 13.2: A sample of a candidate's correct responses to question 13.

In Extract 13.2, the candidate prepared a correct marking scheme for given question. However, he/she did not allocate marks to any established relation, manipulation and substitution of data or correct final answers to show how the 10 marks in the question were distributed.

2.1.14 Question 14: Teaching

In this question, candidates were required to use six factors to support the statement that *"A good Physics teacher must consider the factors for selecting teaching method that enable the students to understand well certain concepts before teaching sessions".*

The question was attempted by 1,708 (100.0%) candidates. The general performance was good as 1,516 (88.8%) candidates scored from 6.0 marks and above. The performance is summarized in Figure 14.

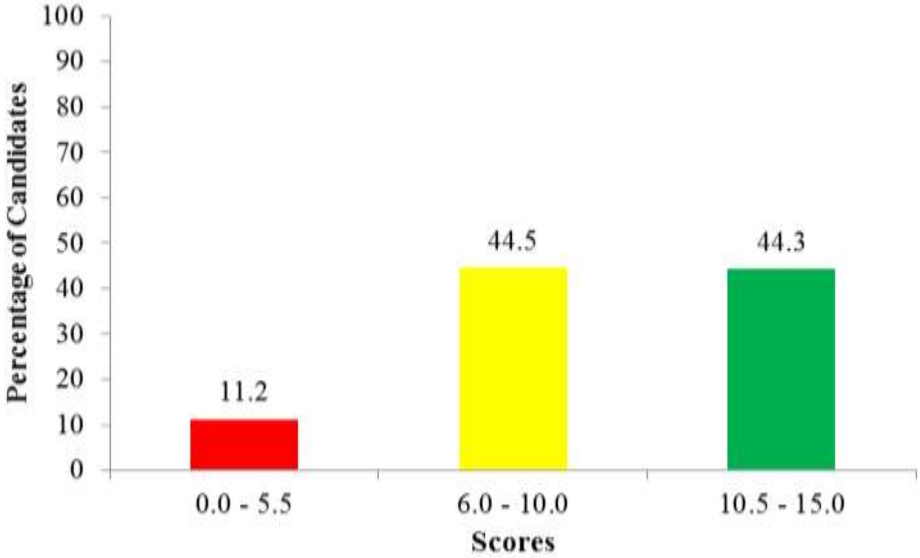


Figure 14: *The Candidates' Performance in Question 14*

The data in Figure 14 indicates that 192 (11.2%) candidates scored from 0.0 to 5.5 marks, 760 (44.5%) scored from 6.0 to 10.0 marks and 756 (44.3%) scored from 10.5 to 15 marks.

The candidates with good performance provided concise and clear details on the factors to consider when selecting a teaching method that enables the students to understand well a certain concept before the teaching session. Some of them supported this assertion by giving concrete examples of the factors suitable for selecting teaching methods or strategies that can make the students understand the concept being taught easily. The factors iwritten by these candidates were: *The nature of the learners; The number of the students available in the given class; Availability of teaching and learning aids; Educational philosophy of the country; Teacher's ability and preference; Cultural aspect of the society; Time bound; The need and interest of the learners and Examination set up*. Extract 14.1 represents one of the correct responses in this question.

Teaching method is a series of the all activities performed by teacher when teaching a lesson. The teaching method differ from one lesson to another. Teacher can choose the teaching method according to the following things

Nature of the content. When teacher selecting teaching method the nature of the subject matter should be considered this is because the nature of the subject can show you the direction on which teacher can do. Forexample practical needs teacher to demonstrate then student can perfome of the experiment.

Level of the learner. Also when choosing the teaching and learning method level of the student is very important to be considered this is because teacher not adviced to use group discussion for standard 3 pupil.

Number of the learners. The number of learners should be considered when selecting teaching and learning method. Forexample the class with many students is not easily to conduct group discussion this is due to of time conservation.

Availability of the teaching and learning materials Also the presence or absence of the teaching and learning resources can affect the selection of the teaching method Forexample if there is a shortage of the materials teacher can failure of use of the teaching novel.

Age of the learner. Age of the learner can help teacher to choose the teaching method because learner differ thinking capacity according to the age. Forexample learner below 12 cannot logic reason

The context also should be considered. The environment also can guide teacher in teaching and learning selection of method. Forexample when your at out of the class like field tour, teacher can not use Jigsaw method to teacher.

Therefore the teaching method can enhance effective teaching and learning to learners due to this proper selection should be done. This is because the good teaching method involves active participation of the learners.

Extract 14.1: A sample of good responses to question 14.

In extract 14.1, the candidate presented precise and proper explanation on the factors to consider when selecting teaching methods that enable students to understand certain topics.

There were a few candidates (1.2%) who scored low marks (0.0-5.5 in this question. These candidates showed to have inadequate knowledge of the factors necessary for selecting teaching method that enable the students to understand the concepts well. For example, one of the candidates wrote factors for selecting teaching methods that enable students to understand well as: *"Simple to complex; Known to unknown; inductive to deductive approaches; from particular to general; from concrete to abstract and from empirical to rational"*. This candidate expressed the concept of different maxims of teaching as applied to the fundamentals of teaching and learning, instead of explaining the factors that favour good selection of teaching methods which help the students to understand well certain concepts easily. Extract 14.2 shows one of the incorrect responses to the question.

14

Teacher is the one who facilitating other people. so a physics teacher is the one who have a professional in teaching physics subject. Teaching method are the ways that a teacher can use to enable the students inorder to understand well a certain concepts. So every teacher must be preparing the teaching method before teaching session.

The following are the factors that a teacher must be considering before teaching session.

Syllabus: Is a list of topics to be covered at a particular subject. So physics syllabus it used to show all the topics to be covered at a certain class as well as show the way how we can teach a particular topic for example in the topic of electric current through syllabus it enable teacher to use an simple electric circuit devices such as battery, switch, wire. So this is the one of the important factors a teacher must be considering before teaching session.

Teachers guide: Is a book which guide a teacher to teach effectively when given a subject matter. A teacher must be have a teachers guide inorder to follow all the steps and ideas of teaching. So this is the one of the important factors required before teaching.

Textbook: Is a book that contains a detailed information of a particular subject. Normally textbook are used by a students so physics a teacher must using a textbook to planning a notes, preparing questions of the students. So this is the one of the factors that

14 Cont.

a teacher required before teaching session.

Supplimentary materials: Are the materials that enable a teacher to teach systematically. example journals, pamphlets, magazines and newspaper. So this is the one of the factors that required a teacher to preparing before teaching session.

Scheme of work: A teacher must prepare a scheme of work earlier before teaching session. because it enable a teacher to teach systematically from the simple concept to the complex concept.

Lesson plan: Is an instructional plan that prepared by a teacher to cover two or one period of a particular period. so every teacher must prepared lesson plan before teaching because a lesson plan it gives confidence teachers during teaching.

Generally! Above are the factors that a teacher required to following before teaching session to enable students to understand well a concepts of a certain period.

Extract 14.2: A sample of incorrect responses to question 14.

In extract 14.2, the candidate presented the concepts of analysis of Physics curriculum materials instead of giving the factors to consider when selecting methods of teaching before teaching session.

731/2 Physics 2 (Actual Practical)

The Physics actual practical paper had three equivalent alternative papers 2A, 2B and 2C each with three questions. The questions tested were set from three topics of *Mechanics, Heat* and *Current Electricity*. Question 1 tested the topic of *Mechanics* and carried 20 marks, while question 2 and 3 tested the topics of *Heat* and *Current Electricity* respectively, each carrying 15 marks. The total of marks for each alternative paper was 50. Candidates were required to answer all questions. The analysis of candidates' performance in each question is as follows:

2.1.15 Question 1: Mechanics

2.1.15.1 731/2A Physics 2A

The question required the candidates to find the weight of the pendulum bob by using the following apparatuses: retort stand, clamps, metre rule, cotton thread, wood pads and stopwatch. They were required to conduct an experiment through the given procedures and then answer the questions that follow.

Procedures:

(a) Set the experiment in such a way that the pendulum bob is at a height, (H) = 100 cm from the ground to the centre of the bob and a length, *l* of the thread be 60 cm from the point of suspension to the centre of the pendulum bob.

(b) Slightly displace the pendulum bob at a small angle and release to allow it swing and measure the time t required to complete 20 oscillations and calculate its periodic time T.

(c) Repeat the procedure in 1(b) by increasing the length of thread, *l* = 70 cm, 80 cm, 90 cm, 100 cm and 120 cm each time recording the values of H and t and hence its corresponding periodic time T.

(d) Finally, measure the mass *m* in kg of the pendulum bob, by using a beam balance.

Questions

(i) Draw a labeled diagram of the experimental set up.

(ii) Tabulate your results, including the values of t, *l*, H, T and T^2.

(iii) Plot the graph of H (cm) against T^2 (sec^2).

(iv) Determine the slope, S of your graph.

(v) Determine the weight W of the metal ball in newton, given that $W = \left(\frac{-0.0254}{mS}\right)^{-1}$.

(vi) Show that T^2 intercept $= \frac{4\pi^2 K}{g}$.

(vii) What is the physical meaning of K?

A total of 1,708 (100%) candidates attempted this question. The general performance of candidates was average as shown in Figure 15.

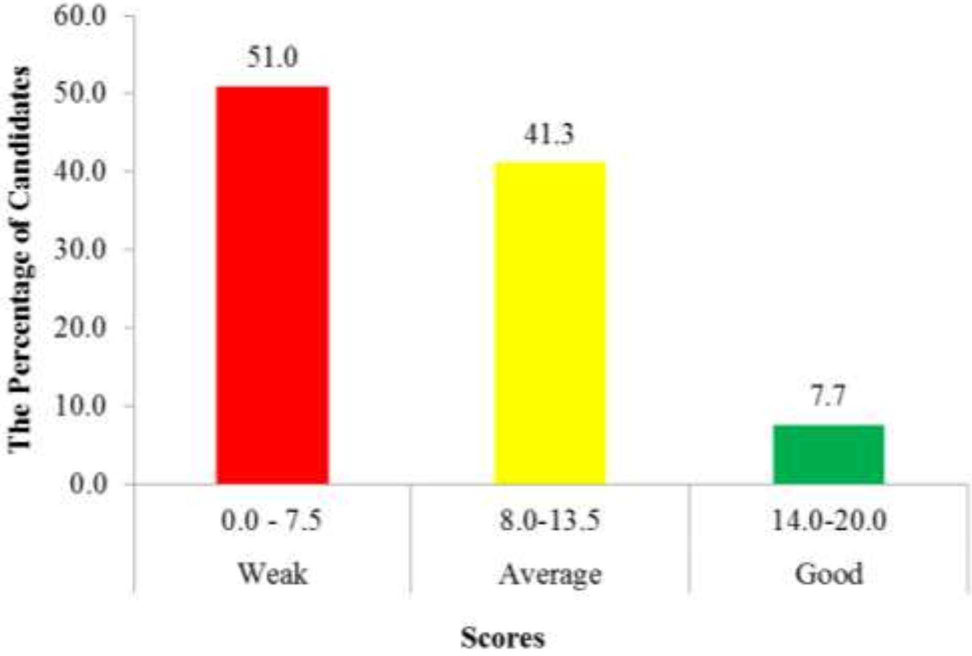


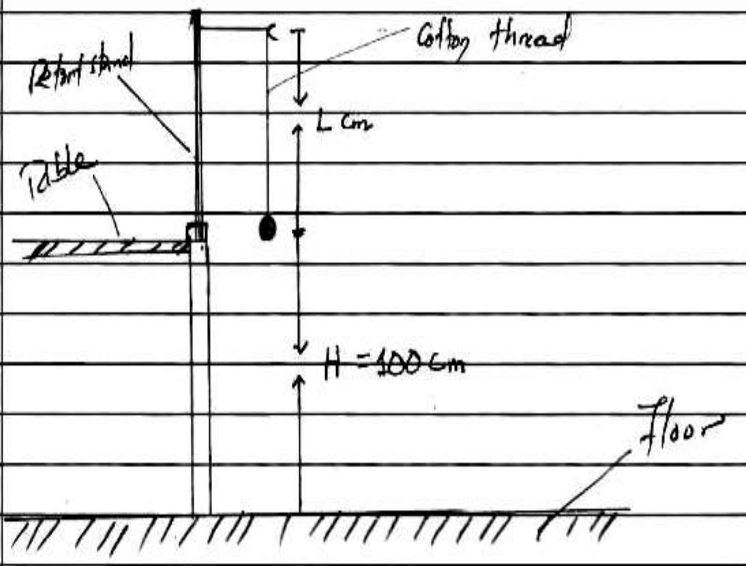
Figure 15: *The Candidates' Performance in Question 1*

The data in Figure 15 shows that 871 (51.0%) candidates scored from 0.0 to 7.5 marks, 705 (41.3%) scored from 8.0 to 13.5 marks and 132 (7.7%) scored from 14.0 to 20.0 marks.

The analysis of candidates' performance shows that the candidates with average scores provided incorrect responses in some parts of the question. Some of these candidates collected the 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 incorrect scale which was tough 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 determined correctly the weight W of the metal ball in newton but failed to show that $T^2\text{-intercept} = \frac{4\pi^2 K}{g}$.

Furthermore, the candidates who scored high marks (14.0 – 20.0) were able to set the apparatus, prepare a table of results and recorded the data correctly. They also plotted correctly the graph of H (cm) against T^2 (sec^2). In the graph, they properly indicated the following important features: Title of the graph, axis and scales with their respective units, transfer of data points, drawing of the best line and slope indication. Likewise, from the graph, they accurately determined the slope S, and used it to determine the weight W, of the metal ball whose mass m was initially measured with the help of a beam balance. Some of them stated correctly the physical meaning of K. The candidates' responses were definitely indicated that they had good knowledge of performing simple pendulum experiments. Extract 15.1 represents a sample of good responses in this question.

(i) The diagram to show the set up of experimental



(ii) Table of result

L cm	H (cm)	t (sec)	T (sec)	T^2 (sec)^2
60	100	31	1.55	2.40
70	90	33	1.68	2.82
80	80	36	1.80	3.24
90	70	38	1.90	3.61
100	60	40	2.00	4.00
120	40	44	2.20	4.84

(iii) Required to find slope

soln

from slope = $\frac{\text{change in Y-axis}}{\text{change in X-axis}}$

(iii) $Slope = \frac{\Delta y}{\Delta x}$

Slope from the graph

$$Slope(s) = \frac{\Delta H}{\Delta T^2} = \frac{90-40}{2.42-4.44} = \frac{50}{-2.02}$$

$$= \frac{50}{-2.02}$$

$$Slope(s) = \frac{50}{-2.02} = -24.75\ cm/sec^2$$

∴ Slope of the graph is $-24.75\ cm/sec^2$

(v) Required to find weight of metal ball

mass from beam balance $m = 0.028\ kg$

$Slope\ (s) = -24.75\ cm/sec^2$

$(s) = -0.2475\ m/sec^2$

Then;

$$W = \left(\frac{-0.0254}{0.028 \times 0.2475}\right)^{-1} = 0.273\ N$$

$Weight\ (W) = 0.273\ N$

∴ Weight of metal ball is $0.273\ N$

(vii) The physical meaning of K is the length of the thread from the point of suspension.

(vi) from the

$$T = 2\pi\sqrt{\frac{L-H}{g}} \quad , L = K$$

$$T^2 = 4\pi^2\left(\frac{L-H}{g}\right)$$

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

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

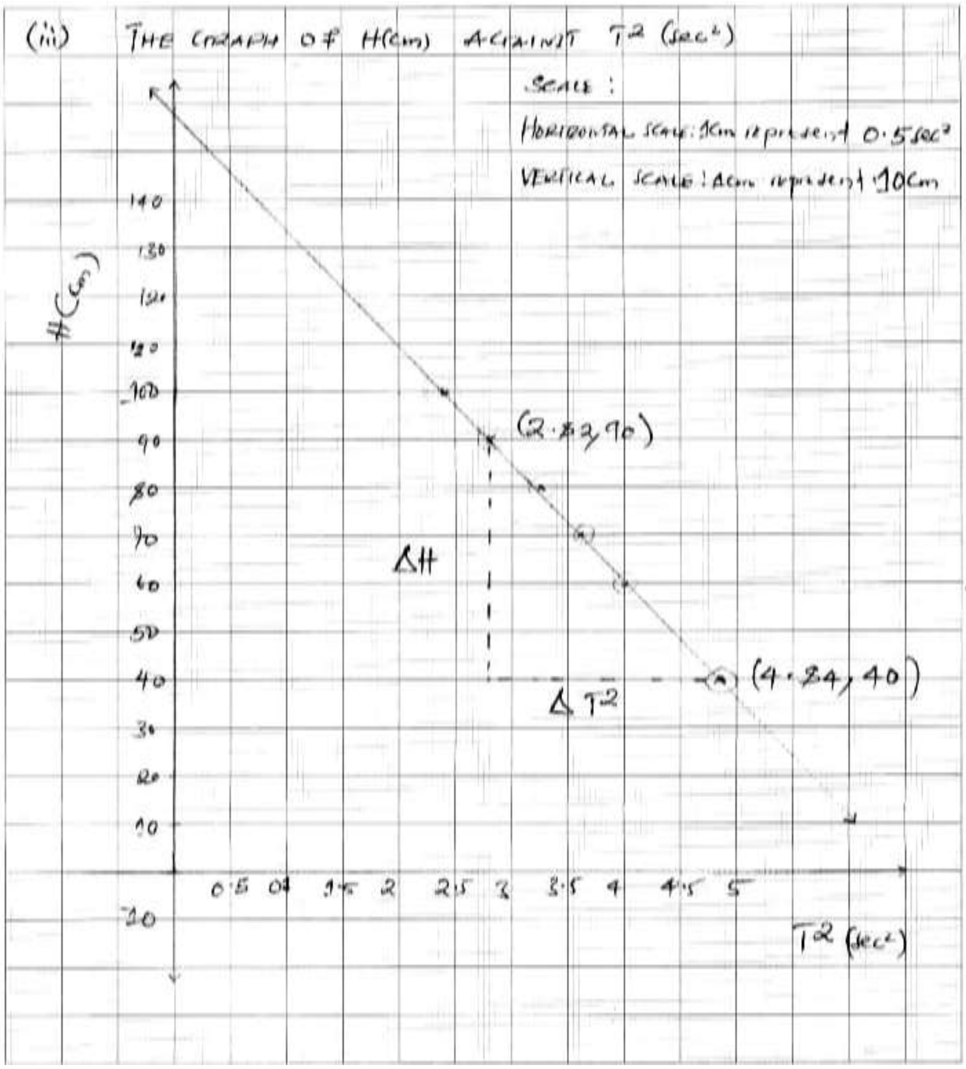
$$T^2 \text{ intercept} = \frac{4\pi^2 L}{g}$$

$L = K$

$$T^2 = \frac{4\pi^2 K}{g}$$

$$T^2 = \frac{4\pi^2 K}{g}$$

Hence shown.

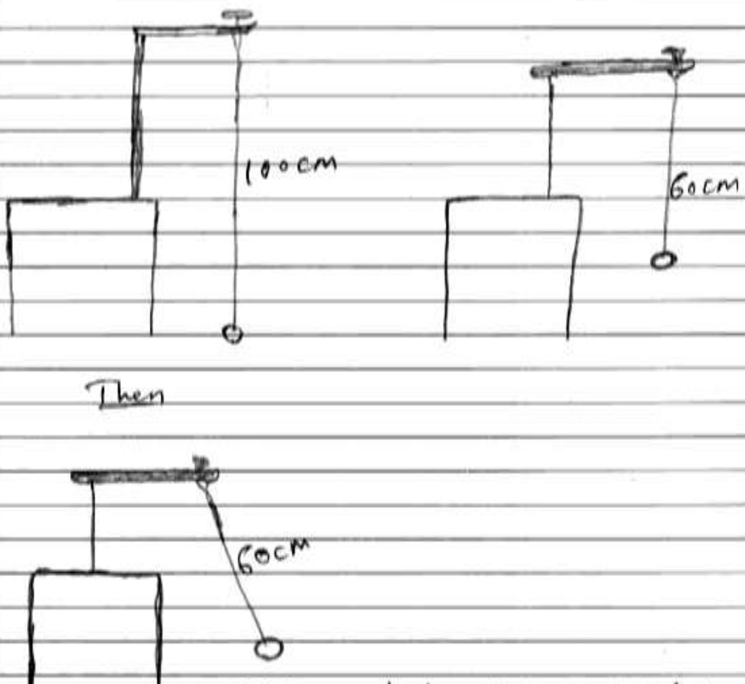


Extract 15.1: A sample of correct responses to question 1 of Physics 2A.

In Extract 15.1, the candidate did correctly in almost all parts of the question.

However, the candidates who scored low marks (0.0 – 7.5) lacked skills for conducting Simple Pendulum experiments to determine the weight of the simple pendulum. These candidates failed to set up the experiment appropriately and, hence, failed to collect and record the required data in the table of results. Because of having poor knowledge on how to set up the experiment, some candidates failed to draw an experimental diagram and therefore, collected undesirable data values. Others were absolutely unable to construct the table of results and thus, failed to do properly the remaining parts of the question. Some of them had lack of mathematical ability since failed to establish the relation for T^2-intercept $= \frac{4\pi^2 K}{g}$. Extract 15.2 is an example of incorrect responses given by one of the candidates in this question.

(i) Setup for the experiment



Swing a bob after a certain angle

Table of result

t	H	L	T	T^2
	0.1	0.6		
	0.9	0.7		
	0.8	0.8		
	0.7	0.9		
	0.6	1.0		
	0.5	1.2		

Pt	H	L	T	T^2
	0.1	60		240
	0.9	70		280
	0.8	80		320
	0.7	90		360
	0.6	100		480
	0.5	120		480

(iv) So as to Find slope

In calculation from the graph we get

0.04 cm/sec²

∴ Slope = 0.04 cm/sec²

(v) ∵ $W = \left(\frac{-0.0254}{M_s}\right)^{-1}$

Where slope = 0.04 cm/sec²

W = 6.5g

Weight of metal ball = 6.5g.

Extract 15.2: A sample of incorrect responses to question 1 of Physics 2A.

In Extract 15.2, the candidate exhibited a lack of knowledge of how to conduct experiments concerning simple pendulum as he/she failed to set up the experiment as per the instructions. He/she roughly set up an irrelevant experiment which made him/her fail to attain time t required to complete 20 oscillations. The candidate then failed to do the next parts of the question.

2.1.15.2 731/2B Physics 2B

In this question, the candidates required to carry out an experiment through the given procedures to find the total mass of the spring.

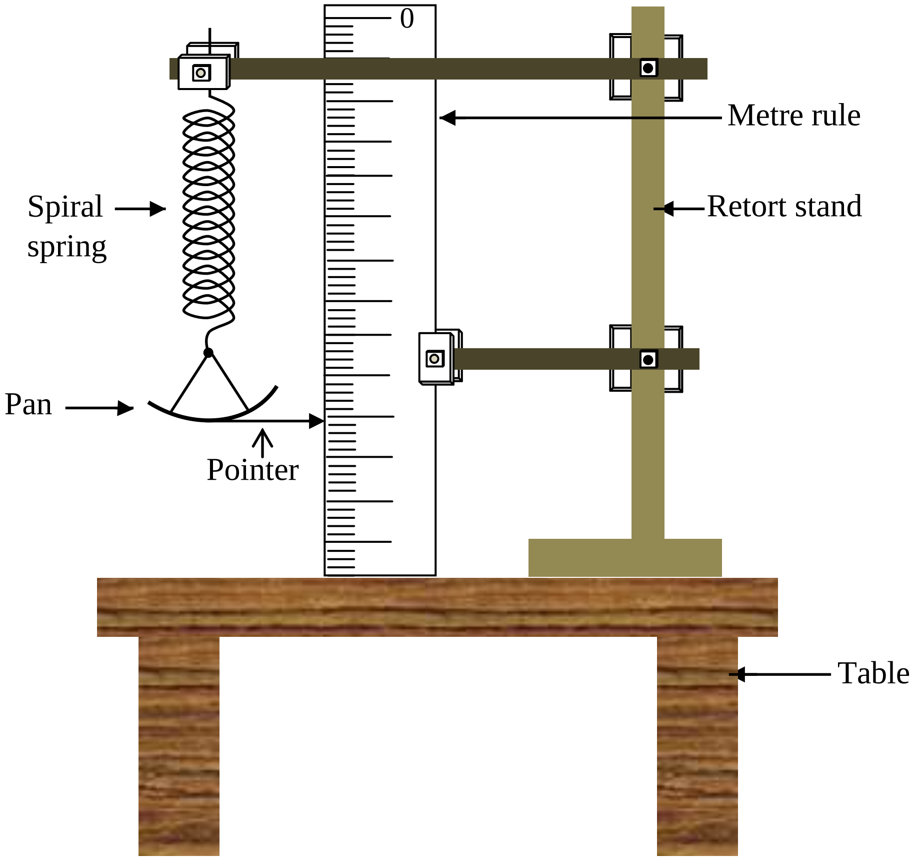


Figure 1

Procedures:

(a) Record the pointer's reading when the pan is empty as X_o (cm).

(b) Put 100 g mass on a pan and record a new pointer's reading as X (cm). Hence find the extension, $S = X - X_o$.

(c) Pull a spring to a small distance and release it so that it oscillates in a vertical motion. Record time t in seconds for 20 complete oscillations.

(d) Repeat the procedure in 1 (c) for masses, 200 g, 250 g, 300 g, 350 g and 400 g.

Questions

(i) Tabulate your results, including the values of m (g), t (sec), T (sec) and T^2 (sec^2).

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

(iii) Using the equation $T^2 = \frac{4\pi^2}{K}(m + m_{es})$, calculate the effective mass (m_{es}) of the spring where $K = \frac{0.98N}{S(cm)}$.

(iv) What is the physical meaning of constant K?

(v) Use y-intercept of the graph to determine the value of the effective mass of the spring m_{es}.

(vi) Using effective mass obtained in 1 (v), write down the relationship between mass of the spring (mS) and m_{es}, and hence use the relation to solve for mS.

(vii) What will be the total mass of the spring loaded over the digital balance?

The candidates who scored high marks (14.0 – 20.0) were able to set the apparatuses, prepare a table of results and record the data correctly. They also plotted correctly the graph of m (g) against T^2 (sec^2). In the graph, they appropriately indicated the important features: Title of the graph, axis and scales with their corresponding SI units, transfer of data points, drawing of the best line and selection of the points to find the slope. Similarly, from the graph, they precisely calculated the effective mass (m_{es}). Some of them stated correctly the physical meaning of K. consequently; they determined appropriately the value of the effective mass of the spring m_{es}. The candidates' responses implied that they had good knowledge of carrying out simple pendulum experiments. Extract 16.1 represents a sample of good responses in this question.

1 (a) When the pan is empty or X_o (cm)

$= 11.5 cm$

(b) $S = X - X_o$

$X = 18.5 cm$

$X_o = 11.5 cm$

Hence

$S = X - X_o$

$= 18.5 cm - 11.5 cm$

$= 7 cm$

$S = 7 cm$

Table of result

Mass (g)	t (sec)	T (sec)	T^2 (sec^2)
100	17	0.85	0.72
200	20	1.0	1.06
250	27	2.5	
300	30	1.50	2.25
350	32	1.60	2.56
400	35	1.75	3.06

(iii) From the graph slope (M)

$$M = \frac{\Delta m (g)}{\Delta T^2 (sec^2)}$$

$$M = \frac{300 - 200}{2.25 - 1.00}$$

1 Cont.

$$\mu = \left(\frac{100}{1.25}\right) g/sec^2$$

$$\mu = 80\ g/sec^2$$

$$\mu = 80\ g/sec^2$$

Hence

from

$$T^2 = \frac{4\pi^2}{k}(m + m_e)$$

But

$$k = \frac{0.98N}{s(cm)}$$

But

$$s = 80\ g/sec^2$$

$$k = \frac{0.98N}{80\ g/sec^2}$$

$$k = 0.012$$

Hence

$$T^2 = \frac{4\pi^2}{k}(m + m_e)$$

$$\frac{T^2 k}{4\pi^2} = \frac{4\pi^2 (m + m_e)}{4\pi^2}$$

$$m + m_e = \frac{T^2 k}{4\pi^2}$$

$$m_e = \frac{T^2 k}{4\pi^2} - m$$

(iii) $M_{es} = \frac{T^2 k}{4\pi^2} - m$

$M_{es} = \frac{0.72 \times 0.012}{4\pi^2} - 100$

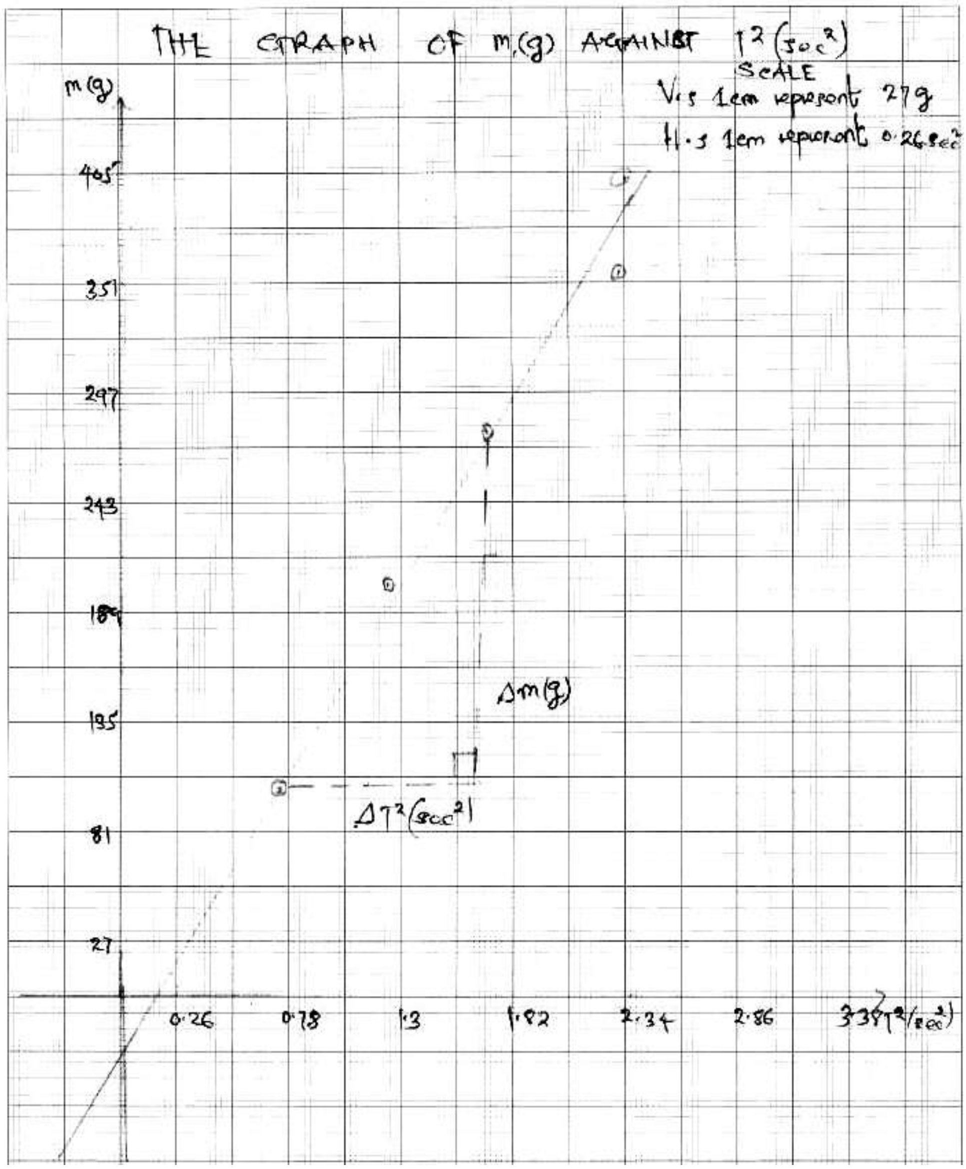
$M_{es} = 21g.$

(iv) The pysical meaning of constant k is spring constant

(v) From the y- intercept the value of the effective mass of the spring (M_{es}) is 26g.

(vi)

(vii) The total mass of loaded spring is
100 + 200 + 250 + 300 + 350 + 400
= 1600 g
∴ The total mass is 1600g.



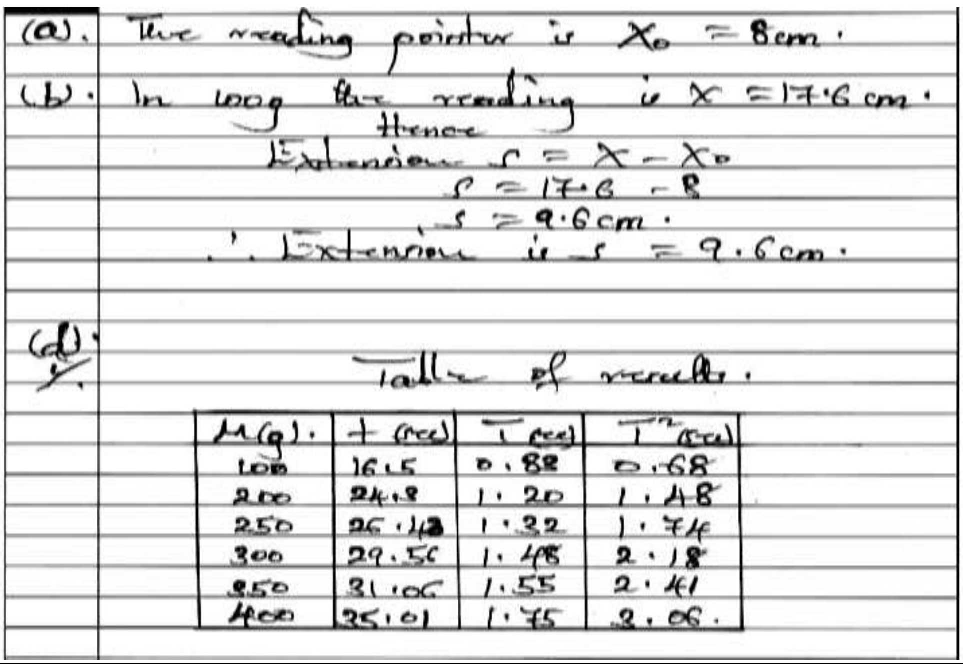
Extract 16.1: A sample of good responses to question 1 of Physics 2B.

In Extract 16.1, the candidate constructed a of results, plotted a graph of m (g) against T^2 (sec^2) and hence calculated the effective mass of the spring correctly. He/she wrote the correct physical meaning of constant K. However, this candidate failed to write down the relationship between mass of the spring (mS) and m_{es}, calculation of mS and the total mass of the spring loaded on the digital balance.

The candidates who scored low marks in this question lacked knowledge of the concept of mechanics, especially the subtopic of motion under gravity (simple pendulum). In this context, the candidates prepared incorrect tables of values which earned them low scores. Another drawback that was experienced by the candidates was lack of drawing skills.

Some of the candidates failed to plot a graph of m (g) against T^2 (sec^2) correctly. Some drew graphs without indicating the axis, title of the graph, the scale used, the best line and slope indication. Consequently, they transferred incorrect data points from wrongly constructed table of results to the graph and hence they plotted wrong graphs.

The majority of the candidates failed to relate the slotted masses placed in the scale pan, the effective mass of the spring and the spring constant and hence, they failed to show their connection with T^2. These candidates were supposed to realize that the total mass pulling down on the spring is actually comprised of two masses, the added mass *m*, plus a fraction of the mass of the spring, which we call the mass equivalent of the spring (effective mass), m_e. From this perspective, candidates were supposed to employ the mathematical relation $m = k\frac{T^2}{4\pi^2} - m_e$ with the linear equation $y = mx + c$ to get the spring constant, k and the effective mass m_e. Extract 16.2 is a sample of the candidate's weak responses from question 1 in Physics 2B.



(a). The reading pointer is $X_0 = 8cm$.

(b). In 100g the reading is $X = 17.6$ cm.

hence

Extension $s = X - X_0$

$s = 17.6 - 8$

$s = 9.6$ cm.

∴ Extension is $s = 9.6$ cm.

(d).

Table of results.

M (g)	t (sec)	T (sec)	T^2 (sec)
100	16.5	0.82	0.68
200	24.8	1.20	1.48
250	26.43	1.32	1.74
300	29.56	1.48	2.18
350	31.06	1.55	2.41
400	35.01	1.75	3.06

Extract 16.2: A sample of part of a candidate's incorrect responses to question 1 of Physics 2B.

In Extract 16.2, the candidate prepared an incorrect table of values which obviously affected these responses in the remaining parts of the question.

2.1.15.3 731/2C Physics 2C

In this question, the candidates were required to carry out an experiment to determine the impact of acceleration due to gravity, when provided with the following apparatuses: spiral spring, retort stand, stopwatch, scale pan, six masses (150 g, 200 g, 250 g, 300 g, 350 g and 400 g) and two wooden pads. They were supposed to conduct an experiment as per procedures given and then answer the questions that followed.

Procedures:

(a) Set up the experiment as shown in Figure 1.

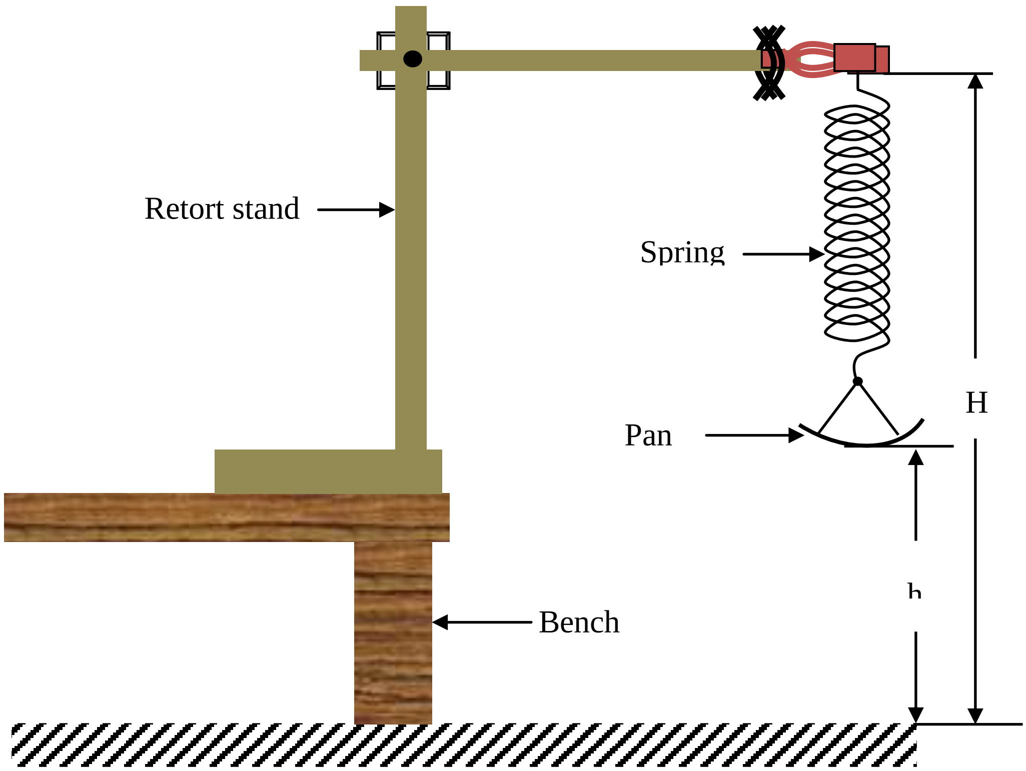


Figure 1

(b) Measure and record the height H from the point of suspension of the spring to the ground. This should be kept constant throughout the experiment.

(c) Place 150 g mass in the scale pan attached at the lower end of the fixed spring and measure the height h from the lower end of the scale pan to the ground.

(d) Slightly displace the spring and record the time for 20 complete oscillations.

(e) Repeat procedures in 1(c) and (d) for masses of 200 g, 250 g, 300 g, 350 g and 400 g.

Questions

(i) Tabulate your results to include corresponding values of h, time, periodic time T and the square of the periodic time, T^2 for each mass.

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

(iii) Find the slope and intercept of the graph.

(iv) From the graph, deduce the relationship between h and T^2 .

(v) Find the ratio of H and intercept of the graph.

(vi) Mention two possible sources of error in doing this experiment.

The candidates who scored high marks (14.0 – 20.0) were able to set the apparatuses, tabulate and record correctly the values of h, time t, periodic time T and the square of the periodic time, T^2 for each mass. They also plotted correctly the graph of h (cm) against T^2 (sec^2). In the graph, they appropriately indicated the important features such as: Title of the graph, axis and scales with their corresponding SI units, transfer of data points, drawing of the best line and selection of the points to find the slope.

Similarly, from the graph, they accurately calculated the slope and intercept of the graph and finally deduced the relationship between h and T^2 . Some of them established correctly the relationship between H and the intercept of the graph. Consequently, they mentioned two correct possible sources of errors in that experiment. The candidates' responses portrayed that they had good knowledge of carrying out simple pendulum experiments specifically, mass-spring experiment. Extract 17.1 represents a sample of good responses in this question.

(i) TABLE OF RESULTS:

Mass (g)	Mass (kg)	h (m)($y-y_0$)	t (s)	T (s)	T^2 (s^2)
150	0.15	0.08	11.40	0.57	0.32
200	0.20	0.11	13.20	0.66	0.44
250	0.25	0.13	14.40	0.72	0.52
300	0.30	0.30	21.80	1.09	1.20
350	0.35	0.35	23.60	1.18	1.40
400	0.40	0.40	25.20	1.26	1.60

(iii) Solution

From the graph drawn on the graph paper then

$$\text{Slope} = \frac{\text{change in } h\ (\Delta h)}{\text{Change in } T^2\ (\Delta T^2)}$$

Let slope = M

1 Cont.	Then
(iii)	$M = \frac{\Delta h}{\Delta T^2}$
	$M = \left(\frac{0.35 - 0.21}{1.32 - 0.88}\right) Ms^{-2}$
	$M = 0.25$ or $0.31\ Ms^{-2}$
	∴ The slope of the graph was $0.25 Ms^{-2}$
	→ The intercept of the graph was $-0.06M$
(iv)	~~from~~ solution
	from the graph equation
	$T^2 = \frac{4\pi^2 h}{g} + \frac{4\pi^2 x}{g}$
	~~$T^2 =$~~
	$\frac{4\pi^2 h}{g} = T^2 - \frac{4\pi^2 x}{g}$
	$\frac{4h}{4} = \frac{T^2}{4} - 4x$
	$h = \left(\frac{1}{4}\right) T^2 - 4x.$
	Means h and T^2 was directly proportional h increase with increase in T^2.

(v) Solution

- Data given
- height of (H) = 1M or 100 cM
- Intercept of the graph = -0.06M

from:

$$\text{Ratio} = \frac{H}{\text{intercept}} = \frac{1M}{-0.06M}$$

$$\text{Ratio} = \left(\frac{1}{-0.06}\right)\frac{M}{M}$$

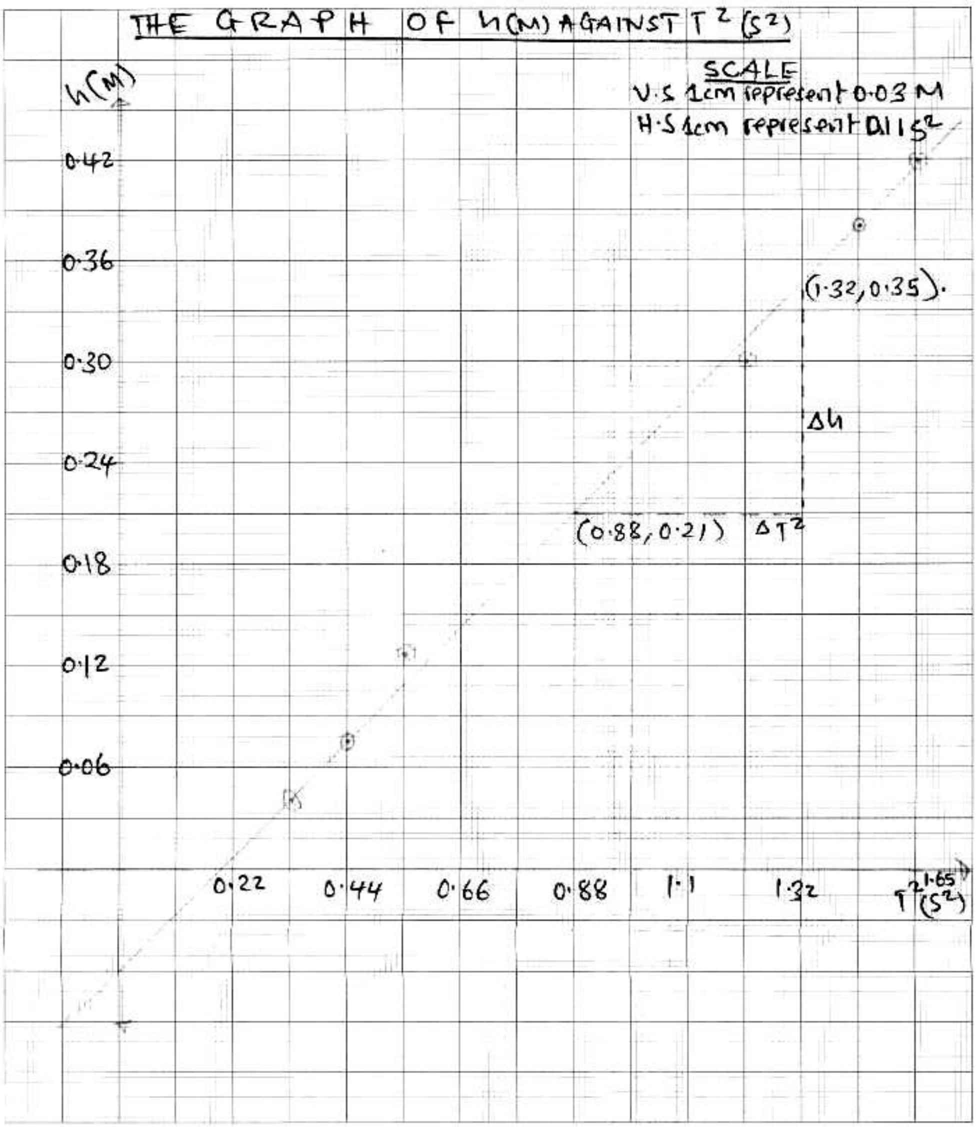
Ratio = -16.67

∴ The ratio was -16.67

(vi) The sources of error are:-

~~(i)~~ - Timing ~~wh~~ error when starting and stopping the stopwatch.

- Air resistance like wind during experiment.



Extract 17.1: A sample of a candidate's good responses to question 1 of Physics 2C.

In Extract 17.1, the candidate responded correctly to most parts of the question.

The candidates who scored low marks in this question lacked knowledge of the concept of mechanics, especially the subtopic of motion under gravity (simple pendulum experiment). These candidates prepared incorrect tables of values, which made them miss some crucial marks. Another shortcoming that was exhibited by the candidates was lack of drawing skills.

Some of the candidates failed to plot the graph of h (cm) against T^2 (sec^2) correctly. Some drew graphs without indicating the axis, title of the graph, the scale used, best line and slope indication. Consequently, they transferred incorrect data points from wrongly constructed table of results to the graph and hence obtained inappropriate graph. Others prepared a table of results with a column of time taken t having empty data but they recorded the periodic time T and the square of the periodic time T^2. This is obvious that these candidates had cooked data since it is impossible to get the periodic time T without values of time t. The following table of values is a sample of responses from a candidate who recorded the values of periodic time T with no values of time t.

iv/ Table value

L	t	T	H	T^2
60	31·87	1·55		2·30
70		1·77		2·30
80		1·79		2·60
90		2·00		2·
10		2·10		2·97

Further analysis reveals that many candidates gathered unsuitable data and thus calculated incorrect values of the slope of the graph since the drawn graph was also irrelevant. Some of them failed to deduce the relationship between h and T^2. They also gave out sources of errors that were not expected due to the nature of the experiment itself. Extract 17.2 is a sample of the candidate's weak responses in question 1 from Physics 2C.

i) The Table of results

M(g)	h(cm)	t(s)	T(s)	T^2 (s^2)
150	119.5	43·6	2·18	4·780
200	117·5	43·2	·2·16	4·700
250	115·1	42·8	2·14	4·604
300	114·1	42·6	2·13	4·564
350	112·3	42·2	2·11	4·492
400	110·5	42·0	2·10	4420

iii	slope (m) = $\Delta h / \Delta T^2$
	slope (m) = $\frac{h_2 - h_1}{T_2^2 - T_1^2}$
	slope (m) = 25 cm s^{-1} and
	∴ slope (m) = 25 cm s^{-1} and intercept is 5.25×10^{10}
iv	The relationship between h and T^2 from
	$T = 2\pi\sqrt{\frac{H-h}{g}}$
	Square both sides.
	$T^2 = \frac{4\pi^2(H-h)}{g}$
	$T^2 = \frac{4\pi^2 H}{g} - \frac{4\pi^2 h}{g}$
	$T^2 - \frac{4\pi^2 H}{g} = -\frac{4\pi^2 h}{g}$
	$-\frac{4\pi^2 h}{g} = T^2 - \frac{4\pi^2 H}{g}$
	$\frac{4\pi^2 h}{g} = T^2 + \frac{4\pi^2 H}{g}$
	$h = T^2 + \frac{4\pi^2 H}{g}$
v	Ratio of H and intercept
	Ratio = $135 / 5.25 \times 10^{10}$
	Ratio = 2.57×10^{-9}
vi	Sources of error are
	Air resistance
	Parallax error due to reading

Extract 17.2: A sample of the candidate's weak responses to question 1 of Physics 2C.

In Extract 17.2, the candidate recorded incorrect values in a table of results and hence missed all the marks. He/she plotted an irrelevant graph and therefore, failed to calculate the slope and intercept of the graph. The candidate also, deduced a wrong relationship between h and T^2 by writing $h = T^2 + \frac{4\pi^2 H}{g}$ instead of $h = -\left(\frac{g}{4\pi^2}\right)T^2 + H$.

2.1.16 Question 2: Heat

2.1.16.1 731/2A Physics 2A

The question required the candidates to determine the specific heat capacity of block A and B. They were given the following apparatuses: a copper calorimeter with its jacket, a thermometer, a stirrer, a tripod stand, a wire gauze, a beam balance, 25 ml beaker, 50 g of metal block A, 50 g of metal block B, a thread, a source of heat and water. They were asked to use the given information to perform the experiment and then answer the questions that follow.

Procedures:

(a) Fill the beaker with water to about $\frac{2}{3}$ of its volume.

(b) Measure and record the mass m_A and m_B of metal blocks A and B respectively.

(c) Tie a thread to block A, gently lower it into water in the beaker.

(d) Heat the water until it boils.

(e) Measure the mass of the calorimeter and its stirrer as m_1. Insert the calorimeter into its jacket.

(f) Fill the calorimeter about $\frac{1}{2}$ with water and measure its mass as m_2.

(g) Read and record the temperature of the water in the calorimeter as θ_1. Quickly transfers block A into the calorimeter and cover with a lid.

(h) Observe the temperature while stirring the water in the calorimeter until it reaches a maximum value.

(i) Record the highest temperature of the water in the calorimeter as θ_2.

(j) Repeat the procedures in 2 (c) to (i) using the metal block B.

Questions

(i) Draw a well labeled diagram showing the two processes of heating water in the beaker and cooling the blocks with water into a calorimeter.

(ii) Write the two sets of equations for conservation of heat for blocks A and B.

(iii) Calculate the specific heat capacity of block A and B using the equations obtained in 2 (ii).

(iv) Giving a reason, identify a block that is most suitable for molding the cooking utensils.

(v) What is the aim of doing this experiment?

A total of 1,708 (100%) candidates attempted this question. The performance of the candidates was weak since 80.1 per cent of them scored below 6.0 marks as summarized in Figure 16.

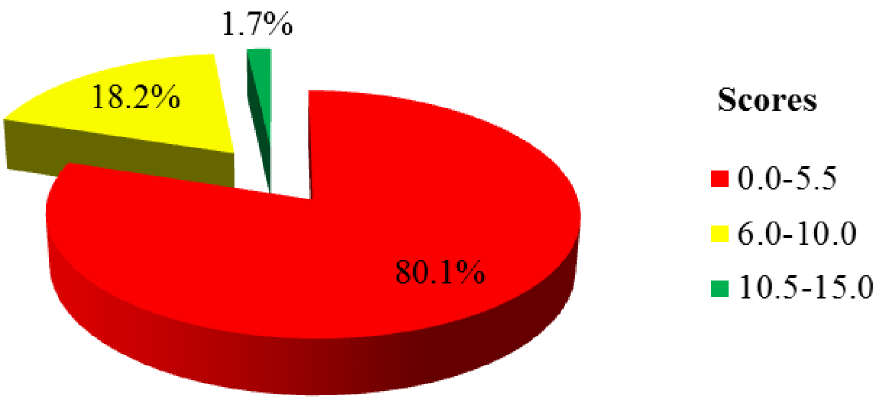


Figure 16: *The Candidates' Performance in Question 2 of Physics 2A*

Figure 16 indicates that 1,368 (80.1%) candidates scored from 0.0 to 5.5 marks, 311 (18.2%) scored from 6.0 to 10.0 marks and 29 (1.7%) scored from 10.5 to 15.0 marks.

The analysis of candidates' performance shows that most of the candidates who scored low marks (0.0 to 5.5) faced a number of difficulties in performing this experiment. Some of them failed to estimate the amount of water to about $\frac{2}{3}$ and $\frac{1}{2}$ while measuring their masses in a calorimeter. In addition, other candidates who used mechanical balance failed to read the accurate masses of metal blocks A and B when compared to those who took measurements by using digital beam balances. The responses provided by some of the candidates denote that they had a problem of using thermometer to measure temperatures in some cases. Another challenge observed was lack of drawing skills. In this area, most of the candidates deemed to draw diagrams which do not show the processes of heating water in the beaker and cooling the blocks with water into a calorimeter.

Further analysis shows that, some candidates failed to write the two sets of equations of conservation of heat for blocks A and B. For example, one of the candidates wrote the equations of conservation of heat for both block A and B as: "$m_1c_i = m_2c_2$". This indicates that the candidate had insufficient knowledge in the concept of heat especially, the principle of mixture. The candidate had to consider that if no loss of heat to the surroundings, by the principle of mixture heat lost by solid = Heat gained by water + Heat gained by calorimeter. The equations were to be written as:

Block A

$$Heat\ lost\ by\ block\ A = Heat\ gained\ by\ water\ and\ calorimeter$$

$$m_AC_A(100-\theta_2) = m_wC_w(\theta_2-\theta_1) + m_cC_c(\theta_2-\theta_1)$$

Block B

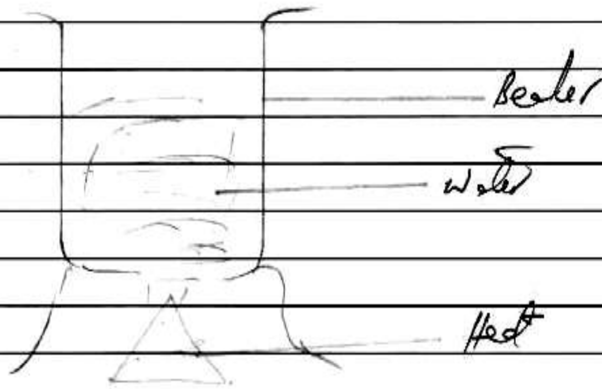
$$Heat\ lost\ by\ block\ B = Heat\ gained\ by\ water\ and\ calorimeter$$

$$m_BC_B(100-\theta_2) = m_wC_w(\theta_2-\theta_1) + m_cC_c(\theta_2-\theta_1)$$

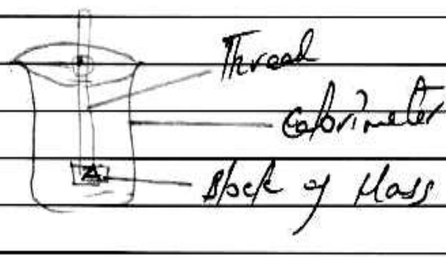
The candidates who failed to make this kind of relationship ended up calculating wrong specific heat capacity of block A and B. Due to this failure; they were unable to identify a block that is most suitable for molding the cooking utensils. Extract 18.1 represents one of the incorrect responses in this question.

Solution (1)

The diagram of Heating water in the Beaker



The diagram of cooling the block with water into calorimeter



2 Cont.

(ci) The Equation for Conservation of Heat

$M_cC_c + M_wC_w = M_aC_a + M_bC_b$

where by

M_c - Mass of Calorimeter
C_c - specific heat of Calorimeter
M_w - Mass of water
C_w - specific heat of water
M_a - Mass of block A
M_b - Mass of block B
C_a - specific heat of a
C_b - specific heat of b

(dii) Required the specific heat capacity of A and B

for $M_cC_c + M_wC_w = M_aC_a$

$C_a = \frac{M_cC_c + M_wC_w}{M_a}$

$M_a = 50g = 0.05kg \quad M_b = 0.05kg$

$C_a = \frac{0.112g \times 400 + 0.068 \times 4200}{0.05}$

$C_a = \frac{4.48 + 285.6}{0.05}$

$C_a = 5801.6 \ J/kg/k$

Extract 18.1: A sample of the candidate's weak responses to question 2 of Physics 2A.

In Extract 18.1, the candidate drew inappropriate diagrams of the processes of heating water in the beaker and cooling the blocks with water in a calorimeter. The candidate also calculated incorrectly the specific heat capacity of block A. He/she failed to identify a block that is most suitable for molding the cooking utensils.

A total of 29 (1.7%) candidates scored good marks (10.5-15.0). These exhibited knowledge of the concepts of specific heat capacity of solids. These candidates knew how to collect and record data using a thermometer and a beam balance. They followed the procedures accordingly and obtained the expected results. They drew proper diagrams for the two processes of heating water in a beaker and cooling the blocks with water in a calorimeter. They also wrote two sets of equations for conservation of heat for blocks A and B. However, they failed to give accurate values of specific heat capacities of blocks A and B, hence, they were unable to identify a block that is most suitable for molding the cooking utensils. They also wrote correctly the aim of doing the experiment. Extract 18.2 represents one of good responses to this question.

Given;.
Block A = 50g.
Block B = 50g.

b) Mass of metal block A, m_A = 50g.
Mass of metal block B, m_B = 50g.

For block A,
e) Mass of calorimeter and its stirrer, m_1 = 62.69g.

f) Mass of calorimeter with water, m_2 = 87.27g.

g) Temperature of water in the calorimeter, θ_1 = 24°c

i) Temperature of water in the calorimeter, θ_2 = 31°C.

For block B.
Mass of calorimeter and its stirrer, m_1 = 62.69g.
Mass of calorimeter with water, m_2 = 87.27g.
Temperature of water in the calorimeter, θ_1 = 24°c
Highest temperature of water in the calorimeter, θ_2 = 29°c.

Mass of empty calorimeter = 29.59g.
Mass of water = 57.68g.

ii)

from; Heat loss by a body = Heat gained by water + Heat gained by calorimeter.

for block A;

Heat loss by block A = Heat gained by water + Heat gained by calorimeter.

from; $H = MC\Delta T$.

then;

$\therefore m_A C_A \Delta T = m_w C_w \Delta T + m_c C_c \Delta T$ ——— (i)

for block B;

Heat loss by block B = Heat gained by water + Heat gained by calorimeter.

$\therefore m_B C_B \Delta T = m_w C_w \Delta T + m_c C_c \Delta T$ ——— (ii)

iii) Specific heat capacity of block A.

$m_A C_A \Delta T = m_w C_w \Delta T + m_c C_c \Delta T$.

$C_A = \frac{m_w C_w \Delta T + m_c C_c \Delta T}{m_A \Delta T}$

$C_A = \frac{57.68 \times 4200 \times 10^{-3} \times (31-24) + (29.59 \times 400 \times 10^{-3} \times 7)}{50 \times 10^{-3} \times (31-25)}$

$C_A = \frac{1695.792 + 82.852}{0.3}$

$C_A = 5928.81$ J/kgK.

$\therefore$ The specific heat capacity of block A is 5928.81 J/kgK.

2 Cont.

iii) Specific heat capacity of block B.

$M_B C_B \Delta T = m_w C_w \Delta T + m_c C_c \Delta T$.

$M_B C_B \Delta T = (M_w C_w + M_c C_c)\Delta T$.

$C_B = \frac{(M_w C_w + M_c C_c)\Delta T}{M_B \Delta T}$.

$C_B = \frac{(57.68 \times 4200 \times 10^{-3} + 29.59 \times 10^{-3} \times 400) \times (29-24)}{50 \times 10^{-3} \times (29-25)}$

$C_B = 6352.3$ J/kgK.

∴ Specific heat capacity of block B is 6352.3 J/kgK.

iv) The block that is most suitable for molding cooking utensils is block B since it has high specific heat capacity.

v) The aim of this experiment is to determine the specific heat capacities of different materials.

Extract 18.2: A sample of good responses to question 2 of Physics 2A.

In Extract 18.2, the candidate recorded the masses and the temperatures of the calorimeters and their contents correctly. He/she wrote correct sets of equations for conservation of heat for blocks A and B and stated well the aim of the experiment. However, the candidate provided incorrect values of the specific heat capacities of blocks A and B.

2.1.16.2 731/2B Physics 2B

The candidates were required to perform an experiment to investigate the capacity of the liquids to absorb the amount of heat from the running metal parts per kilogram per degree rise in temperature. They were required to use the procedures provided and then answer the questions that follow.

Procedures:

(a) Weigh an empty calorimeter with its stirrer and lid as m_C.

(b) Fill $\frac{3}{4}$ of the calorimeter with hot liquid, A which is about 70 °C.

(c) Put the calorimeter with its contents into the jacket and cover it with lid.

(d) While stirring gently, record the temperature of the liquid at an interval of 2 minutes until the liquid cool to the temperature of about 45 °C.

(e) Remove the calorimeter with its contents from the jacket, measure and record its mass with stirrer and lid as m_{CA}.

(f) Repeat the procedures in 2 (a) to (d) with liquid B, measure and record the mass of the calorimeter with its contents, stirrer and lid as m_{CB}.

Questions

(i) Tabulate your results.

(ii) Plot the cooling curve for liquid A and B on the same axis.

(iii) Obtain the gradient at 60 °C for each liquid from the graph plotted in 2 (ii).

(iv) Deduce the equation governing this experiment.

(v) Determine the specific heat capacity of liquid B given that the specific heat capacity of liquid, A, C_A = 4200 J/kg K and the specific heat capacity of calorimeter, C = 400 J/kg K.

(vi) Compare the specific heat capacities of the two liquids and explain why one of the liquids is more suitable to be used as a cooling agent in a car radiator than the other.

(vii) What is the aim of doing this experiment?

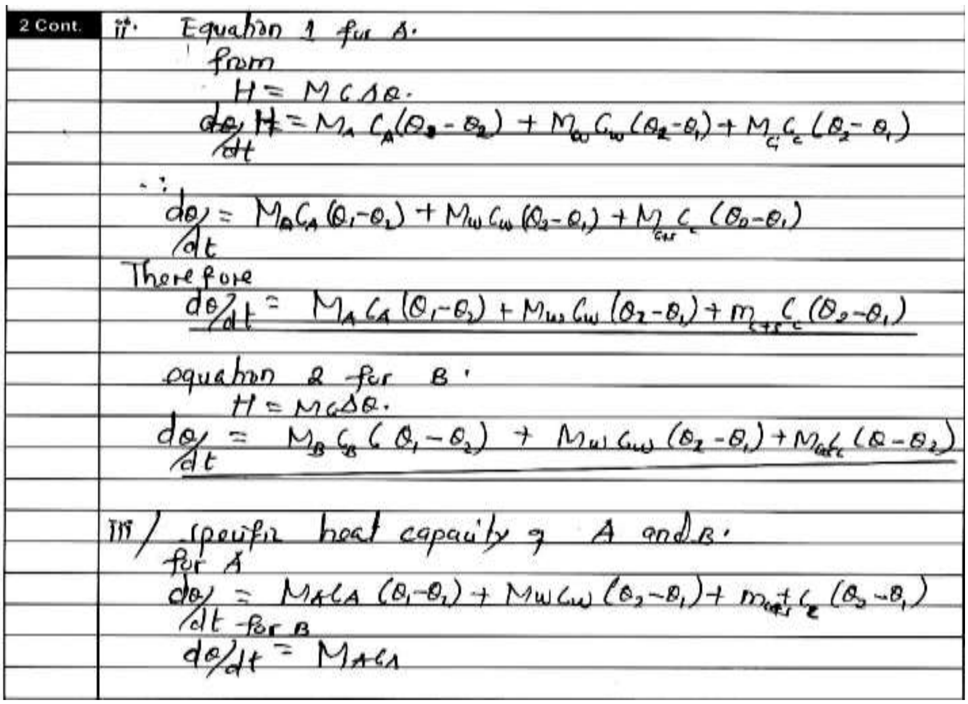
The candidates who scored low marks (0.0-5.5) collected and tabulated incorrect data, which means that they had unsatisfactory knowledge about the topic of heat specifically, specific heat capacity. They plotted incorrect cooling curves for liquids A and B. In the graph, some important key points were not well presented. For instance, some of the candidates wrote incorrect patterns styles of writing scales. For example, the following wrong styles of writing scales were used by a number of candidates: *"Horizontal scales: 1 cm = 2 minutes; and vertical scales: 1 cm* $\rightarrow 15^{O}C$ *"*. In order to write correct scales, candidates were supposed to use either statement scale (1 centimeter represents 10 ^{o}C) or fractional scale (1:5 min). Other candidates did not realize that the gradient at any temperature is obtained by drawing a tangent line at that particular point; thus, they had to choose two points along it in order to calculate the gradient.

Further analysis reveals that many candidates failed to deduce the equation governing the experiment. These candidates seemed to be unaware of the fact that when two objects at different temperatures are placed in contact with each other, heat always flows from the hotter to the cooler object. Heat will flow until the two reach thermal equilibrium, (i.e when they are at the same temperature). The amount of heat that is lost by a sample of metal as it cools is equal to the amount of heat gained by the water in the calorimeter. This assumes that no heat is lost from the calorimeter to its surroundings (the room), and that the amount of heat absorbed by the calorimeter itself is negligible. They were supposed to use the concept of rate of heat flow as follows:

$$\begin{pmatrix} \textit{Heat gained by calorimeter} \\ \textit{and stirrer from} \\ \textit{liquid B per unit time at } 60^oC \end{pmatrix} = \begin{pmatrix} \textit{Heat gained by calorimeter} \\ \textit{and stirrer from} \\ \textit{liquid A per unit time at } 60^oC \end{pmatrix}$$

$$\left(m_B C_B + m_C C_C\right)\left(\frac{d\theta}{dt}\right)_B = \left(m_A C_A + m_C C_C\right)\left(\frac{d\theta}{dt}\right)_A$$

Extract 19.1 represents the incorrect responses from one of the candidates who scored low marks in this question.


2 Cont.

ii. Equation 1 for A.
from
$H = MC\Delta\theta$.
$\frac{d\theta}{dt} H = M_A C_A(\theta_1 - \theta_2) + M_w C_w(\theta_2 - \theta_1) + M_c C_c(\theta_2 - \theta_1)$
∴
$\frac{d\theta}{dt} = M_A C_A(\theta_1 - \theta_2) + M_w C_w(\theta_2 - \theta_1) + M_{c+r} C_c(\theta_2 - \theta_1)$
Therefore
$\frac{d\theta}{dt} = M_A C_A(\theta_1 - \theta_2) + M_w C_w(\theta_2 - \theta_1) + m_{c+r} C_c(\theta_2 - \theta_1)$

equation 2 for B.
$H = MC\Delta\theta$.
$\frac{d\theta}{dt} = M_B C_B(\theta_1 - \theta_2) + M_w C_w(\theta_2 - \theta_1) + M_{c+r} C_c(\theta - \theta_2)$

iii/ specific heat capacity of A and B.
for A
$\frac{d\theta}{dt} = M_A C_A(\theta_1 - \theta_1) + M_w C_w(\theta_2 - \theta_1) + m_{c+r} C_c(\theta_2 - \theta_1)$
for B
$\frac{d\theta}{dt} = M_A C_A$

Extract 19.1: A sample incorrect responses to question 2 of Physics 2B.

In Extract 19.1, the candidate did not construct the table of values and hence he/she failed to plot the cooling curves for liquid A and B on the same axis. Consequently, the candidate deduced the equation governing the experiment by employing the concept of the amount of heat flow instead of the rate of heat flow.

The candidates who scored high marks (10.5-15.0) managed to prepare a correct table of results for both liquids A and B. They were also able to plot the cooling curves for liquids A and B on the same axis. Hence, these candidates drew correct tangent lines at the given temperature ($60^{o}C$) and then obtained their respective gradients.

Some of them deduced the equation that governed the experiment correctly and used it to determine the specific heat capacity of liquid B, when the specific heat capacity of liquid A is 4200J/Kg K and that of a calorimeter is 400 J/Kg K. A small number of candidates were able to compare the specific heat capacities of the two liquids, and explained correctly why one of them was suitable to be used as a cooling agent in a car radiator. Finally, they correctly stated the aim of the experiment.

a. Table of result.

Temp °C H_2O	t sec	θ oil
70	0	70
65	2	60
60	4	56
55	6	50
50	8	46
46	10	40
43	12	35

(ii)

For liquid A

$S = \frac{\Delta T}{\Delta t}$

2 Cont.

$$= \frac{\Delta T_2 - \Delta T_1}{\Delta t_2 - \Delta t_1}$$

$$= \frac{65-60}{4-2}$$

$$S = 2.5\ ^\circ C\ sec^{-1}$$

At liquid B

$$S = \frac{\Delta T}{\Delta t}$$

$$= \frac{60-52}{3.2-2}$$

$$S = 6.66\ ^\circ C\ sec^{-1}$$

iv) $M_c M_{CA} C_w (\theta_2 - \theta_1) = M_c M_{CB} C_{oil} (\theta_2 - \theta_1)$

v) $0.21 \times 0.42 \times 4200 (65-60)+273 = 0.21 \times 0.154 C_B (60-52)+273.$

$1058 \cdot C_B = 32010\ C_B$

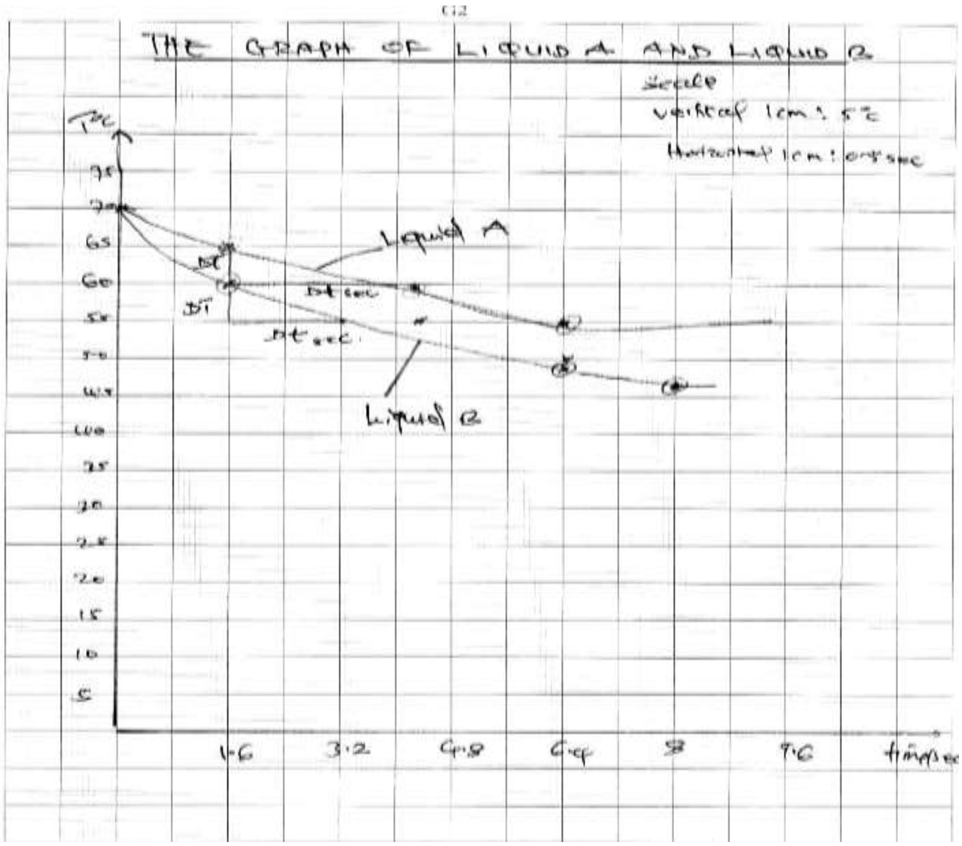
$C_{oil} = 2450\ J/kgK.$

∴ The specific heat capacity of liquid B is 2450 J/kgK.

2 Cont.

vi) The specific heat capacity of liquid A is large than liquid B. Therefore liquid A is suitable to be used as cooling agent.

vii) The aim of this experiment is to determine the specific heat ~~of~~ capacity of liquid B.



Extract 19.2: A sample of part of a candidate's correct responses to question 2 of Physics 2B.

2.1.16.3 731/2C Physics 2C

The candidates were required to perform an experiment to investigate the hotness of the porridge in cup A as compared to that in cup B. They were asked to use the procedures provided and then answer the questions that followed.

Procedures:

(a) Fill the metal cup A with hot water whose temperature should initially be about 80 ^{o}C, put it on the wooden base.

(b) Constantly stir the hot water in the cup A and record the temperature of the water for every 1 minute.

(c) Continue reading the temperature θ °C for 15 minutes.

(d) Empty cup A and put it into a measuring cylinder. Record its volume as V.

(e) Repeat procedures in 2 (a) – (c) for metal cup B. Measure the same volume V as obtained in (c).

Questions

(i) Tabulate your results.

(ii) Using the same axis, plot a cooling curve for cup A together with its content and another cooling curve for the cup B together with its content.

(iii) If R_A represent the rate at which the cup A and its content loose heat, and R_B represent the rate at which the cup B and its content loose heat, determine the ratio $\frac{R_A}{R_B}$ at the temperatures $75°C$ and $65°C$.

(iv) Which calorimeter is represented by cup A? Explain by giving a reason.

(v) Why does the student drink the porridge comfortably without complaining about its hotness in one cup rather than in the other cup?

(vi) State the two sources of errors in this experiment.

The analysis of candidates' performance shows that most of the candidates who scored low marks (0.0 to 5.5) encountered challenges when carrying out the experiment.

In this alternative paper, the majority of the candidates prepared inappropriate tables of results and hence they failed to plot the cooling curves for cup A and cup B together with their contents in the same axis. They also failed to determine the ratio of $\frac{R_A}{R_B}$ at the temperatures $75°C$ and $65°C$. In reality, they had little knowledge of the effect of wrapping the calorimeter with an aluminium foil and a calorimeter whose outer surface is painted black in relation to heat loss. Many candidates skipped most parts of the question. Because of this, they even failed to identify the calorimeter represented by cup A. These candidates were supposed to understand that the calorimeter represented by cup A is the calorimeter with the aluminium foil. Since the aluminium foil prevents heat to be lost by radiation, its rate of cooling is lower than that of the blackened body. Thus, according to Kirchhoff's law of radiation, a black body is a good emitter of heat; hence a container whose outer surface is painted black will cool down faster (has high rate of cooling).

Others failed to explain why a student drinks the porridge comfortably without complaining about its hotness in one cup rather than in the other. In this part, candidates were supposed to know that a student drinks the porridge comfortably in cup B because it loses heat at a higher rate (blackened one) and hence cools faster than the other which loses heat slowly (the one covered by aluminium foil) as explained earlier. A few candidates stated correctly the two sources of errors committed while conducting the experiment. Extract 20.1 represents a sample of weak responses from one of the candidates in this question.

(i) Metal cup A.

θ°(c)	t (min)
80	0
79	1
78	2
77	3
76	4
75	5
74	6
73	7
72	8
71	9
70	10
69	11
68	12
67	13
66	14
65	15

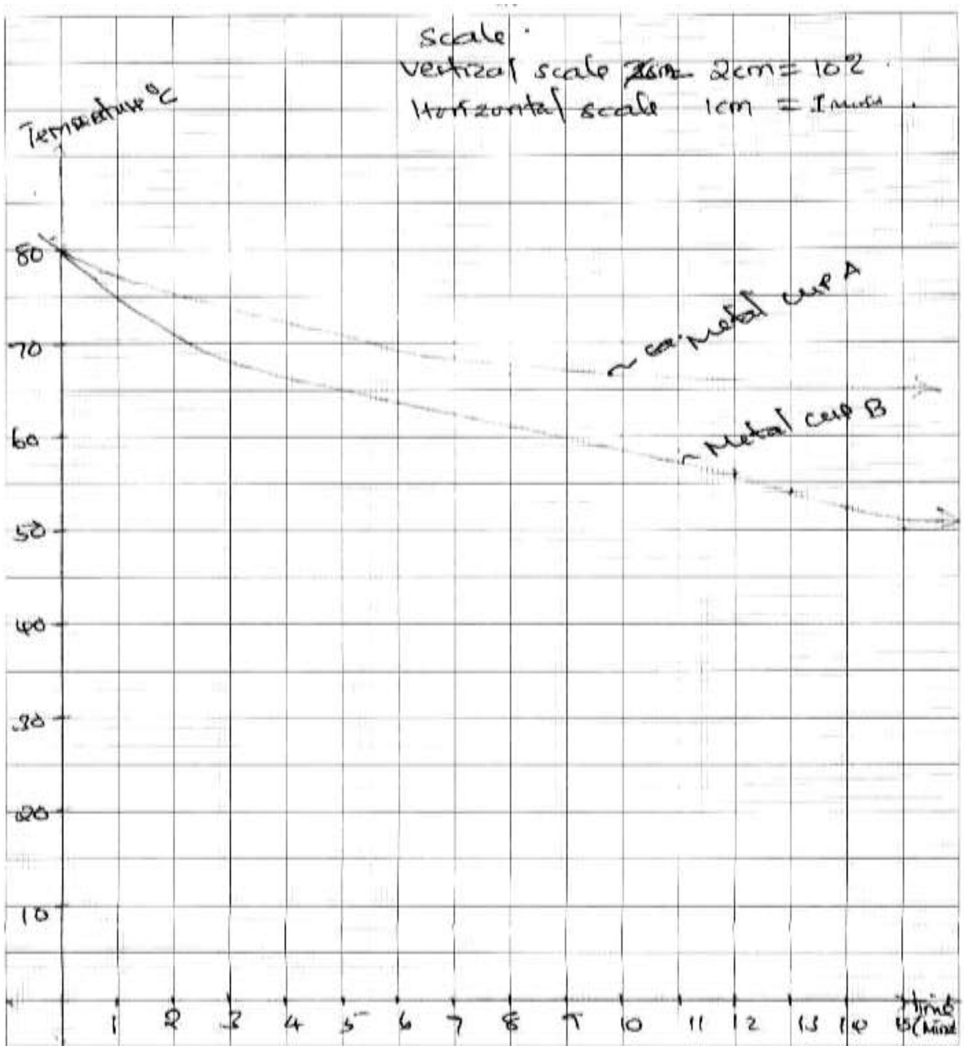
Volume

2 Cont.

Metal cup B

θ (°C)	t minutes
80	0
78	1
76	2
74	3
72	4
70	5
68	6
66	7
64	8
62	9
60	10
58	11
56	12
54	13
52	14
50	15

(iii)	$R_A = \frac{QT}{\Delta T}$
	$= \frac{75 - 65}{15 - 5}$
	$= \frac{10}{10}$
	$= 1$.
	$R_B = \frac{75 - 65}{7.5 - 2.5}$
	$= \frac{10}{5}$
	$= 2$.
	$\therefore \frac{R_A}{R_B} = \frac{1}{2}$.
(IV)	The calorimeter represented by A is the calorimeter covered by foil outside.
(V)	The student drink the ~~ntolli~~ porridge comfortable ~~because~~ the the porredge at the ~~ntolli~~ calorimeter"B" ~~a~~ because it loose easly the heat while at calorimeter A it loose the heat slowly.



Extract 20.1: A sample of a candidate's incorrect responses to question 2 of Physics 2C.

In Extract 20.1, the candidate provided incorrect responses almost to all parts of the question.

On the other hand, 3 (0.18%) candidates scored 14 out of 15 marks. This is an indicator that the question was not well performed by majority of the candidates. The candidates who scored high marks in the range of 10.5 to 15.0 marks were competent in terms of knowledge and skills, particularly in terms of data gathering and recording, mathematic application and drawing and interpretation of graphs. To a large extent, these candidates tabulated the results correctly, plotted correct curves, determined the ratio

$\frac{R_A}{R_B}$ at the temperatures $75°C$ and $65°C$, identified a calorimeter represented by cup A and supported their answers with a reason. They also stated correctly the two sources of errors in the experiment. However, many failed to explain why the student drinks the porridge comfortably without complaining about its hotness in one cup rather than in the other. Extract 20.2 represents correct responses from one of the candidates who did well this question.

	Temp°c (A)	Temp°c (B)	t	
	80	80	0	
	78	76	1	
	77	75	2	
	76	74	3	
	75	73	4	
	74	71	5	
	73	70	6	
	72	70	7	
	70	68	8	
	69	67	9	
	68	66	10	
	67	65	11	
	67	65	12	
	66	64	13	
	65	63	14	
	64	62	15	
	Volume = $6cm^3$.	Volume = $4.5cm^3$.		

2 Cont.

Soln (iii).

$\frac{R_A}{R_B}$ 75°c and 65°c.

$= \frac{75°c}{65°c}$.

= 1.154.

∴ Ration of $\frac{R_A}{R_B}$ = 1.154.

(iv) Soln.

- Calorimeter represented by A is the calorimeter that Filled with Foil in order to reduce heat loss From the calorimeter.

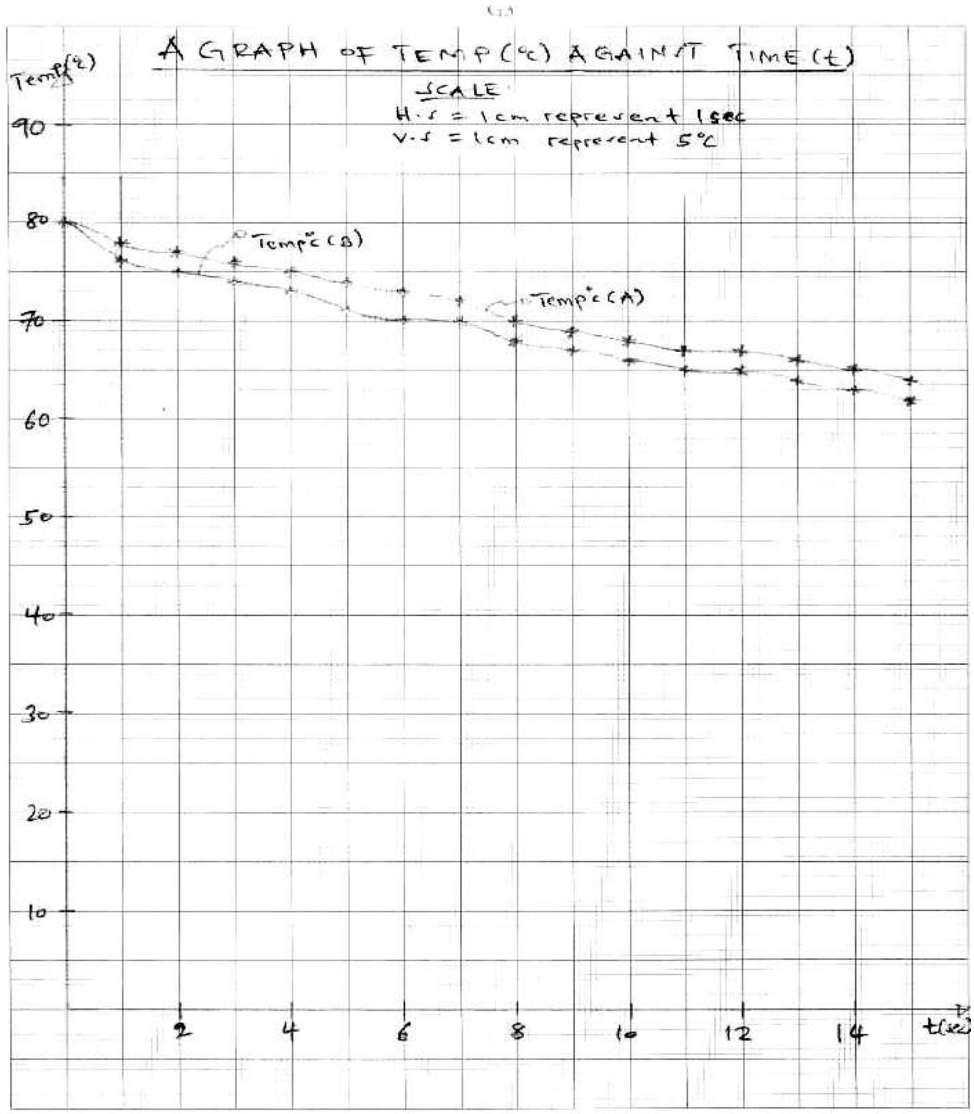
(V) Soln.

- Because cup A is Filled with Foil so that there is less amount of heat loss compared to cup B which have not Filled with Foil so that there is loss of heat in high amount than cup A.

2 Cont.

(Vi) Soln.

- Effect on temperature of surrounding.
- Instrumental error like Stopwatch and etc. which affect time readings.



Extract 20.2: A sample of a candidate's good responses to question 2 of Physics 2C.

In Extract 20.2, the candidate constructed a table of results correctly, plotted the graphs in the same axis slightly correct as he/she expressed time t in seconds instead of minutes and logically identified the calorimeter represented by cup A. However, the candidate was unable to determine the ratio $\frac{R_A}{R_B}$ at the temperatures $75°C$ and $65°C$.

2.1.17 Question 3: Current Electricity

2.1.17.1 731/2A Physics 2A

In this question, the candidates were required to conduct an experiment to verify whether wire Q has high conductivity or the same as that of copper. They were required to follow the procedures provided and then answer the questions that follow.

Procedures:

(a) Connect a dry cell, an ammeter, a voltmeter, a key K and rheostat in series.

(b) Join a voltmeter across the battery terminal.

(c) With the Key K open, record the voltmeter reading.

(d) With the Key K closed, adjust the rheostat so that the ammeter pointer is at exactly 0.2 A and record its corresponding voltmeter reading in volts.

(e) Repeat procedure 3 (d) with ammeter readings of 0.4, 0.6, 0.8 and 1.0 A.

Questions

(i) Tabulate your results, including the values of I and V.

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

(iii) Plot a graph of V and I.

(iv) Use your graph to determine the internal resistance and e.m.f of that dry cell and comment on your answer comparing to the value given by the factory.

(v) If the dry cell used in 3 (iv) is replaced by another dry cell an internal resistance that is twice that of the first one, what will be the magnitude of the current flowing in the circuit?

The question was attempted by 1,708 (100%) candidates. The data analysis shows that the overall performance was weak as illustrated in Figure 17.

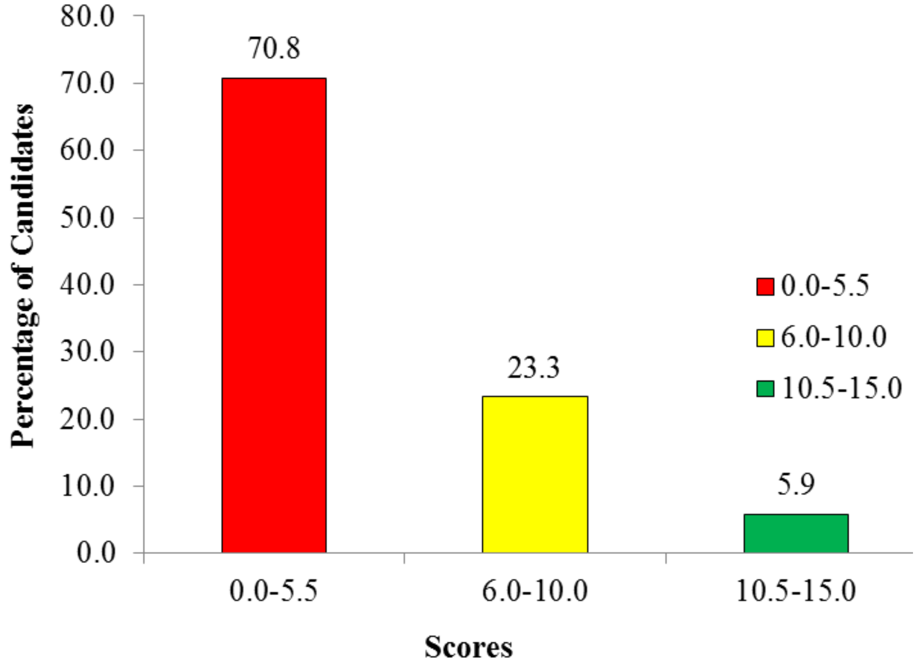


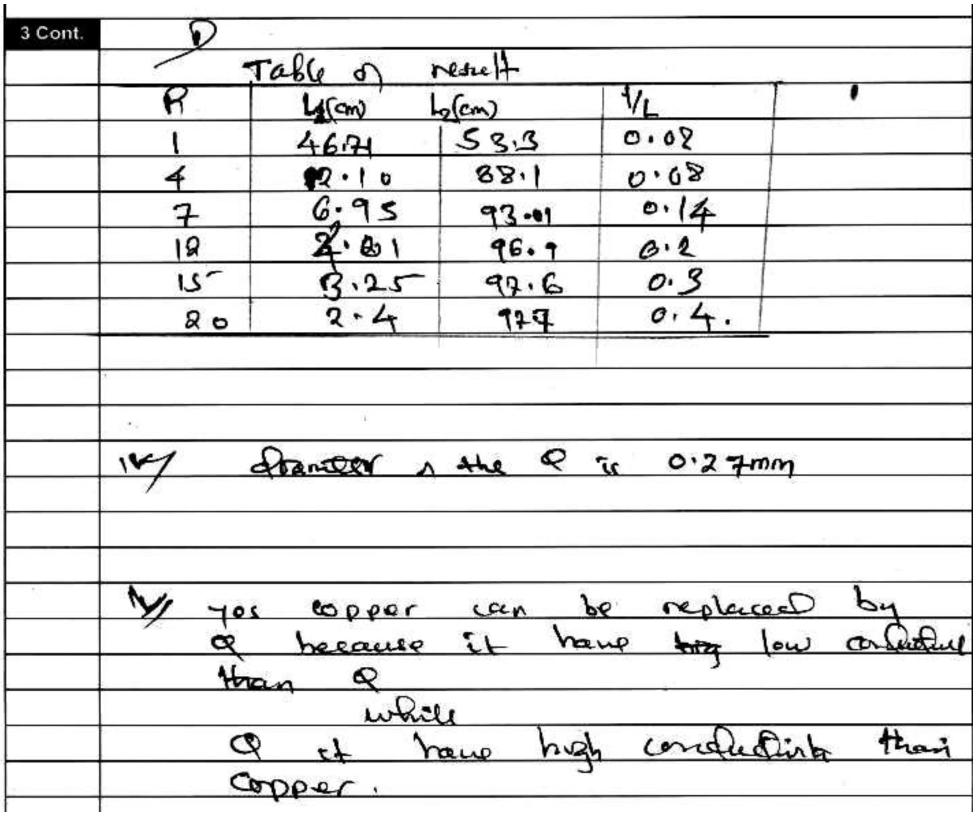
Figure 3: *The Candidates' Performance in Question 17*

Figure 17 shows that 1210 (70.8%) candidates scored from 0.0 to 5.5 marks; 398 (23.3%) scored from 6.0 to 10.0 marks; and 100 (5.9%) scored 10.5 to 15.0 marks.

The candidates who scored low marks (0.0-5.5) in this question had insufficient knowledge about the concepts of Current electricity, especially the metre bridge. The majority of the candidates (70.8%) scored less than 6.0 marks implying that they did not manage to perform well most parts of the question. The candidates' weak performance might be due to: failure to set-up the slide metre wire as per instructions given; failure to read and record the correct balance point; construction of incomplete table of data values; incorrectly sketched diagram of the experimental set up; incompetent in the use of micrometer screw jack for measuring the diameter of the wire; and lack of mathematical (computational) skills in solving the resistivity of the wire.

Further analysis reveals that 291 (17.0%) candidates scored zero. These candidates either provided incorrect and irrelevant responses or re-wrote the procedures given in the question instead of answering the question items. Others presented their responses in experimental report writing form contrary to the requirement of the question.

Extract 21.1 displays an example of weak responses from one of the candidates.



3 Cont.

i)

Table of result

R	L_1(cm)	L_2(cm)	1/L
1	46.71	53.3	0.08
4	12.10	88.1	0.08
7	6.95	93.01	0.14
12	2.01	96.9	0.2
15	3.25	97.6	0.3
20	2.4	977	0.4.

iv) diameter of the Q is 0.27mm

v) yes copper can be replaced by Q because it have low conductivity than Q while Q it have high conductivity than copper.

Extract 21.1: A sample of weak responses to question 3 of Physics 2A.

In extract 21.1, the candidate prepared incorrect table of results and also failed to measure the diameter of the wire Q. He/she failed to plot the graph and a sketch of diagram for the experimental set up.

In contrast, the candidates who scored high marks (10.5 – 15.0) in this question had sufficient knowledge of the concepts of Current electricity, especially the metre bridge. These candidates (5.9%) managed to perform well most parts of the question. The candidates' good performance was due to: proper set-up of the slide metre wire as per the instructions given; accurate reading and recording of the balance point; construction of correct tables of data values; correctly sketched diagrams of the experimental set up; competent use of micrometer screw jack for measuring the diameter of the wire; and good mathematical competence (computational) in solving problems of the resistivity of the wire. Extract 21.2 represents correct responses from one of the candidates.

i/

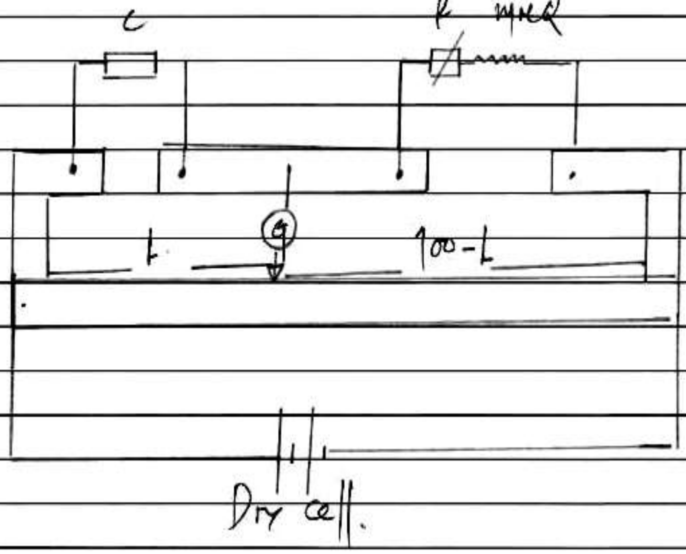


Table of Results

R (Ω)	L (cm)	1/L (cm)
1	27.7	0.036
4	21.7	0.046
7	17.9	0.056
12	13.8	0.072
15	12.1	0.083
20	10.1	0.099

iv) d of the wire $\phi = 0.32\ mm = 0.32 \times 10^{-3}\ m$

Recall

$$\frac{R_e}{L} = \frac{R + R_\theta}{100 - L}$$

But $R_\theta = \frac{\rho L}{A}$

$$\frac{R_e}{L} = \frac{R + \rho L/A}{100 - L}$$

$$R_e (100 - L) = L\left(R + \rho \cancel{L}x/A\right)$$

$$100R_e - R_e L = RL + \frac{\rho x . L}{A}$$

$$100 R_e = R_L + \frac{\rho x . L}{A} + R_e L$$

$$\frac{100 R_e}{L} = \left(R + \frac{\rho x}{A} + R_e\right)$$

$$R + \frac{\rho x}{A} + R_e = \frac{100 R_e}{L}$$

$$R = \frac{100 R_e}{L} - \left(\frac{\rho x}{A} + R_e\right)$$

Then:

$$R = 100R_c\left(\frac{1}{L}\right) - \left(\frac{\rho x}{A} + R_c\right)$$

$$y = m\,x + c$$

$M = 100R_c$

from the graph

$$\text{Slope}(m) = \frac{(13.4 - 8)\,\Omega}{(0.085 - 0.065)\,\text{cm}}$$

$M = 270\,\Omega\text{cm}$

$\therefore M = 100R_c$

$270 = 100R_c$

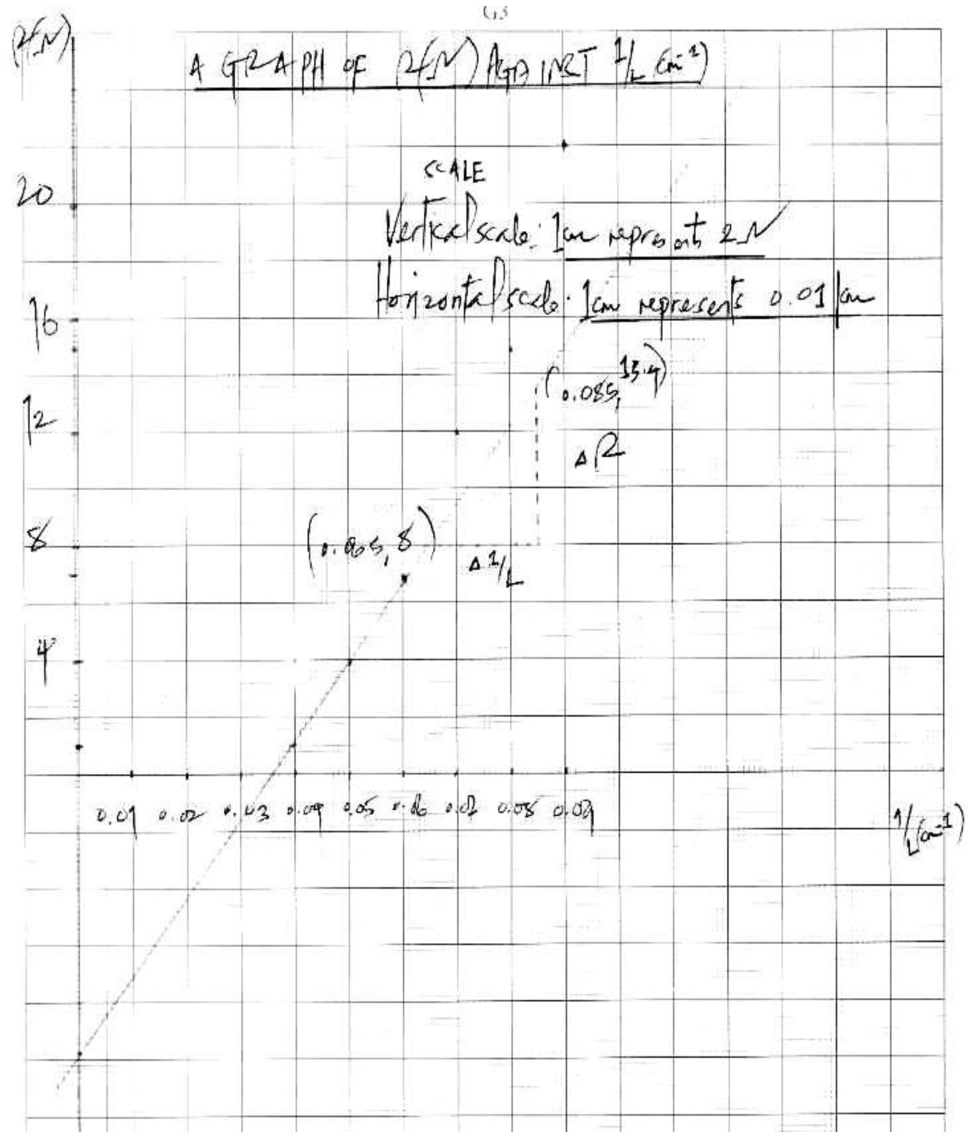
$$R_c = \frac{270}{100} = 2.7\,\Omega = 3\,\Omega$$

y intercept, $c = -9.8\,\Omega$ from the graph

Then $\frac{\rho x}{A} + R_c = 9.8$ But $x = 50\,\text{cm} = 0.5\,\text{m}$

$$\frac{\rho x}{A} = 9.8 - R_c, \quad \frac{\rho \times 0.5 \times 4}{\pi(0.32 \times 10^{-3})^2} = 6.8$$

$\therefore \rho = 1.1 \times 10^{-6}\,\Omega\text{m}$



Extract 21.2: A sample of correct responses to question 3 of Physics 2A.

In Extract 21.2, the candidate responded correctly to most parts of the question. However, he/she failed to justify whether wire Q can replace the copper wire in the market or not.

2.1.17.2 731/2B Physics 2B

In this question, the candidates were required to conduct an experiment to determine the resistance of the resistor Q from the following procedures:

Procedures:

(a) Connect resistor Q, resistance box, two dry cells and a switch in series to complete a circuit. Then connect a 0 – 5 V voltmeter across the resistance box.

(b) Read the voltmeter and record the value of V when a resistor of 2 Ω is set on the resistance box.

(c) Repeat the procedure in 3 (b) by setting a resistance box in such a way that R = 4 Ω, 6 Ω, 8 Ω and 10 Ω to obtain a total of four other readings.

Questions

(i) Draw the circuit diagram you connected as per instructions given.

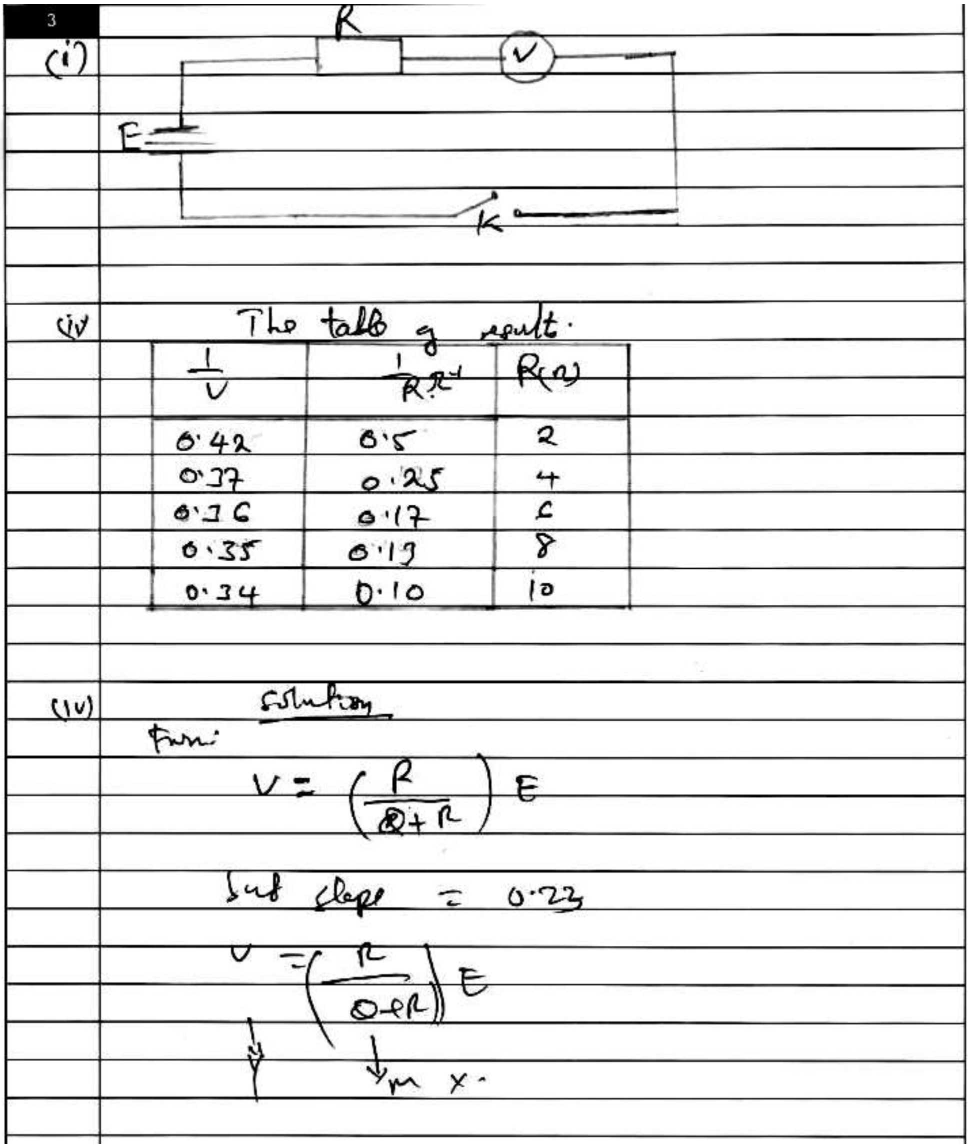
(ii) Tabulate your results including the columns for $\frac{1}{V}$ and $\frac{1}{R}$.

(iii) Plot a graph of $\frac{1}{V}$ against $\frac{1}{R}$.

(iv) Using a graph and the equation $V = \left(\frac{R}{Q+R}\right)E$, determine the values of resistor Q and e.m.f of the dry cells.

(v) If an electrical engineer used another method to determine the value of resistor Q and got 5 Ω, would the value be recommended to replace the damaged resistor? Justify your answer.

The candidates who scored low marks in this question had limited knowledge of the concept of current electricity; notably, they did not know how to determine the unknown resistance of the wire. The major obstacle that made most of the candidates to perform poorly was a lack of knowledge on how to connect the voltmeter with the resistance box. These candidates connected the voltmeter in series with the resistance box, while in practice and according to instruction, the voltmeter is always connected in parallel to the conductor or any electric component. Another shortcoming observed was lack of drawing skills as most of the candidates failed to design a circuit diagram as per the given instruction. Because of these factors the data obtained by these candidates were incorrect and hence plotted the graph of $\frac{1}{V}$ against $\frac{1}{R}$ by using wrong data. Another problem that made them score low marks was their inability to formulate mathematical relations (lack of mathematical skills). Due to this reason, they failed to establish the relation which could help to determine the values of resistor Q and e.m.f of the dry cells from the graph and the equation $V = \left(\frac{R}{Q+R}\right)E$. Extract 22.1 shows incorrect responses provided by one of the candidates who scored low marks in this question.



3

(i)

(iv) The table of result.

$\frac{1}{V}$	$\frac{1}{R}$ Ω^{-1}	R(Ω)
0.42	0.5	2
0.37	0.25	4
0.36	0.17	6
0.35	0.13	8
0.34	0.10	10

(iv) Solution

From:

$V = \left(\frac{R}{Q+R}\right)E$

but slope = 0.23

$V = \left(\frac{R}{Q+R}\right)E$

y m x.

3 Cont.

$m = \frac{R}{Q+R}$

$0.23 = \frac{R}{Q+R}$

but

$R = 2$.

$0.23 = \frac{2}{Q+2}$

$0.23(Q+2) = 2$.

$0.23Q + 0.46 = 2$.

$0.23Q = 2 - 0.46$

$\frac{0.23Q}{0.23} = \frac{1.54}{0.23}$

$Q = 6.4$

∴ The value of resistor $Q = 6.4$

Then to find E.

From the graph of the y-intercept the value of E is 3.019

Extract 22.1: A sample of a candidate's good responses to question 3 of Physics 2B.

In this extract, the candidate connected a voltmeter in series with a resistance box R, contrary to the principles of connecting a voltmeter in an electric circuit and against the instruction. This cause the candidate to plot an incorrect table of results.

On the other hand, some of the candidates scored high marks (10.5-15.0) in this question. These candidates were capable of connecting all the given electric components as per the instruction. They also managed to draw the circuit diagram correctly and hence they obtained an appropriate table of results. These candidates showed good ability of transferring the data from the table of values to a graph of $\frac{1}{V}$ against $\frac{1}{R}$. They also formulated correct mathematical relation using a graph and equation $V = \left(\frac{R}{Q+R}\right)E$.

Extract 22.2 depicts the responses of one of the candidates who scored at least 12.5 out of 15.0 marks allocated to this question.

PRACTICAL REPORT

AIM: To determine the resistance of the resistor Q.

INSTRUMENT USED; Resistor Q, Resistance box, two dry cells, switch, 0-5V Voltmeter.

PROCEDURES;

(i) circuit diagram

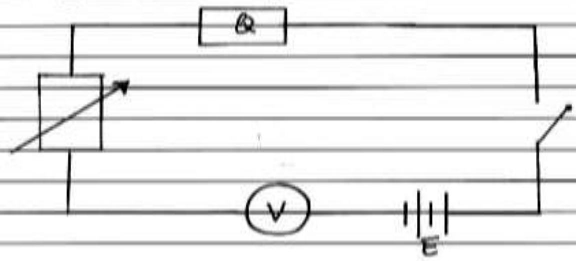


TABLE OF RESULTS.

(ii)

R (Ω)	V (V)	1/R (Ω⁻¹)	1/V (V⁻¹)
2	0·83	0·5	1·2
4	1·29	0·25	0·78
6	1·58	0·17	0·63
8	1·78	0·13	0·56
10	1·93	0·1	0·52

3 Cont.

$V = \left(\frac{R}{Q} + 1\right) E$

$V = \frac{RE}{Q} + E$

Reciprocate the equation

$\frac{1}{V} = \left(\frac{Q}{E}\right) \frac{1}{R} + \frac{1}{E}$

hence; $\frac{Q}{E}$ = Slope from the graph

$\frac{1}{E} = \left(\frac{1}{V}\right)$ - intercept

Slope in graph $= \frac{\Delta \frac{1}{V} (V^{-1})}{\Delta \frac{1}{R} (\Omega^{-1})}$

$= \frac{1.1 - 0.56}{0.42 - 0.13} \ \Omega/V$

$= \frac{0.56}{0.29} \ \Omega/V$

$= 1.862 \ \Omega V^{-1}$

thus,

$\frac{Q}{E} = 1.862$

but $\frac{1}{E} = \left(\frac{1}{V}\right)$-intercept

$\frac{1}{E} = 0.34$

$E = \frac{1}{0.34}$

$= 2.94 V.$

3 Cont.

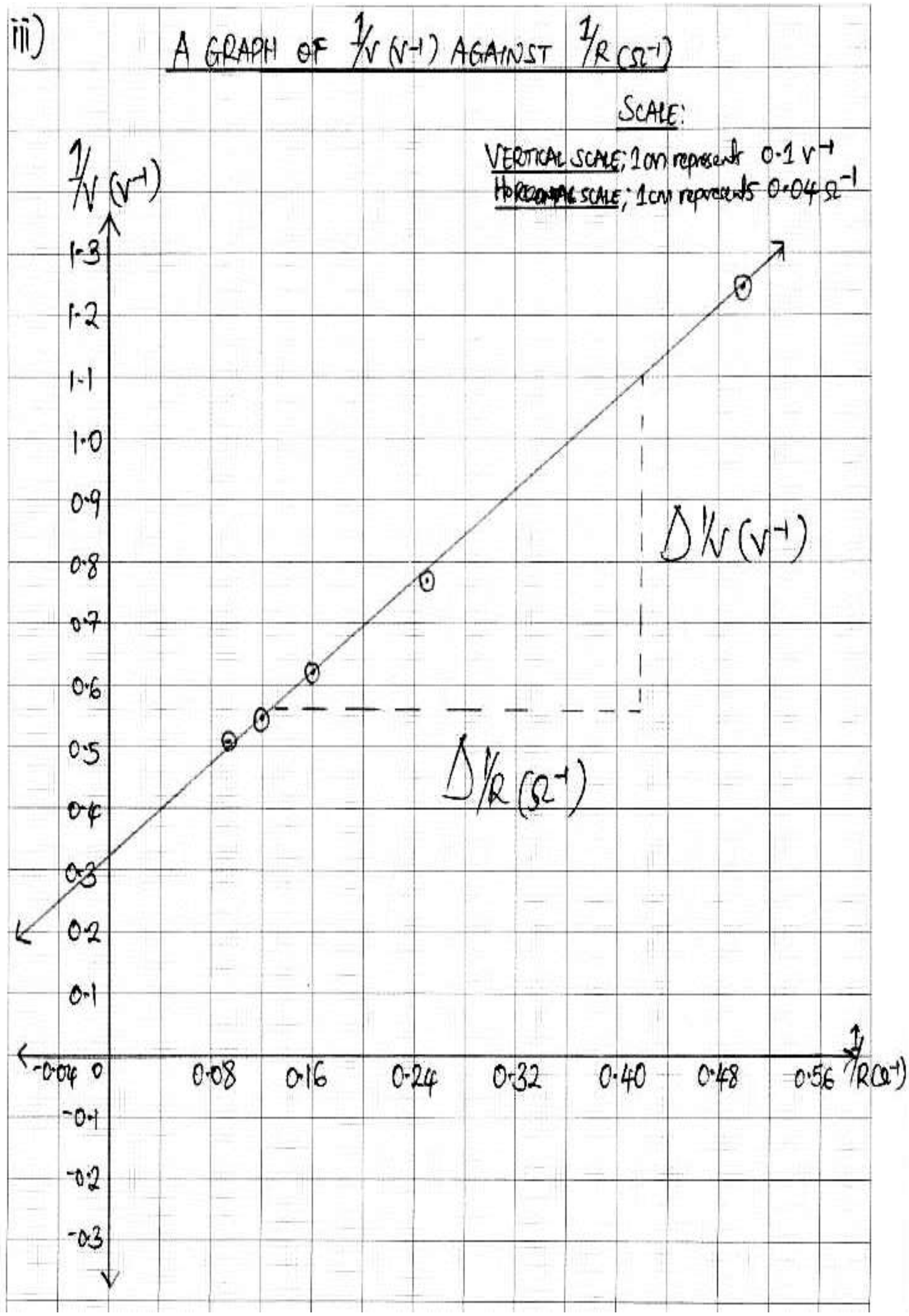
$\frac{Q}{2.94(V)} = 1.862 \ \Omega(V^{-1})$

$Q = (2.94 \times 1.862) \ \Omega$

$= 5.063 \Omega$

∴ The value of e.m.f of dry cells is 2.94 volts and value of resistor Q is 5.063Ω

V) Yes, the value would be recommended to replace the damaged resistor since it resembles my experimental value of resistor Q which, i got 5.063Ω thus they will work under similar function.



Extract 22.2: A sample of a candidate's good responses to question 3 of Physics 2B.

2.1.17.3 731/2C Physics 2C

In this question, candidates were required to conduct an experiment to determine the approximate value of the internal resistance of the dry cell.

Procedures:

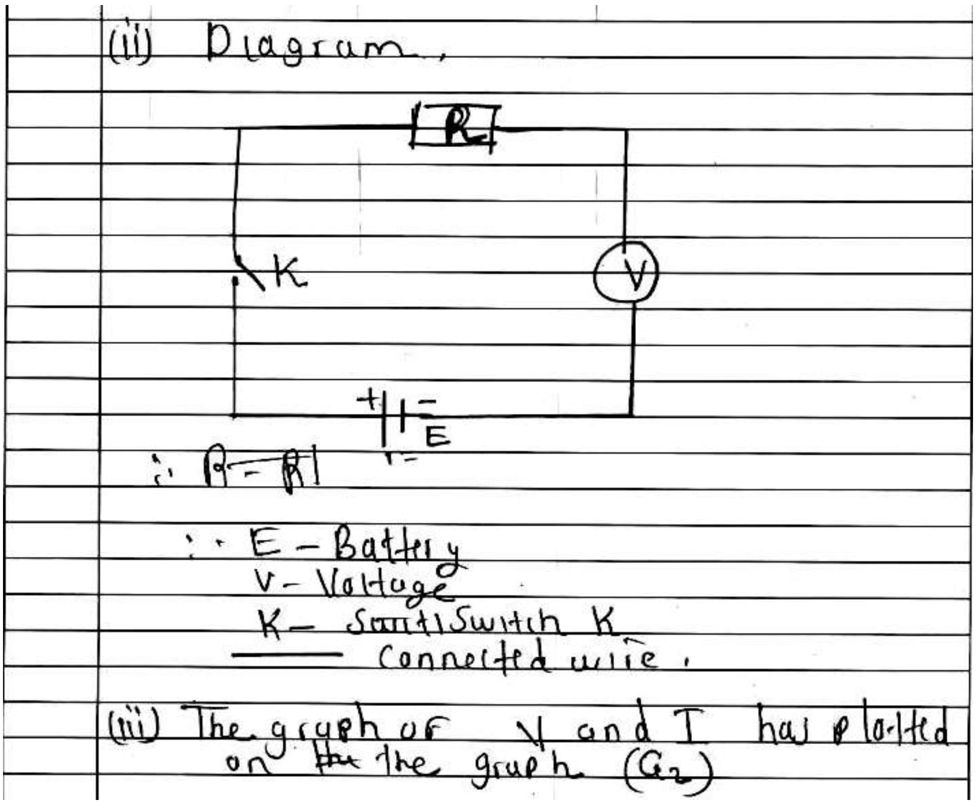
(a) Connect a dry cell, an ammeter, a voltmeter, a key K and rheostat in series.
(b) Join a voltmeter across the battery terminal.
(c) With the Key K open, record the voltmeter reading.
(d) With the Key K closed, adjust the rheostat so that the ammeter pointer is at exactly 0.2 A, and record its corresponding voltmeter reading in volts.
(e) Repeat procedure 3 (d) with ammeter readings of 0.4, 0.6, 0.8 and 1.0 A.

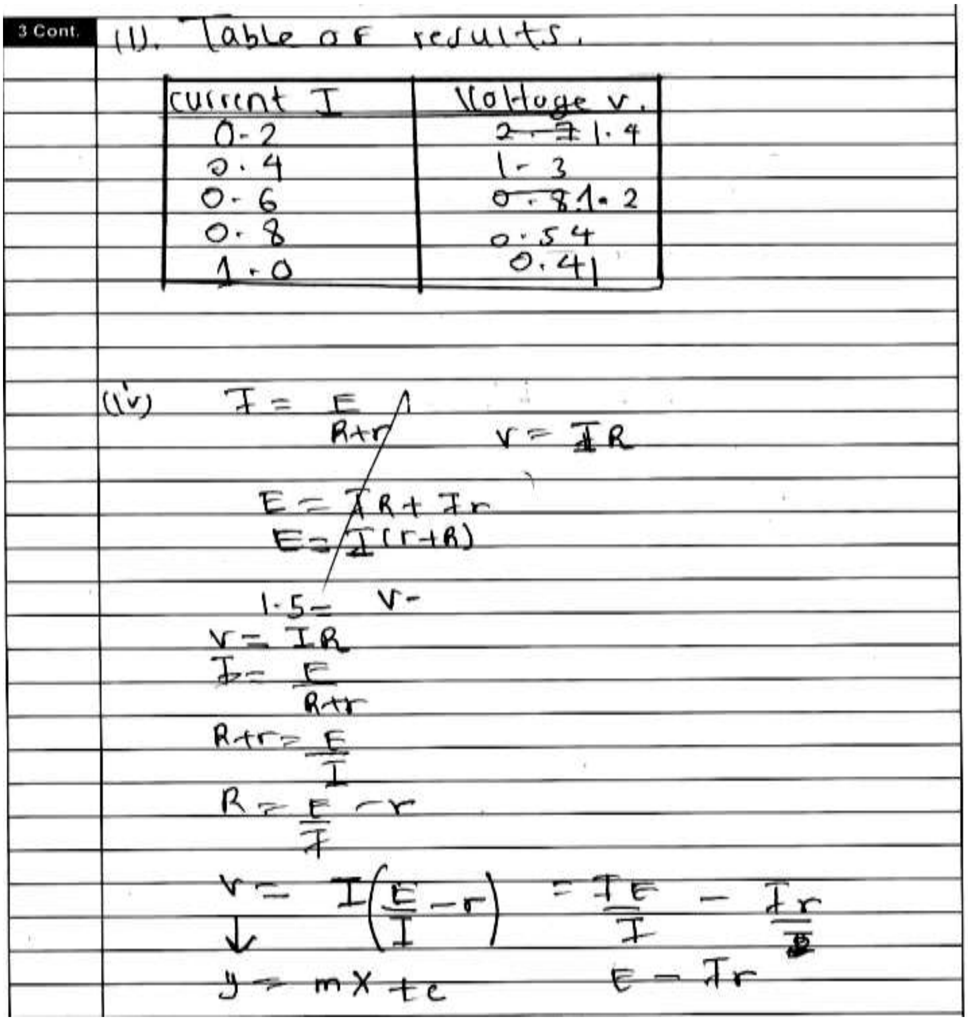
Questions

(i) Tabulate your results including the values of I and V.
(ii) Draw a well labeled diagram for the experimental set-up.
(iii) Plot a graph of V and I.
(iv) Use your graph to determine the internal resistance and e.m.f of that dry cell and comment on your answer comparing to the value given by the factory.
(v) If the dry cell used in 3 (iv) is replaced by another dry cell with twice internal resistance of the first one, what will be the magnitude of the current flowing in the circuit?

The candidates who scored low marks (0.0-5.5) in this alternative practical paper showed the following weaknesses: they had no knowledge on how the ammeter and voltmeter should be connected in electrical circuits. Some of the candidates connected the ammeter in parallel (instead of connecting it in series) and connected the voltmeter in series (instead of connecting it in parallel). These candidates were supposed to understand that an ammeter will always be connected in series as it has low resistance and the voltmeter will always be connected in parallel because it has high resistance. On interchanging their position, by connecting an ammeter in parallel its resistance will be too low and most of the current will be flowing through it causing a short circuit and damage to the circuit. Now, if the voltmeter is connected in series it will be having a high resistance such that no current will flow through it and the voltage indicated will be zero; therefore, no voltage would be recorded in the voltmeter.

Another weakness observed was lack of drawing skills among the candidates. The majority of the candidates failed to draw a well labelled diagram for the experimental set-up because of what has been explained above. Consequently, they collected and tabulated wrong data and, hence, plotted an inappropriate graph of V against I. In the graph, some of them failed to indicate the title of graph, axis, scales, slope indication and their corresponding SI units. They also obtained wrong best line because of transferring incorrect data values. Likewise, they failed to use a graph to determine the internal resistance and the e.m.f of the dry cell. They also failed to give a reasonable comment about the calculated internal resistance with respect to the value given by the factory. Some of them skipped some parts of the question. Extract 23.1 is an incorrect response from one of the candidates who had weak performance in this question.




3 Cont. (iii). Table of results.

current I	Voltage V.
0.2	~~2.7~~ 1.4
0.4	1.3
0.6	~~0.8~~ 1.2
0.8	0.54
1.0	0.41

(iv) $I = \frac{E}{R+r}$ $V = IR$

$E = IR + Ir$

$E = I(r+R)$

$1.5 =$ $V-$

$V = IR$

$I = \frac{E}{R+r}$

$R+r = \frac{E}{I}$

$R = \frac{E}{I} - r$

$V = I\left(\frac{E}{I} - r\right) = \frac{IE}{I} - \frac{Ir}{I}$

$y = mX + c$ $E - Ir$

Extract 23.1: A sample of a candidate's weak responses to question 3 of Physics 2C.

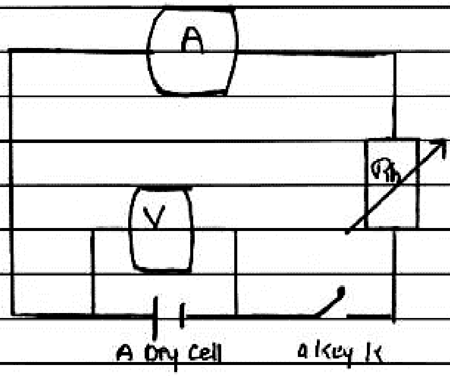
In Extract 23.1, the candidate connected a voltmeter in series with the battery terminal, contrary to procedure (b) in the question and against the principles of connecting voltmeters in electrical circuits. He/she excluded the ammeter in the electric circuit diagram. Yet she/he recorded the current I in the table of values.

Despite the weak performance shown by majority of the candidates, some of them (5.9%) scored high marks (10.5-15.0). These candidates drew correct and well labelled diagram for the experimental set-up. They also collected and recorded appropriate values of current and voltage in table of results. Some of them plotted good and neat graph of V against I and used it to determine correct values of internal resistance and e.m.f of the dry cell.

Extract 23.2 is a sample of correct responses from one of the candidates who attempted this question.

I (A)	V (V)
0.2	0.12
0.4	0.2
0. 6	0.34
0. 8	0.5
1.0	0.54

ii) Diagram set up.

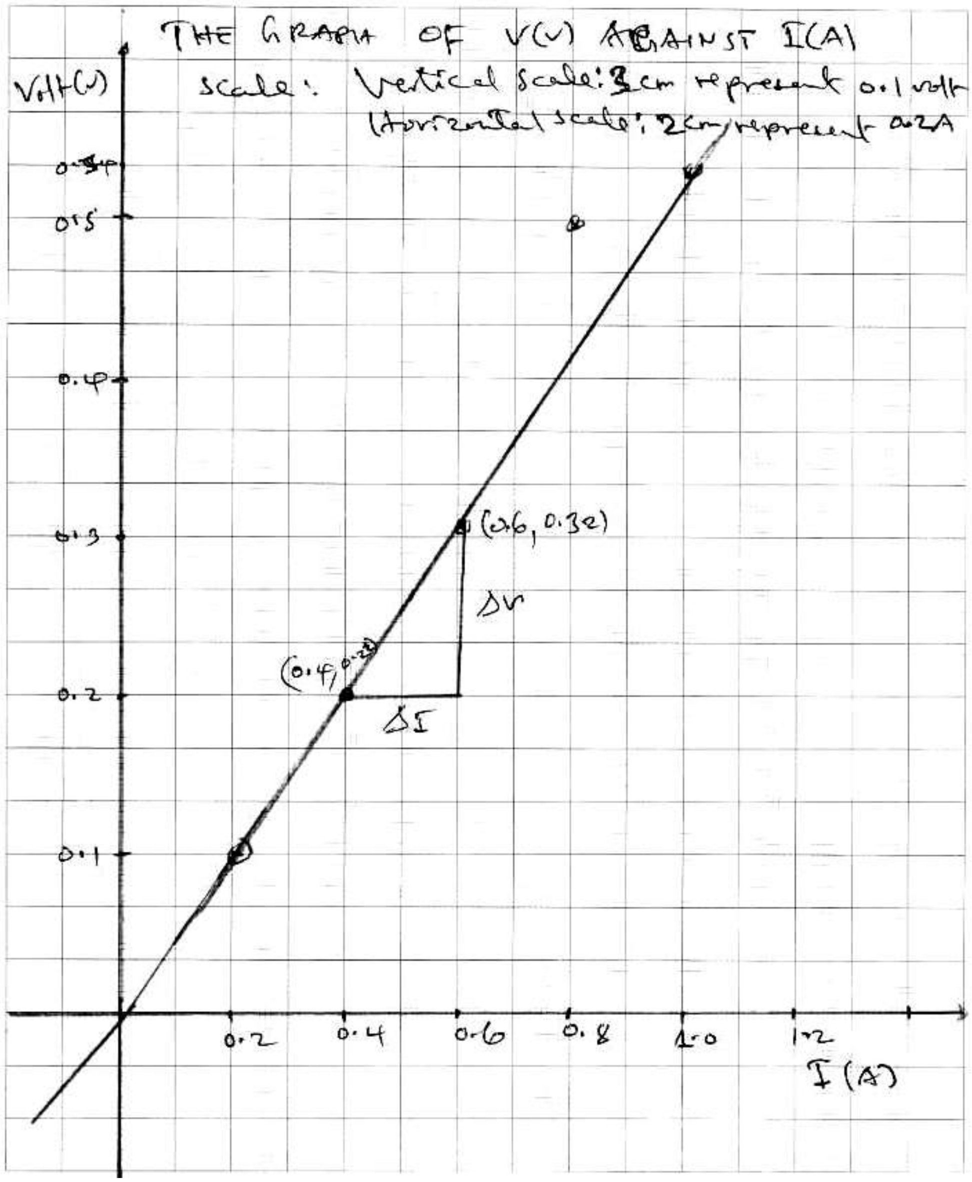


iv) from the graphy.

$$Slope = \frac{\Delta y}{\Delta x} = \frac{\Delta V}{\Delta I} = \frac{1.3 - 1.1}{0.8 - 0.4}$$

$$Slope = \frac{0.2}{0.4}$$

$$Slope = 0.5\,\Omega$$



Extract 23.2: A sample of part of the candidate's good responses to question 3 of Physics 2C.

In Extract 23.2, the candidate constructed a correct table of results and drew a well labelled diagram for the experiment. He/she calculated the internal resistance r indicated by the slope of the graph.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH TOPIC

3.1 Analysis of Candidates' Performance in Each Topic for Physics 1

A total of 12 out of 15 topics were examined in Physics examination paper 1. These topics were: *Measurement*, *Properties of Matter*, *Mechanics*, *Atomic Physics*, *Waves*, *Electronics*, *Physics Laboratory Management*, *Fundamental of Teaching and Learning Physics*, *Heat*, *Current Electricity*, *Assessment in Physics* and *Teaching*.

The analysis of the candidates' responses in each topic in Physics 1 showed good performance in the topics of *Fundamentals of Teaching and Learning Physics* (90.8%) and *Teaching* (88.8%). Average performance was observed in the topics of *Atomic Physics* (61.7%), *Properties of Matter* (61.4%) and *Physics Laboratory Management (48.8%)*. Furthermore, the topics of *Waves* (22.1%), *Electronics* (18.6%), *Measurement* (12.6%), *Assessment in Physics* (11.7%), *Mechanics* (9.6%), *Heat* (7.7%) and *Current Electricity* (3.9%) had weak performance (See Appendix I).

3.2 Analysis of Candidates' Performance in Each Topic for Physics 2

The analysis of Physics 2 (Actual Practical Paper) revealed that the topic of *Mechanics* had average performance (49.0%) while the topics of *Current Electricity* and *Heat* had weak performance of 29.2 per cent and 19.9 per cent respectively (See Appendix II).

4.0 CONCLUSION

The general performance of Physics paper was good (96.18%). The candidates' performance increased by 1.23 per cent compared to 2021 in which 94.95 per cent of the candidate passed. The analysis of the candidates' performance revealed that candidates encountered substantial challenges while doing the questions. It was observed that inadequate content knowledge was one of the most important reasons for the weak performance of some candidates. Some of them provided responses that were irrelevant to the demand of the questions. Others skipped some of the items i.e they left them unanswered.

Further analysis has shown that lack of mathematical skills was also a great challenge that caused the performance of most of the candidates who failed to comply to the requirement of using formulas and calculations which go through a number of steps before obtaining the final answer. However, because of unsatisfactory knowledge on the electric circuits and computational skills they failed to apply the correct principles and formulae and hence they ended up with incorrect answer.

Another reason was poor English language proficiency, where some candidates provided responses with inappropriate verb tenses (grammatical errors). The candidates with language problems failed to give clear explanations of concepts.

5.0 RECOMMENDATIONS

In order to improve the performance of the forthcoming candidates in Physics subject, tutors are advised to:

(a) use group discussion, demonstration and experiments in teaching the concept of production and propagation of mechanical waves by using teaching resources such as slinky coil springs, helical springs, ripple tank and coupled pendulums. This will help the learners to understand propagation of mechanical waves and their behaviours.

(b) explain the concept, structure and application of logic gates in order to draw truth tables by using teaching aids like batteries, switches, thermistor heaters, marker pens and flip charts. This will help the students teachers to acquire ability to analyze and simplify digital gates using Boolean algebra.

(c) apply questions and answers, group discussion, demonstrations and deductive inquiry in teaching dimensional analysis of physical quantities and errors in the topic of errors and dimensions. These methods will help learners to develop competencies and skills in reducing systematic errors in everyday life experience.

(d) use a reciprocal teaching method to explain the concept of parking orbit when launching the satellite from the surface of the earth to other heavenly bodies above the earth.

(e) perform an experiment on verification of temperature distribution along lagged and unlagged metal conductors by using resources like unlagged metal conductors, insulated metal conductors and sources of heat, metal rods, cotton wool, thermometers, stopwatches and graph papers.

Appendix 1

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

Na.	Topic	Question Number	Performance in each topic (%)	Average performance per topic (%)	Remarks
1.	Fundamentals of Teaching and Learning Physics	10	90.8	90.8	Good
2.	Teaching	14	88.8	88.8	Good
3.	Atomic Physics	5	61.7	61.7	Average
4.	Properties of Matter	2	61.4	61.4	Average
5.	Physics Laboratory Management	8	53.7	48.8	Average
		9	43.9		
6.	Waves	6	22.1	22.1	Weak
7.	Electronics	7	18.6	18.6	Weak
8.	Measurement	1	12.6	12.6	Weak
9.	Assessment in Physics	13	11.7	11.7	Weak
10.	Mechanics	4	9.9	9.6	Weak
		3	9.2		
11.	Heat	11	7.7	7.7	Weak
12.	Current Electricity	12	3.9	3.9	Weak

Appendix 2

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

S/N	Topic	Question Number	Performance in each question (%)	Average performance per topic (%)	Remarks
1.	Mechanics	1	49.0	49.0	Average
2.	Current Electricity	3	29.2	29.2	Weak
3.	Heat	2	19.9	19.9	Weak