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) 2021

PHYSICS

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CANDIDATES' ITEM RESPONSE ANALYSIS REPORT ON THE DIPLOMA IN SECONDARY EDUCATION EXAMINATION (DSEE) 2021

731 PHYSICS

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FOREWORD

The National Examinations Council of Tanzania is pleased to issue the 2021 Candidates' Item Response Analysis Report on the Diploma in Secondary Education Examination (DSEE) in Physics subject. This report provides feedback to student teachers, tutors, policy makers and the public in general about the performance of the candidates. Basically, the candidates' responses to the examination questions indicate what the education system was able/ unable to offer to student teachers in their Diploma in Secondary Education course.

The general performance of the candidates in Physics subject was good. The report shows factors which contributed to the candidates' ability to answer the examination questions correctly and score high marks. The factors includes, ability to identify the task of the questions, good knowledge of the subject matter, good mathematical skills and correct application of the principles in interpreting scientific observation. However, the candidates with low marks lacked such qualities.

It is hoped that the suggestions and recommendations provided in this report will enable various education stakeholders to take proper teaching and learning interventions so as to enable the student teachers to master the required skills and knowledge hence improve performance in the future examinations administered by the Council.

Lastly, the Council is grateful to all examination officers, examiners and all other staff members who participated in the preparation of this report.

Dr. Charles E. Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report analyses candidates' responses in Physics subject in the Diploma in Secondary Education Examination on May 2021. It provides feedback to educational stakeholders about the strength and weaknesses of the candidates' performance.

The DSEE 2021 physics examination paper covered the 2009 academic and pedagogy syllabus and was set based on the 2017 Examinations Format. The examination comprised of two papers; Physics 1 and Physics 2A which are theory paper and actual practical paper respectively.

The Physics 1 consisted of sections A, B and C with a total of sixteen (16) questions. Section A consisted of ten (10) short-answer questions which assessed both academic and pedagogy knowledge each carrying 4 marks. Sections B had three (3) essay type questions which assessed the academic contents and were set from three different topics. Each question carried 15 marks. Section C consisted of three (3) essay type questions which tested pedagogy contents which were set from three topics. Each question carried 15 marks. The candidates were required to answer all questions in section A and any two (2) questions from each of section B and C. On the other hand, Physics 2A consisted of three (3) questions. Questions 1 carried 20 marks while question 2 and 3 each 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 and sample of extracts which illustrate 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. In addition, the Green, Yellow and Red colours are used in charts or graphs to represent these categories respectively.

A total of 382 candidates sat for 731 Physics examination in 2021. Among them, 357 (94.95%) passed the examination while 19 (5.05%) failed. The candidates' performance in this year has declined by 4.47 per cent when compared to the year 2020 in which 99.42 per cent of the candidates passed. The analysis of the candidates' performance in 2021 with different grades as compared to the year 2020 is summarized in the following table.

Year	**Sat**	**Number of Candidates and Percentage**						
		Passed	**Grades**					
			A	**B**	**C**	**D**	**F**
2021	382	357	0	1	110	246	19
		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 many candidates scored grade C and D for the two consecutively years. On the other hand, there was no candidate who scored grade A for the two years.

Lastly, this report provides conclusion and recommendations that may help to enhance 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 the analysis of each question, an overview of what the candidates were required to do, the general performance and the possible reasons for the observed performance, have been provided. Samples of extracts showing the candidates' responses have been used in appropriate sections to illustrate the cases presented.

2.1 731/1 Physics 1 (Theory)

Physics paper 1 tested 14 topics which are *Measurements*, *Atomic Physics*, *Mechanics*, *Properties of Matter*, *Waves*, *Analysis of O-Level Physics Curriculum Materials*, *Physics Laboratory Management*, Planning *for Teaching*, *Fundamentals of Teaching and Learning Physics*, *Current Electricity*, *Heat*, *Electronics*, *Assessment in Physics* and *Teaching* with a total of 16 questions. Question 1 to 10 carried 4 marks each and question 11 to 16 carried 15 marks each. The candidates' scores have been termed as weak, average or good based on the performance. The analysis of each question is as follows:

2.1.1 Question 1: Measurements

The question required the candidates to use the equation to compute the dimensions of the constants x and y from $\left(P+\frac{x}{V}\right)(V-y)=RT$, given that P is pressure, V is volume, T is temperature and R is universal molar gas constant.

A total of 382 candidates corresponding to 100 per cent attempted this question. Generally, the candidates' performance was average as shown in Figure 1.

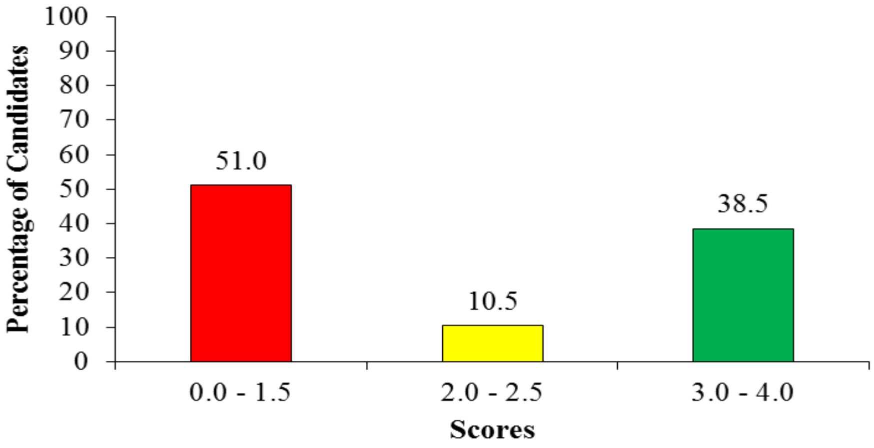


Figure 1: *Candidates' Performance on Question 1*

Figure 1 indicates that 49.0 per cent of the candidates scored 2.0 to 4.0 marks. Among them 10.5 per cent scored 2.0 to 2.5 marks and 38.5 per cent scored 3.0 to 4.0 marks. However, 51.0 per cent of the candidates scored 0.0 to 1.5 marks.

The data analysis shows that the candidates with average scores (2.0 - 2.5) had inadequate knowledge about the concept of measurements. They established the correct dimensions for pressure and volume but failed to make mathematical manipulation. For example, some of the candidates wrote $\left[V^2\right]=L^3$ instead of $\left[V^2\right]=\left(L^3\right)^2=L^6$. This mathematical mistake led them to lose two marks from the question. The other candidates wrote wrongly the dimension of y as $y=\left[\text{Volume}\right]=\left[L^2\right]$ and $y=\left[\text{Volume}\right]=\left[L^{-2}\right]$ instead of $\left[\text{Volume}\right]=\left[L^3\right]$.

Furthermore, the candidates who scored above average were able to use the given equation to identify that the physical quantity $\frac{x}{V^2}$ and y represents pressure and volume respectively. They applied the dimensions formula correctly to compute the dimensions of the constants 'x' and 'y' as per question demands. The candidates' responses implied that they had good understanding on the topic of measurements, specifically on performing calculations based on dimensional analysis. Extract 1.1 represents a sample of good responses from one of the candidates.

1. Solution

Data given

equation $\left(P + \frac{X}{V^2}\right)(V - y) = RT$.

Required: Dimension of X and y.

Recall;

From dimension rules;

For the quantity to be added or subtracted should have the same dimension.

From equation above.

$P + \frac{X}{V^2}$

so $P = \frac{X}{V^2}$.

$X = PV^2$.

Dimension of $P = ML^{-1}T^{-2}$.

Dimension of $V = L^3$.

$X = (ML^{-1}T^{-2})(L^3)^2$.

$X = ML^{-1+6}T^{-2}$.

$X = ML^5T^{-2}$.

For y.

From $V - y$

recall from dimension rule above.

$V = y$.

$y = V = L^3$.

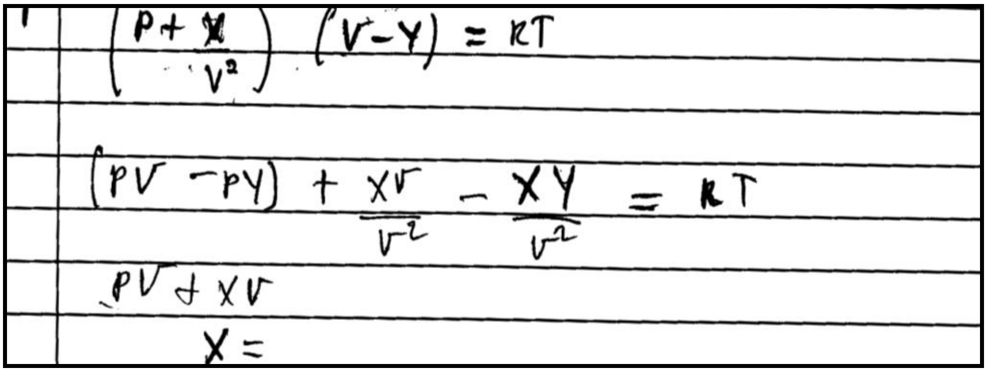
$y = L^3$.

$\therefore$ Dimension of $X = ML^5T^{-2}$ and of $y = L^3$.

Extract 1.1: A sample of a good response in Question 1.

The data analysis also revealed that, the candidates who scored low marks (0.0 – 1.5) in this question wrongly interpreted the given equation

$\left(P+\frac{x}{V}\right)(V\text{-}y)=RT$ and applied expansion of algebraic expression to calculate the dimensions of constants x' and 'y'. Some of them failed to manipulate the exponents of the physical quantities in dimensions formula and others failed to treat physical quantity ($P+\frac{x}{V^2}$) as pressure and $V\text{-}y$ as volume. The candidates' responses signified lack of knowledge in solving dimensions of physical quantities. Extract 1.2 illustrates an example of weak responses supplied by one of the candidates.



1 $\left(P+\frac{x}{V^2}\right)(V-Y)=RT$

$(PV-PY)+\frac{XV}{V^2}-\frac{XY}{V^2}=RT$

$PV+XV$

$X=$

Extract 1.2: A sample of incorrect response in Question 1.

In Extract 1.2; the candidate responded wrongly by expanding the given equation instead of computing the dimensions of constants x and y.

2.1.2 Question 2: Atomic Physics

This question required the candidates to calculate the speed acquired by the electron when an electron is emitted from a hot cathode in an evacuated tube is accelerated by a potential difference (p.d) of $1.0\times10^3\text{V}$.

The question was attempted by 382 candidates equivalent to 100 per cent. The overall candidates' performance in this question was weak. Figure 2 is illustrative.

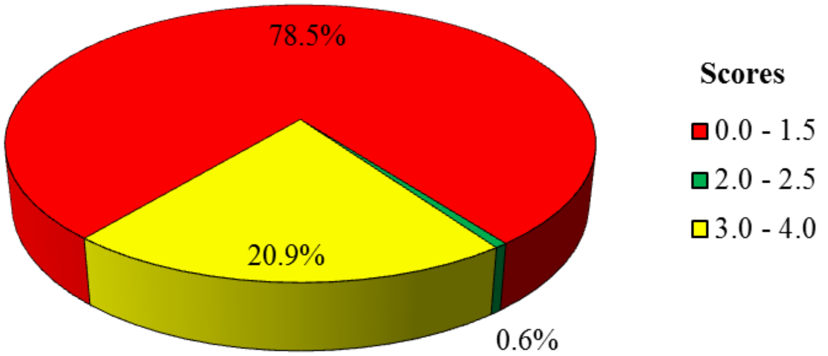


Figure 2: *Candidates' Performance on Question 2*

Results in Figure 2 indicate that 21.5 per cent of the candidates scored 2.0 to 4.0 marks, among them 0.6 per cent scored 3.0 to 4.0 marks and 78.5 per cent of the candidates scored from 0.0 to 1.5 marks.

A further analysis indicates that the candidates with weak performance failed to establish the relationship between the concepts of kinetic energy of electrons and the potential difference/electron volt ($\frac{1}{2}\text{mv}^2 = \text{e}\upsilon$) which could help them to calculate the speed v of the electron. For example one of the candidates wrote that; *the speed of the electron is equal to the ratio of the electron volt and mass of the electron* ($V = \frac{\upsilon}{m_e}$). It was also noted that some candidates used incorrect concepts and formulas to determine the speed of electron. For examples the concepts of *electric field* ($ma = eE$), *velocity of waves* ($\text{V}=\lambda\text{f}$), *quantity of charge* ($\text{Q}=\text{P.d}\times\text{e}$), *terminal velocity* $\text{V}_\text{T} = \frac{2(\rho - \sigma)}{9\eta}$ and *drift velocity of electrons when an electric field is applied to a length of a conductor* ($\text{I} = \text{nev}$). Therefore, these incorrect responses from candidates imply that they had insufficient knowledge about the topic of atomic physics particularly the concept of thermionic emission. Extract 2.1 is a sample of an incorrect responses from one of the candidates.

2 Soln

$V = IR$.

Data given

potential difference $= 1 \times 10^3 V$.

Speed acquired by the electron. 1.6×10^{-16}

Extract 2.1: A sample of incorrect response in Question 2.

Extract 2.1 shows that the candidate applied the Ohm's equation to calculate the speed of electron. She/he thought that letter V in Ohm's equation represent speed while in actual fact it represents potential difference P.d.

In contrary, 21.5 per cent of the candidates who scored above 1.5 marks responded correctly to this question. They had enough knowledge about the topic of atomic physics. These candidates were able to grasp the thermionic emission concept that when an electron is accelerated it moves with a kinetic energy equals to the accelerating potential energy given by the product of electronic charge and the accelerating potential. Some of them also substituted correctly the given physical constants to calculate the speed of electron. Extract 2.2 displays an example of good responses from a candidate.

2. Recall from;

$$W.D = \frac{Mv^2}{2}.$$

But WD for the current = P.d e^-.

$$P.d e^- = \frac{Mv^2}{2}.$$

$M = Me$, $v = ve$

$$P.d e^- = \frac{Me ve^2}{2}.$$

$$\frac{Me ve^2}{Me} = \frac{2 P.d e^-}{Me}.$$

$$\sqrt{ve^2} = \sqrt{\frac{2 P.d e^-}{Me}}$$

$$Ve = \sqrt{\frac{2 P.d e^-}{Me}}.$$

$$= \sqrt{\frac{2 \times 1.0 \times 10^3 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}}.$$

$= 1.875 \times 10^7$ m/s.

∴ Speed acquired by electron is 1.875×10^7 m/s.

Extract 2.2: A sample of correct response in Question 2.

2.1.3 Question 3: Mechanics

This question had two parts: (a) and (b). In part (a); the candidates were instructed to give the meaning of the term "fixed point" as used in Simple Harmonic Motion. Part (b) required the candidates to deduce the maximum magnitudes of velocity of the bob and acceleration of the bob given that the period and amplitude of swing of a simple pendulum are 2.0 s and 5.0 cm respectively.

A total of 382 (100%) candidates attempted this question. The analysis of candidates' performance shows that the performance was average. These data are summarised in Figure 3.

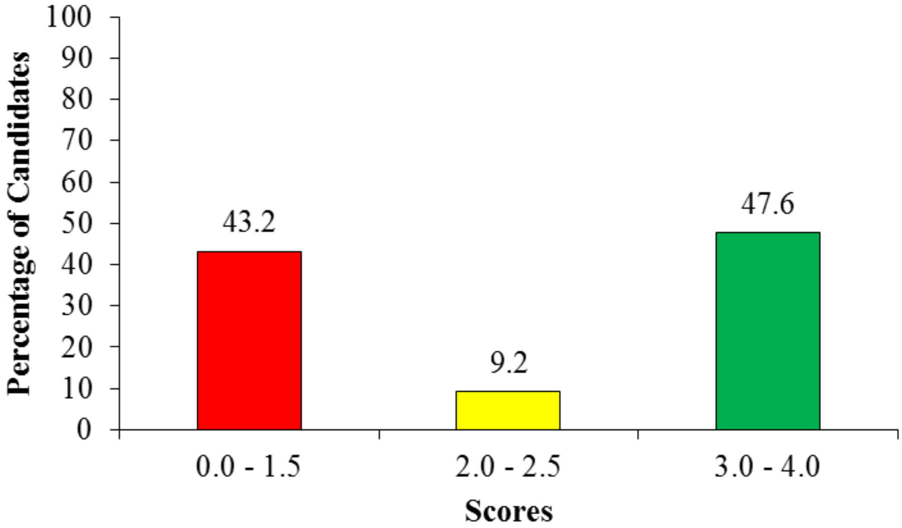


Figure 3: *Candidates' Performance on Question 3*

The statistical data in Figure 3 shows that 165 (43.2%) candidates scored 0.0 to 1.5 marks and 35 (9.2%) candidates scored 2.0 to 2.5 marks. The remaining 182 (47.6%) scored 3.0 to 4.0 marks.

The data analysis reveals that 9.2 per cent of the candidates who scored average marks either skipped or gave incorrect answers to some parts of the question. Some of them gave incorrect meaning of the term "fixed point" in Simple Harmonic Motion in part (a). For example one candidate explained as, "*a point found in string of a bob.*" Similarly, others wrote "*is a point where a bob is attached, it gives supports a bob."* The other candidates missed some of the steps in deducing either maximum velocity or acceleration of the bob in part (b). This implies that these candidates lacked some skills of calculating velocity and acceleration of a pendulum bob when is in oscillatory motion.

However, those who scored high marks responded correctly to most parts of the question. They provided the correct meaning of the term "fixed point" as used in simple harmonic motion. These candidates showed to have understood properly the concept of simple pendulum when the bob is used to execute to and fro motion. Most of them were able to analyse the potions of a bob at which the maximum velocity and acceleration are attained which in turn enabled them to deduce their magnitudes. Extract 3.1 is a sample from one of the candidates who performed well.

3 (a) fixed point is the equilibrium position of a particle at which displacement is zero

(b) solution (i)

Data given

period, $T = 2s$.

Amplitude, $A = 5.0cm$.

vequived maximum velocity, $V_{max} = ?$

from

$V_{max} = wA$

$V_{max} = \frac{2\pi A}{T}$

3

$V_{max} = \frac{2 \times 3.14}{2} \times 5 \times 10^{-2}$

$V_{max} = 0.157 m/s$.

∴ maximum velocity is 0.157 m/s.

(ii) acceleration of the bob.

$a_{max} = w^2 A$

Maximum acceleration of the bob $= \left(\frac{2\pi}{T}\right)^2 A$

$a_{max} = \left(\frac{2 \times 3.14}{2}\right)^2 (5 \times 10^{-2})$

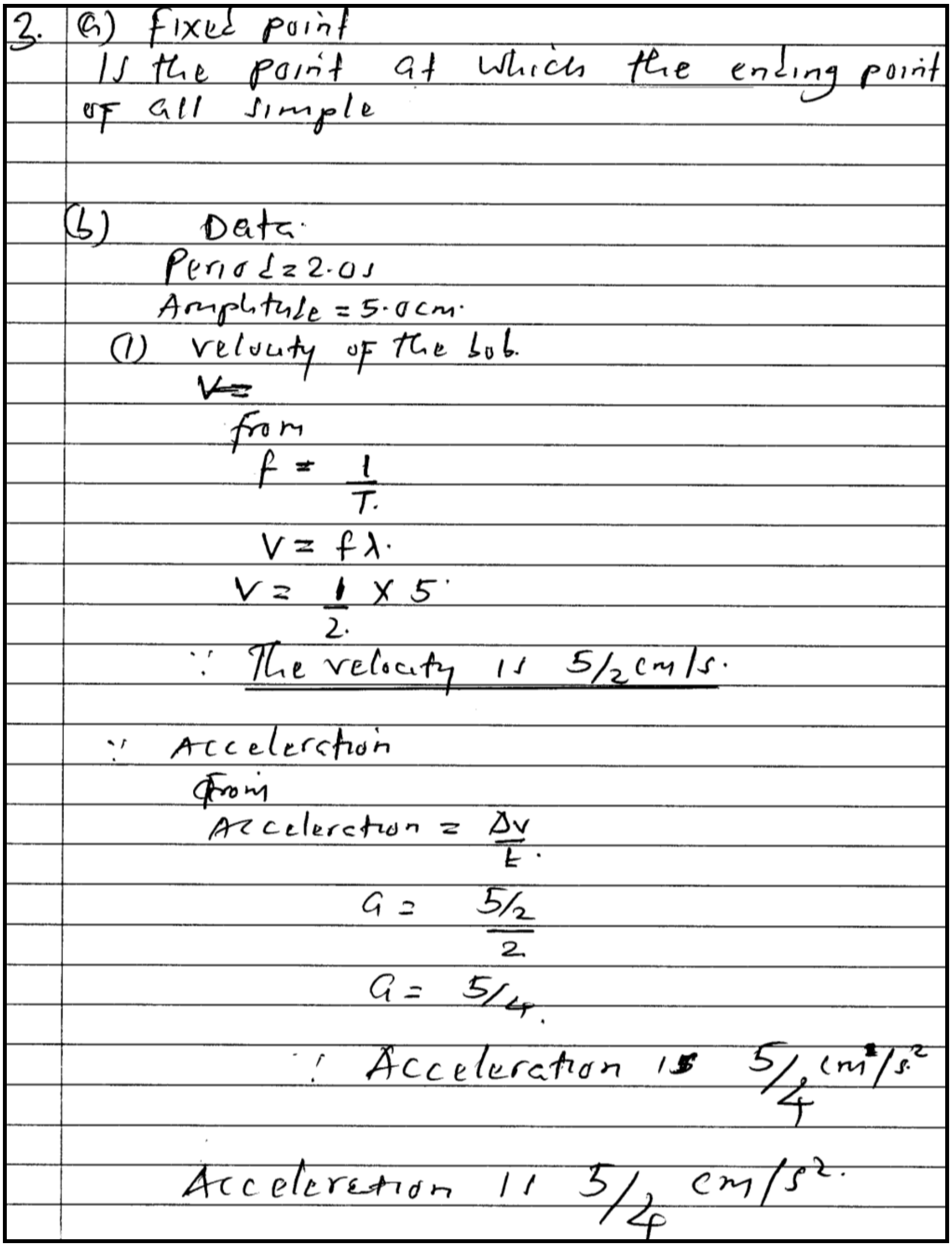
$a_{max} = 0.49298 m/s^2$.

∴ Maximum acceleration of the bob is 0.49298 m/s

Extract 1:3: A sample of candidate's good response in Question 3.

On the other hand, some of the candidates who scored low marks provided incorrect meaning of a term “fixed point” in part (a) of the question. They failed to grasp the fact that the term “fixed point” is the same as equilibrium point in a Simple Harmonic Motion. For example one of the candidates wrote: *fixed point is the point where by two bodies can be meet or collide*. This response is related to the concept of collision of two bodies in a subtopic of Newton’s laws of motion. Moreover, some of the candidates treated the term “fixed point” in the manner of gravitational motion as some of them stated: *Fixed point is the point where the acceleration due to gravity is zero*.

In part (b), some of the candidates failed to understand that the velocity is maximum when the amplitude is zero while the acceleration is maximum when the amplitude is maximum. Consequently, they applied wrong simple equations like $v = \frac{amplitude\ (\mathrm{A})}{period\ (t)}$ and $a = \sqrt{\frac{T}{g}}$ instead of $\mathrm{v} = \pm\omega\sqrt{\left(\mathrm{r}^2 - \mathrm{x}^2\right)}$ and $\mathrm{a} = -\omega^2\mathrm{r}$ to deduce the values of velocity and acceleration respectively. These responses are some evidence that the candidates lacked knowledge of describing and deducing expressions for maximum velocity and acceleration of a particle performing Simple Harmonic Motion. Extract 3.2 shows a sample of an incorrect response from one of the candidates.



3. (a) Fixed point
Is the point at which the ending point of all simple

(b) Data.
Period = 2.0s
Amplitude = 5.0cm.
(i) velocity of the bob.
~~V=~~
from
f = 1/T.
V = fλ.
V = 1/2 × 5.
∴ The velocity is 5/2 cm/s.

∴ Acceleration
From
Acceleration = Δv/t.
a = (5/2)/2
a = 5/4.
∴ Acceleration is 5/4 cm/s²

Acceleration is 5/4 cm/s².

Extract 3.2: A sample of an incorrect response in Question 3.

In Extract 3.2; the candidate incorrectly deduced the maximum magnitudes of the velocity and acceleration of the bob by using velocity of sound waves and linear motion respectively.

2.1.4 Question 4: Properties of Matter

In part (a) the candidates were required to explain why a soap solution is a better cleansing agent than ordinary water. In part (b), they were required to find the energy stored in a steel wire of length 4 m and cross-section area of 3×10^{-6} m^2 when extended by 1 mm, given the Young modulus of steel wire $= 2.0\times10^{11}$ Pa.

A total of 382 (100%) candidates attempted the question and the overall performance was weak as 272 (71.2%) candidates scored 0.0 to 1.5 marks. The summary of the candidates' performance in this question is shown in Figure 4.

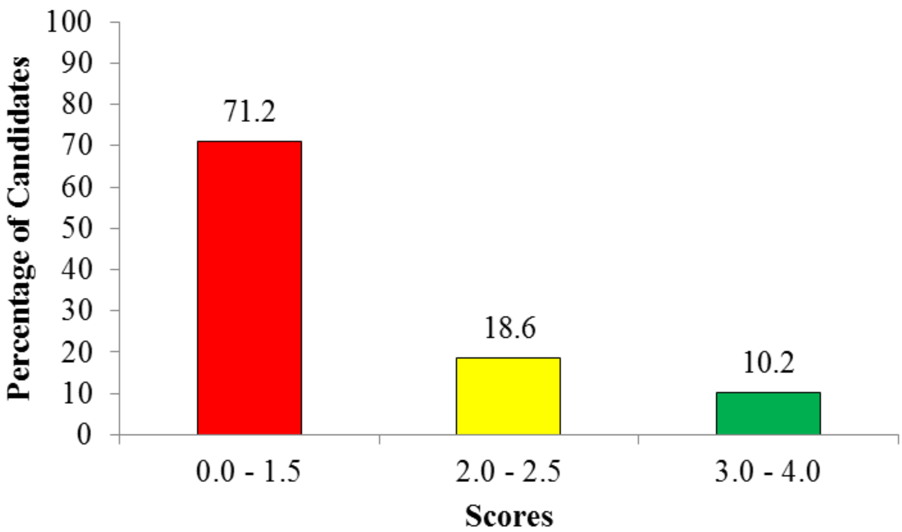
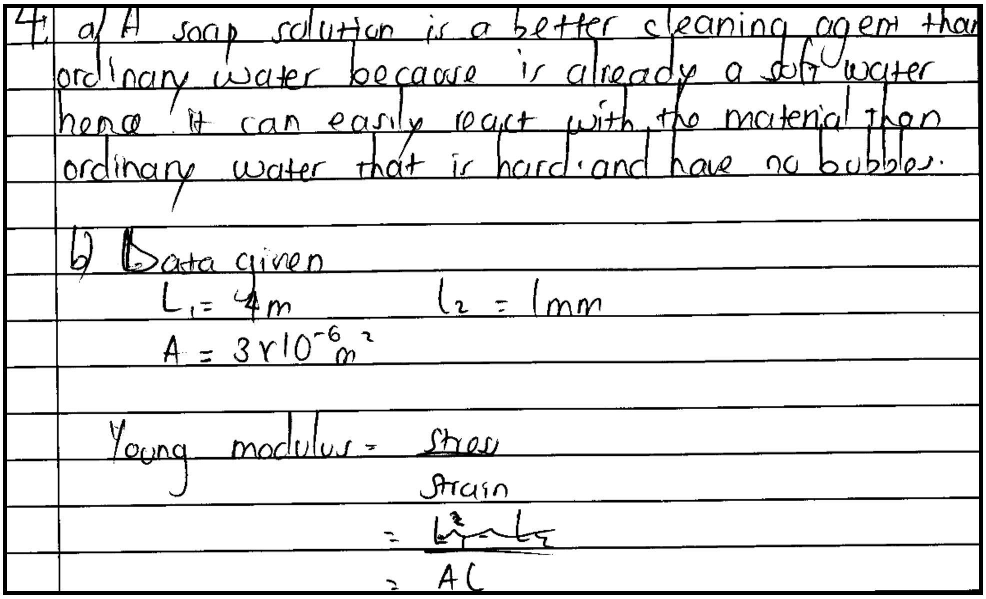


Figure 4: *Candidates' Performance on Question 4*

Figure 4 shows the candidates' performance as follows: 272 (71.2%) scored 0.0 to 1.5 marks; 71 (18.6%) scored 2.0 to 2.5 marks and 39 (10.2%) scored 3.0 to 4.0 marks.

Further analysis of the candidates' performance indicates that weak performance was due to the following reasons: Failure to understand the effect of soap solution to the surface tension of water, inability to relate the application of surface tension in daily life and failure to relate surface tension and capillarity rise in porous cloth fabrics. In addition, some candidates gave incorrect explanations to part (a) such as: *detergent chemicals of soft water and hard water, adhesive forces and cohesive* *forces are opposite forces in water* and *softness of the particles in soap solution*. These candidates confuse the concepts of softness and hardness of water with the concept of surface tension of liquid. Extract 4.1 is a sample of incorrect responses from one the candidates.


4. a) A soap solution is a better cleaning agent than ordinary water because is already a soft water hence it can easily react with the material than ordinary water that is hard and have no bubbles.

b) Data given

$L_1 = 4m$ $\quad l_2 = 1mm$

$A = 3 \times 10^{-6} m^2$

Young modulus = $\frac{Stress}{Strain}$

= [illegible]

= AC

Extract 4.1: A sample of weak response in Question 4.

In Extract 4.1; the candidate provided explanation about reaction of soft water and other materials instead of explaining basing on capillary rise and reduction of surface tension of water.

However, some of the candidates who scored high marks (3.0 – 4.0) had enough knowledge and skills on the topic of properties of matter. They understood that liquids with high surface tension tend to penetrate easily in cloth fabrics due to low angle of contact. Therefore, soap solution added to water increases the surface tension of water leading to low angle of contact and hence high capillary rise. These candidates applied the correct formula and made the correct manipulation of the data to obtain the required value of stored energy. Extract 4.2 is a sample of correct responses from one of the candidates.

Q4. (a) A soap solution is better cleaning agent than ordinary water. This is because the angle of contact of soap is less than 90° which will allow the water to spread easily but the angle of contact of water is greater than 90° this will prevent the spreading of water.

(b) Soln

Data

length $L = 4m$

Area(A) $= 3 \times 10^{-6} m^2$

extention(e) $= 1mm = 1 \times 10^{-3} m$

Young modulu $E = 2.0 \times 10^{11} Pa$.

Energy = ?

From

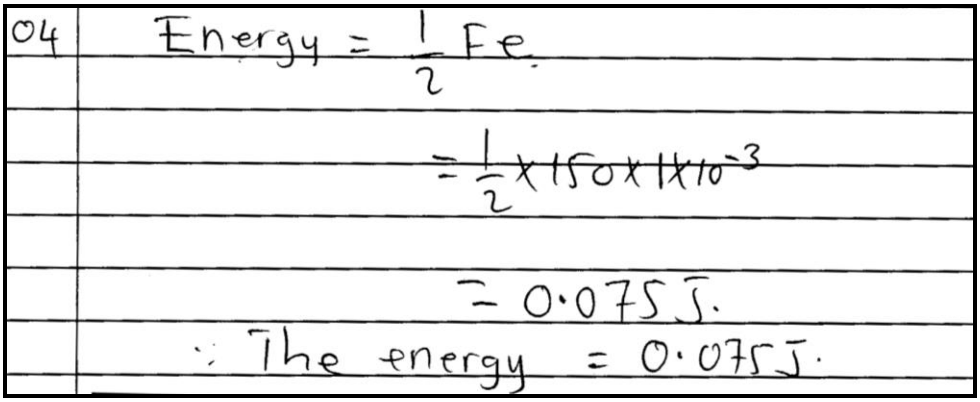
$$E = \frac{FL}{Ae}$$

$$F = \frac{EAe}{L}$$

$$F = \frac{2.0 \times 10^{11} \times 3 \times 10^{-6} \times 1 \times 10^{-3}}{4}$$

$$F = 150N.$$

From $E = \frac{1}{2} Fe$.



04 Energy $= \frac{1}{2} Fe$

$= \frac{1}{2} \times 150 \times 1 \times 10^{-3}$

$= 0.075 J$.

$\therefore$ The energy $= 0.075 J$.

Extract 4.2: A sample of correct response in Question 4.

2.1.5 Question 5: Mechanics

This question required the candidates to differentiate the following terms as applied in Fluid Mechanics: (a) viscous fluid and streamline flow and (b) compressible fluid and incompressible fluid.

The question was attempted by 382 (100%) candidates. The overall candidates' performance was average since 55.2 per cent passed the question by scoring 2.0 marks and above.

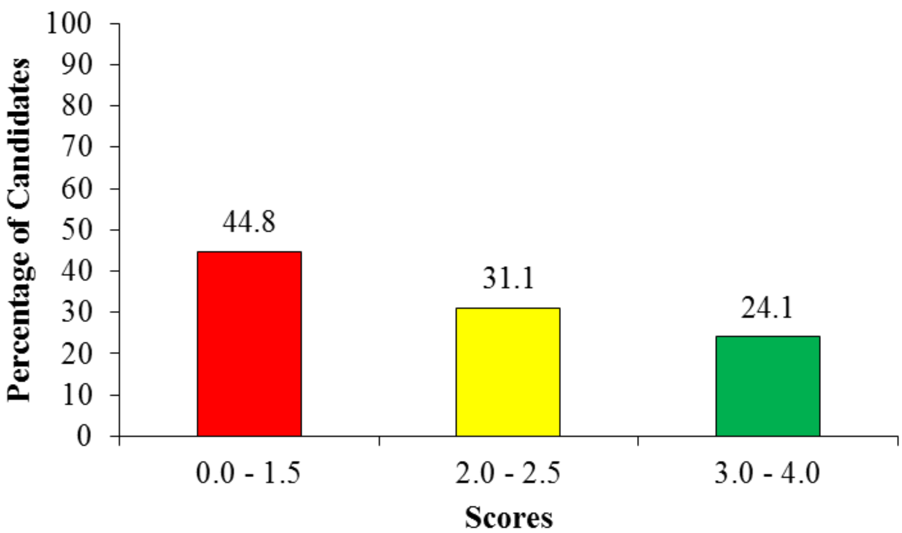


Figure 5: *Candidates' Performance in Question 5*

Figure 5 shows that among the candidates who attempted the question; 171 (44.8%) scored low marks (0.0 to 1.5). Further analysis reveals that, 211

(55.2%) scored from 2.0 to 4.0 marks among them, 31.1 per cent scored average marks (2.0 to 2.5) while 24.1 per cent scored good marks (3.0 to 4.0)

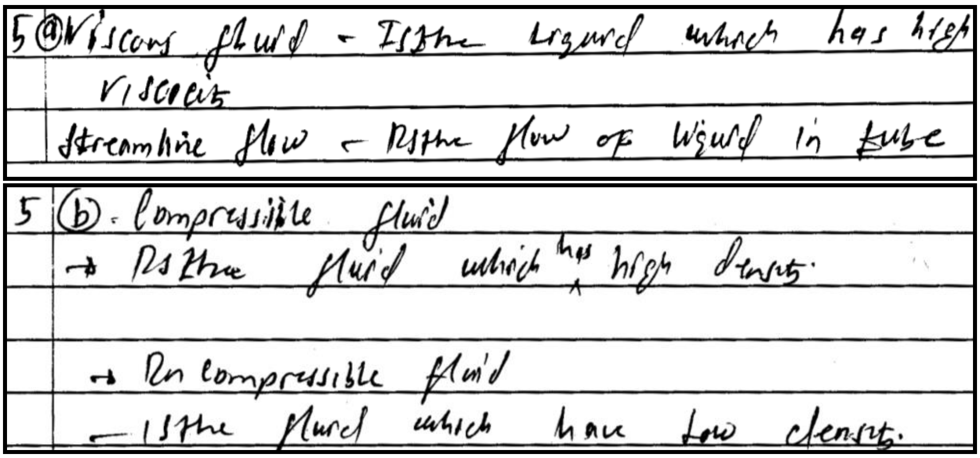
The data analysis reveals that the candidates with average marks had inadequate knowledge about Fluid mechanics specifically on explaining the concepts of fluid motion. Most of them failed to differentiate correctly the given pair of the basic terms as applied in Fluid dynamics.

Nevertheless, the candidates who scored good marks (24.1%) were knowledgeable in the concepts of viscous fluid, streamline flow, compressible fluid and incompressible fluid. These candidates understood how the change in fluid density and pressure determines whether a fluid is compressible or not. Consequently, they were able to verify how viscous force influences the flow fluid particles and hence differentiate between viscous fluids and streamline flow. Extract 5.1 is illustrative.

5·(a)	Viscous fluid is the fluid that possess friction as they
	flow in a given vessel like pipe.
	while
	Streamline flow refers to the flow of fluid where
	by all particles at all points have the same velocity
	and there is no friction between the fluid and the
	vessel or pipe to which fluid flow.
(b)	Compressible fluid is the kind of fluid where by
	when pressure applied in it cause change in density
	and volume.
	while
	Incompressible fluid is the fluid which when pressure
5(b)	applied do not cause change in pressure and volume
	of the fluid, means volume and density remain
	constant.

Extract 5.1: A sample of candidate's good responses in Question 5.

In contrast, 44.8 per cent of the candidates who scored low marks had insufficient knowledge about the concept of fluid motion. Some of them provided irrelevant answers to part (a) of the question. For example, one of the candidates responded that; *viscous flow is a flow which has friction called viscosity while streamline flow is the fluid flow which has no viscosity*. In addition, some candidates wrote *viscous fluid is the fluid of which evaporate easily while streamline flows are the flow of fluid in the streamline position.* These responses referred viscous fluid as a surface tension instead of internal friction force between layers of the fluid. Furthermore, some of the candidates differentiated the given terms interchangeably. For example, one of them wrote; *compressible fluid is the internal friction of water while incompressible fluid there is internal friction of water moving*. The idea of internal friction is for viscous fluid but not incompressible fluid. The candidate failed to understand that compressible and incompressible fluids are based on the concepts of effect of variation of pressure and density in a particular fluid. Extract 5.2 shows a sample of incorrect responses.


5 (a) Viscous fluid - Is the liquid which has high viscosity
streamline flow - Is the flow of liquid in tube
5 (b). Compressible fluid
→ Is the fluid which has high density.
→ In compressible fluid
- Is the fluid which have low density.

Extract 5.2: A sample of weak response in Question 5.

In Extract 5.2; the candidate failed to associate the viscous fluid with its resistance to flow also the streamline flow with its flow speed in part (a). Likewise, in part (b) compressible and incompressible fluids were related to high and low density respectively, instead of effect of pressure variation to density of fluid.

2.1.6 Question 6: Waves

The question required the candidates to state; (a) two differences between progressive and stationary waves and (b) four methods used to form interference patterns.

The question was attempted by 382 candidates equivalent to 100 per cent. The performance was generally weak as shown in Figure 6.

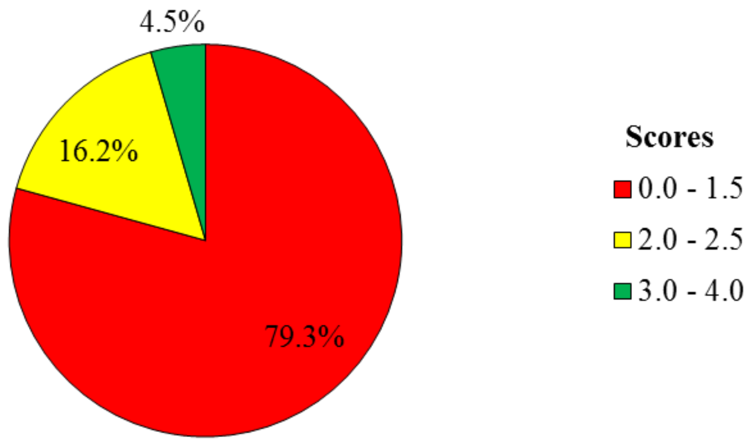
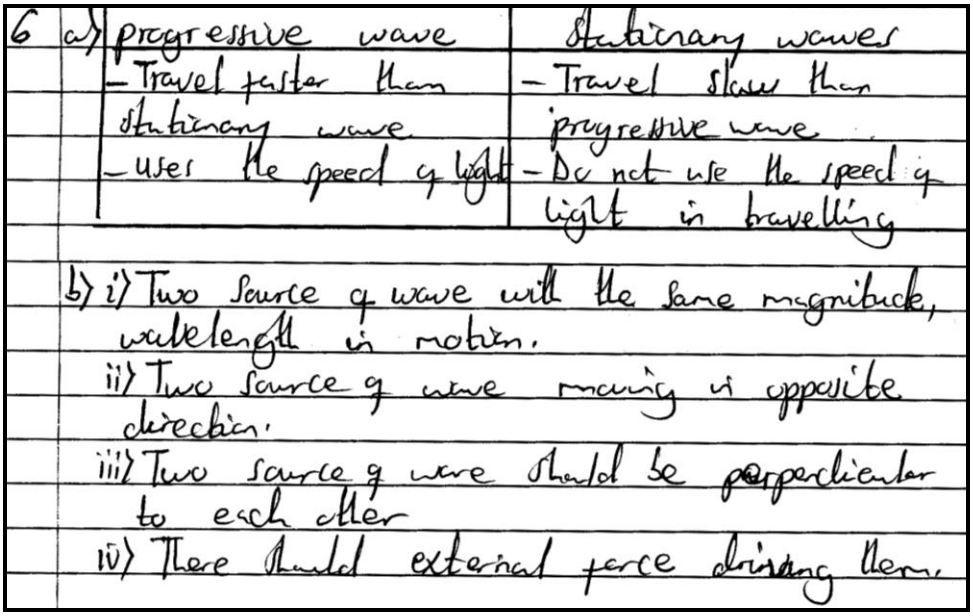


Figure 6: *Candidates' Performance on Question 6*

Figure 6 shows that 303 (79.3%) candidates scored 0.0 to 1.5 marks, 62 (16.2%) scored 2.0 to 2.5 marks and 17 (4.5%) scored 3.0 to 4.0.

The analysis of the candidates' responses showed that the candidates who scored marks below average failed most parts of the question. They were not able to state the difference between progressive and stationary waves. For example, one candidate responded as *"in progressive wave the particles move at the same direction of the wave while stationary wave the particle and the wave stay stationary"* and the other candidate asserted that "*progressive waves are like water while stationary wave is like sound waves*." In addition, some of the candidates used interchangeably the properties of progressive waves with those of stationary waves. For example, one of them stated that "*progressive waves have different amplitude while stationary waves have same amplitude*." Their responses show that they lacked knowledge about propagation in progressive waves and stationary waves. These candidates failed to realise that in progressive waves the amplitude is constant while in standing waves it varies as the wave vibrates. They were supposed to understand that the differences of the two terms are based in the concept of mechanical vibrations.

Moreover, some of the candidates wrongly stated the four methods used to form interference patterns of light in part (b). For example, one of the candidates wrote the following methods: "*closed room, echo, sound and reverberation of sound.*" Some of these responses are concepts in sound waves and not interference. The other candidate wrote the methods as "*diffraction, small hole, division of wave front and sound transmitted*." Another candidate provided the answers related to properties of light instead of the methods which used to form interference. The candidate wrote the following properties of light: "*reflection of light, diffraction of light and refraction of light.*" These responses show that the candidates did not understand the methods of forming interference of light. In addition, they were not familiar with the properties of progressive and stationary waves. Extract 6.1 represents one of the weak responses in this question.



6 a) progressive wave	Stationary waves
- Travel faster than stationary wave.	- Travel slow than progressive wave.
- uses the speed of light	- Do not use the speed of light in travelling

b) i) Two source of wave with the same magnitude, wavelength in motion.
ii) Two source of wave moving in opposite direction.
iii) Two source of wave should be perpendicular to each other
iv) There should external force driving them.

Extract 6.1: A sample of incorrect responses in Question 6.

In Extract 6.1; the candidate provided incorrect differences between progressive and stationary waves basing on the speed of light in part (a). She/he wrote some properties of interference of light and stationary waves instead of the methods used to form interference patterns instead of four as instructed in part (b) of this question.

However, 16.2 per cent of the candidates who scored average marks responded correctly to one part of the question. Some of these candidates either stated correctly one difference between progressive and stationary waves in part (a) or two methods used to obtain interference in part (b).

Further analysis reveals that some of the candidates with good marks (4.5%) were able to differentiate between progressive and stationary waves. Moreover, they stated the four methods used to obtain interference patterns of light. Generally, their responses imply that they had mastered the topic of Waves particularly on mechanical vibrations and interference. Extract 6.2 shows a sample of good responses from one of the candidates.

6. (a) Progressive waves	stationary waves.
(i) Is the type of wave which transfer energy from point of vibration to another point.	- It does not transfer energy since are stationary.
ii) It formed due to vibration of the wave particles.	- It is formed due to supperposition of two waves with the same wavelength, amplitude and phase angle.

6. (b) Methods that can be used to form interference patterns are.

(i) Young double slit experiment.

(ii) Newton's Ring experiment.

(iii) Fresnell's Biprism.

(iv) Air wedge fringes.

Extract 6.2: A sample of correct response in Question 6.

2.1.7 Question 7: Analysis of O-Level Physics Curriculum Materials

In this question candidates were required to outline four importance of teacher's guide book in teaching Physics subject.

A total of 382 candidates corresponding to 100 per cent attempted the question. The, overall performance in this question was good as summarised in Figure 7.

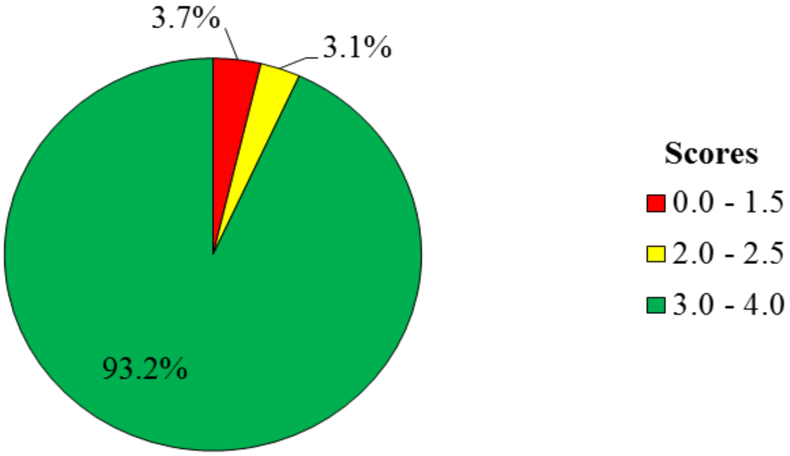
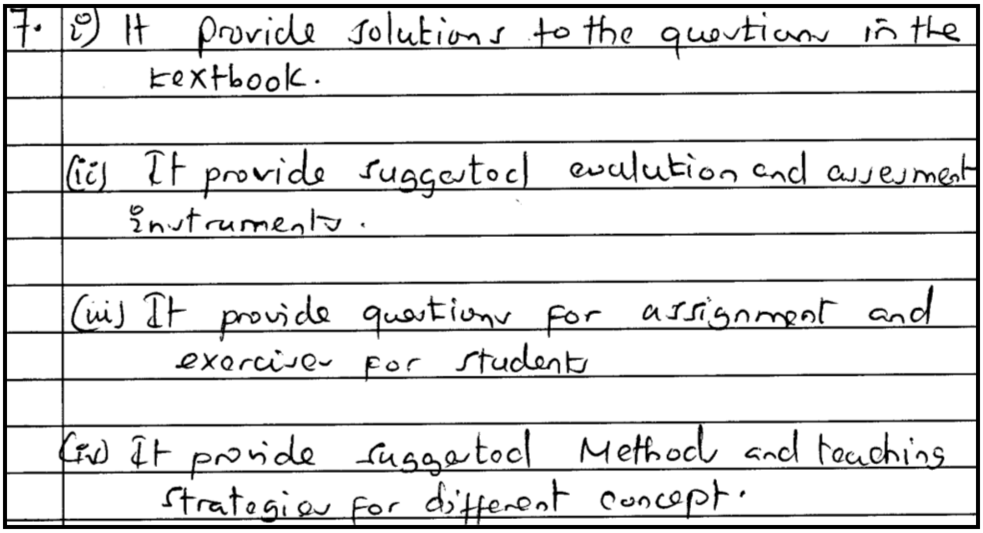


Figure 7: *Candidates' Performance on Question 7*

Figure 7 indicates that the candidates' scores were as follows: 93.2 per cent scored 3.0 to 4.0 marks; 3.1 per cent scored 2.0 to 2.5 marks and 3.7 per cent scored 0.0 to 1.5 marks.

The analysis of the candidates' responses shows that, those who scored high marks had adequate knowledge of physics curriculum materials. These candidates were able to provide the importance of teacher's guide book in teaching Physics subject as per demands of the question. Extract 7.1 illustrates a sample of such a good response.



7\. (i) It provide solutions to the question in the textbook.

(ii) It provide suggested evalution and assesment instruments.

(iii) It provide questions for assignment and exercises for students

(iv) It provide suggested Method and teaching strategies for different concept.

Extract 7.1: A sample of good response in Question 7.

On the other hand, the candidates who scored low marks proved to have insufficient knowledge about the subtopic Analysis of Teacher's Guides. These candidates failed to specify the importance of teacher's guide book in teaching physics. Further analysis on the responses reveals that they failed to think in details on the influence of teacher's guide book during teaching learning process. For instance, one of the candidates wrote "*helps to prepare scheme of work and lesson plan, helps to obtain objectives of subjects*" while the other candidate wrote "*it contain practical procedure to use when teaching, it shows the references that a teacher has to use.*" Their responses indicated that they mixed up the concepts of syllabus and scheme of work which are found from a topic of planning for teaching. This is an indication that they had not mastered properly the concepts pertaining to analysis of physics curriculum materials. Extract 7.2 is a sample of weak response from one of the candidates.

7 i	It help teacher to understand on how to prep aring practical of physics.
ii	It help to show the scientific procedure of pra ctical in physics subject
iii	It help to show how the diagram set up appa ratus in experiment of physics subject
iv	It help to simply teaching of practical to the student teacher in physics subject

Extract 7.2: A sample of incorrect response in Question 7.

In Extract 7.2; the candidate outlined the importance of practical manual instead of teacher's guide book in teaching physics.

2.1.8 Question 8: Physics Laboratory Management

This question required the candidates to give four measures to be considered in ensuring safety in a Physics laboratory.

The question was attempted by 382 (100%) candidates. The candidates' performance was good as 93.7 per cent scored 2.0 marks or above. Figure 8 illustrates the given information.

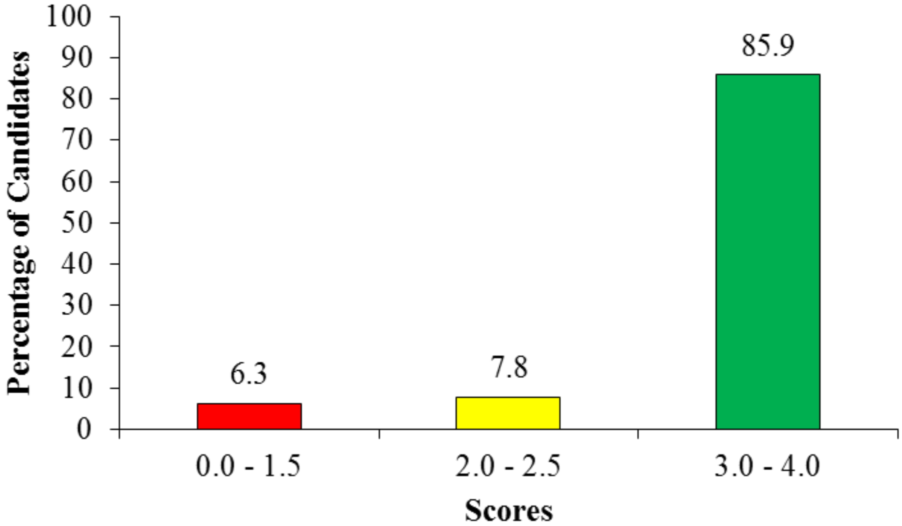
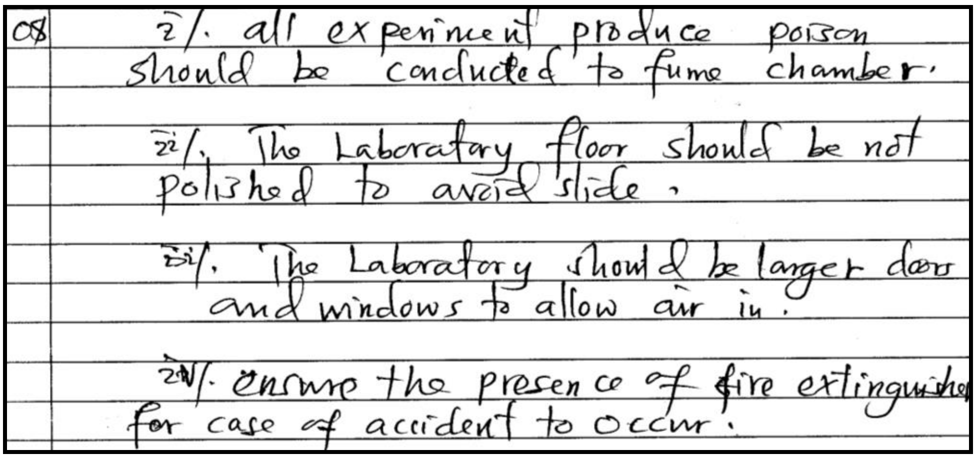


Figure 8: *Candidates' Performance on Question 8*

Figure 8 shows that among the candidates who attempted the question; 85.9 per cent scored 3.0 to 4.0 marks; 7.8 per cent scored 2.0 to 2.5 marks and 6.3 per cent scored 0.0 to 1.5 marks.

The candidates who scored high marks (3.0 – 4.0) had good knowledge about Physics Laboratory Management especially the concept of safety rules. These candidates provided proper measures in ensuring safety in a Physics laboratory. However, the candidates who had average performance provided two out of four correct measures and therefore scored marks ranging from 2.0 to 2.5. For example one of the candidates wrote incorrect measures as: "*shine and set"* and the other mentioned *"standard and sort*." Extract 8.1 is a sample of good responses from one of the candidates.


Q8 i/. all experiment produce poison should be conducted to fume chamber.

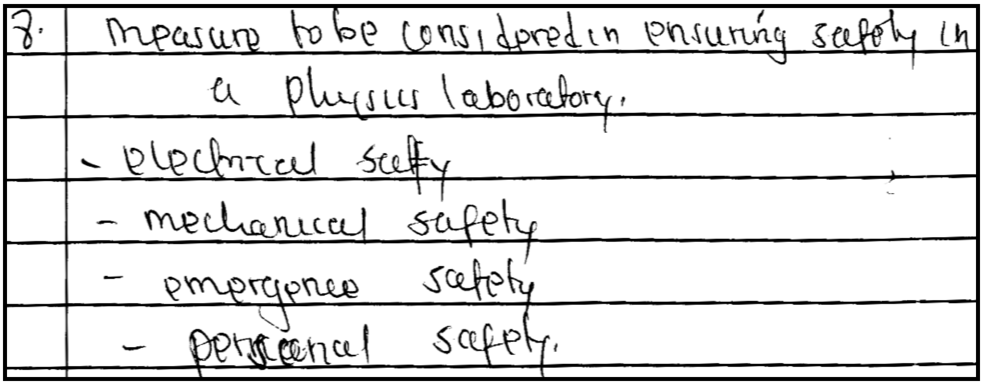
ii/. The Laboratory floor should be not polished to avoid slide.

iii/. The Laboratory should be larger door and windows to allow air in.

iv/. ensure the presence of fire extinguisher for case of accident to occur.

Extract 8.1: A sample of good responses in Question 8.

Although the general performance in this question was good, there were few (6.3%) candidates who wrote wrong answers. Their weak performance was due to inability to comprehend basic laboratory safety measures. Some of them confused between two concepts of laboratory rules with safety measures. For example, one of the candidates wrote *"don't eat or drink in the laboratory, following instruction given by a laboratory technician, don't enter the laboratory without permission, and don't touch anything in the laboratory without permission."* In addition, other candidates outlined the procedures of apparatus storage instead of safety measures. For example one of them wrote "*document all the apparatus after experiment."* Extract 8.2 represent an incorrect responses from one of the candidates.



8. Measure to be considered in ensuring safety in a physics laboratory.
- electrical safety
- mechanical safety
- emergence safety
- personal safety.

Extract 8.2: A sample of weak response in Question 8.

In Extract 8.2; the candidate wrote incorrect responses reflecting on concepts about sources of accident and precautions in Physics laboratory but not safety measures as the question demanded.

2.1.9 Question 9: Planning for Teaching

The candidates were required to argue using four points the statement, "before conducting any physics lesson a teacher must prepare a lesson plan".

A total of 382 candidates equivalent to 100 per cent attempted the question. The, overall performance was good as summarized in Figure 9.

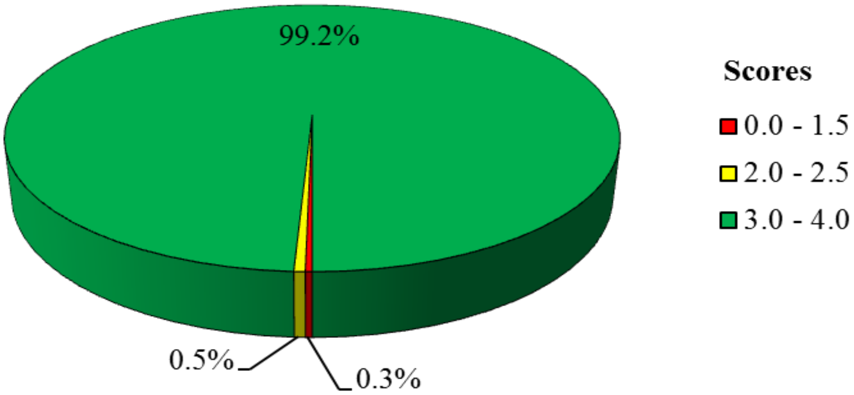
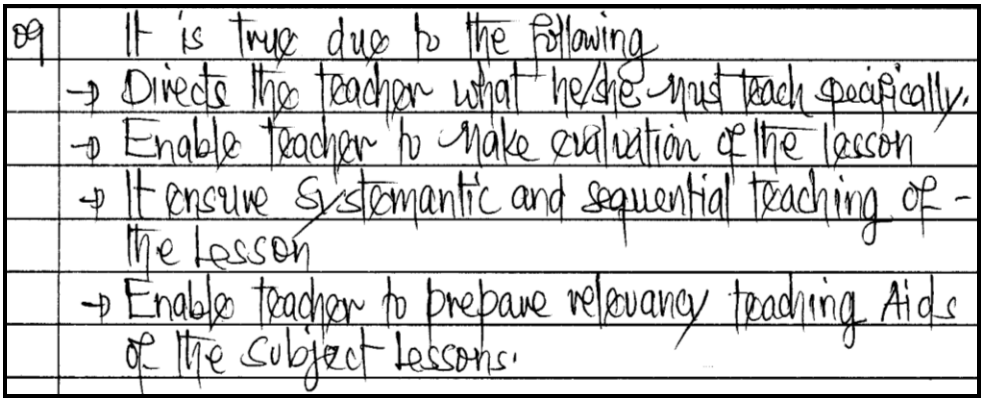


Figure 9: *Candidates' Performance on Question 9*

Figure 9 indicates that 379 (99.2%) candidates scored 3.0 to 4.0; 2 (0.5%) scored 2.0 to 2.5 and 1 (0.3%) candidate scored 0.0 marks.

The analysis of the candidates' responses shows that almost all (99.7%) candidates passed this question. These candidates argued properly that preparing lesson plan is vital for a physics teacher. They clarified correctly the importance for a physics teacher to prepare a lesson plan before teaching. Their responses clarified that they had sufficient knowledge about the topic of Planning for Teaching, particularly the concept of a lesson plan. Extract 9.1 displays a sample of good responses from one of the candidates.


09 It is true due to the following
→ Directs the teacher what he/she must teach specifically.
→ Enable teacher to make evaluation of the lesson
→ It ensure Systemantic and sequential teaching of - the Lesson
→ Enable teacher to prepare relevancy teaching Aids of the Subject lessons.

Extract 9.1: A sample of correct response in Question 9.

Despite the good performance in this question, only one candidate failed by scoring 0.0 mark. This indicates that he/she lacked knowledge about the concept of lesson plan.

2.1.10 Question 10: Fundamentals of Teaching and Learning Physics

The candidates were required to show the four basic rules under the principle "students learn better when they approach materials from simple ideas to complex" when teaching and learning physics.

The question was attempted by 382 candidates equivalent to 100 per cent. Generally the candidates' performance in this question was average since 45.5 per cent scored 2.0 marks and above. The data are summarised in Figure 10.

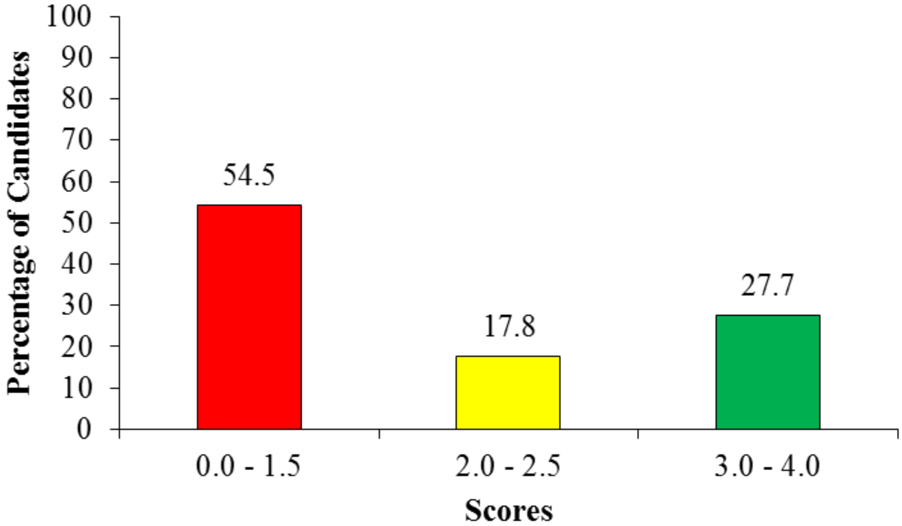
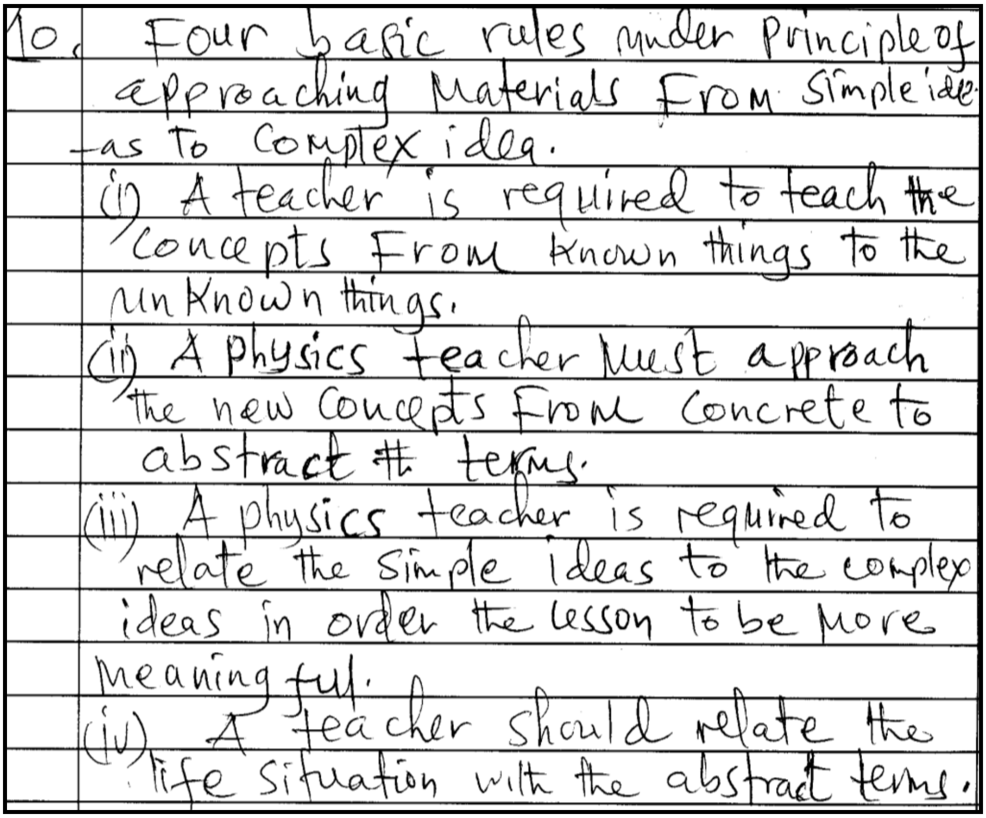


Figure 10: *Candidates' Performance on Question 10*

The data in Figure 10 indicates that 208 (54.5%) candidates scored 0.0 to 1.5 marks, 68 (17.8%) scored 2.0 to 2.5 marks and 106 (27.7%) scored 3.0 to 4.0 marks.

The candidates who scored high marks were able to explain correctly the basic four rules under the principle "Student learn better when they approach materials from simple ideas to complex". They knew that topics in physics syllabus and text books are arranged basing on the principle of "simple subject matter to complex". This implies that, these candidates had understood the Fundamentals of Teaching and Learning Physics. Extract 10.1 is a sample of correct responses from one of the candidates.



10. Four basic rules under Principle of approaching materials From Simple idea to Complex idea.
(i) A teacher is required to teach the concepts From known things to the unknown things.
(ii) A physics teacher must approach the new concepts From concrete to abstract ~~th~~ terms.
(iii) A physics teacher is required to relate the simple ideas to the complex ideas in order the lesson to be more meaningful.
(iv) A teacher should relate the life situation with the abstract terms.

Extract 10.1: A sample of good response in Question 10.

It was further noted that, the candidates who scored low marks (0.0 - 1.5) failed to identify and explain four rules pertaining the principles of teaching physics from simple to complex concepts. Most of them provided irrelevant responses which did not suit the demand of the question about principle of teaching simple ideas to complex ones. For example one of the candidates wrote four basic rules are: "*making revision of the previous period, use of teaching and learning aids and using of inductive teaching to deductive teaching*." Another candidate wrote: "*Emphasis the cooperative learning approach, practical work, create conducive environment in teaching.*" Their responses show that, they had misconceptions between the concepts related to stages in preparing a lesson plan and teaching strategies.

Moreover, the analysis indicates that some of these candidates provided explanation based on the topic of Planning for teaching. For example one of the candidates wrote: "*teacher should teach the relevant content as the age of learners, nature of subject matter should be considered and the level of the learners*." This signified that the candidates had inadequate knowledge of the topic of Fundamentals of Teaching and Learning Physics. Extract 10.2 illustrates incorrect responses from one of the candidates.

10 (i) Use discussion method

(ii) Use learner centred approach.

(iii) Employ the use of teaching aids in the process of teaching and learning.

(iv)

Extract 10.2: A sample of weak response in Question 10.

In Extract 10.2; the candidate provided responses based on the topic of Teaching and concept of improvisation instead of Fundamentals of teaching and learning Physics.

2.1.11 Question 11: Current electricity

This question had three parts: (a); (b) and (c). Part (a), required the candidates to explain why Ohm's law cannot be verified using a filament lamp. In part (b), they were required to explain why the electrical conductivity of electrolytes is less than that of metals. Part (c), required the candidates to find the time used to deposit 0.254 kg of copper on the cathode of copper voltammeter when a steady current of 100A is maintained.

A total of 298 candidates corresponding to 78.0 per cent attempted the question. Generally, the candidates' performance was weak as 75.5 per cent scored less than 6.0 marks. The performance is summarised in Figure 11.

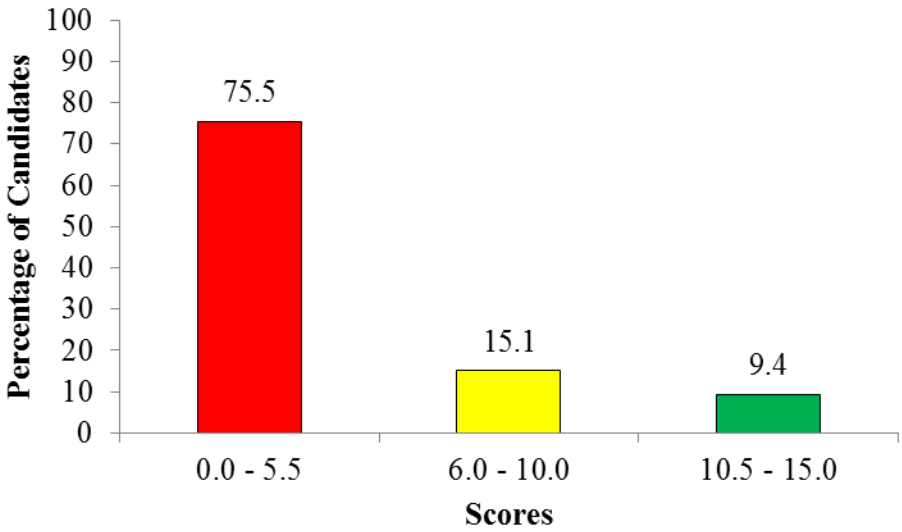


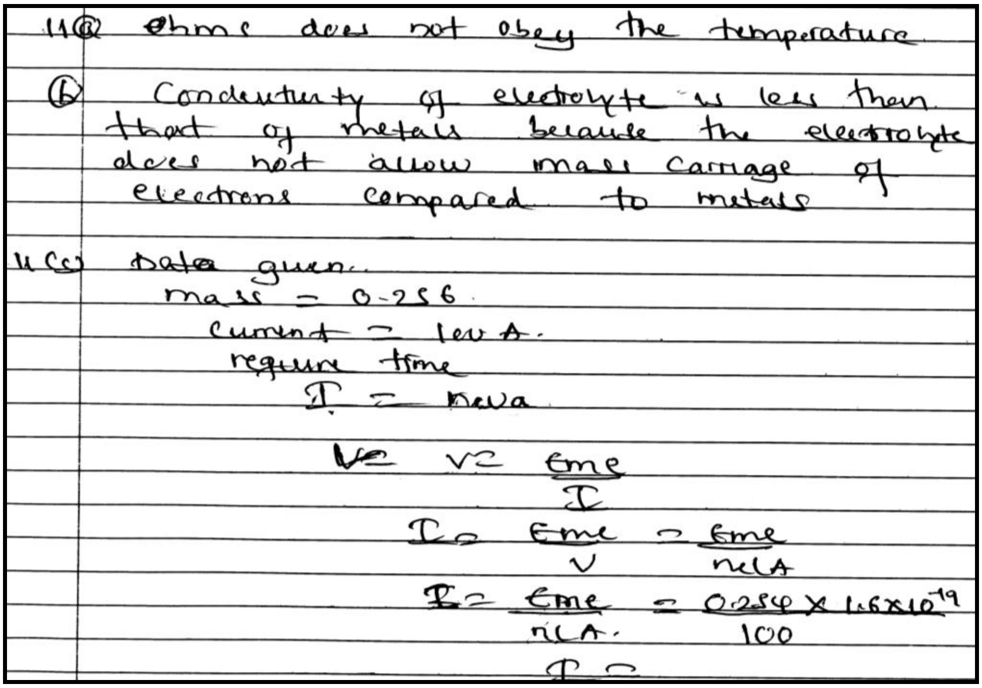
Figure 11: *Candidates' Performance on Question 11*

Figure 11 indicates that the scores of candidates are as follows: 75.5 per cent scored 0.0 to 5.5; 15.1 per cent scored 6.0 to 10.0 and 9.4 per cent scored 10.5 to 15.0 marks.

The candidates who scored low marks (0.0 - 5.5) were incompetent. They provided incorrect responses in most parts of this question. Some of them failed to describe why Ohm's law cannot be verified by using a filament lamp in part (a). For example, one candidate wrote that "*the reason is that filament lamp can burn directly the material which can make difficult in verifying*" and other candidates responded that "*the filament lamp is not a good conductor and it has higher heating effect."* Their responses show that they failed to understand that filament lamp conduct current electricity. Ohm's law is applicable when the temperature remains constant such that potential difference (V) and current (I) varies linearly. But in filament lamp, the current does not increase as fast as the potential difference because resistance varies as temperature changes making harder for electrons to pass easily. Hence variation of potential difference and current do not vary linearly in filament lamp.

Furthermore, some candidates lacked knowledge on relative mobility of electrons and ions. They failed to understand that electrical conductivity is a result of charged particles mobility in part (b). They could not understand the fact that in metals mobility is due to electrons and in electrolyte mobility is due to ions. They failed to recognize that free electrons in metal are fast moving than heavy ions in electrolyte. For example, one of candidates wrote that "*Most of electrolyte is semiconductors have less conductivity compared to the metals and Metals has high melting point which support conductivity to take place easily.*" Another candidate gave reason related to concept of melting of metal as: "*Metals has high melting point which support conductivity to take place easily.*"

Consequently, some of the candidates faced challenge on applying first Faraday's law of electrolysis to determine the mass of copper deposited in part (c). These candidates failed to manipulate equation ($m = ZIt$) to obtain time (t) which used by copper to deposit its 0.254 kg. They also failed to realize that the value of electro chemical equivalent (Z) could be calculated from equation $Z = \frac{m}{pF}$. In addition, improper mathematical computations and SI unit conversion led some of them to obtain wrong answers. Extract 11.1 represent one of an incorrect response.


11(a) Ohms does not obey the temperature

(b) Conductivity of electrolyte is less than that of metals because the electrolyte does not allow mass carriage of electrons compared to metals

11(c) Data given.
mass = 0.256
Current = 100 A.
require time
I = neva

V= v= Eme / I

I= Eme / V = Eme / neA

I= Eme / neA = 0.254 × 1.6×10^19 / 100

I =

Extract 11.1: A sample of incorrect response in Question 11.

In Extract 11.1; the candidate applied equation of drift velocity in metal to calculate time used by copper to deposit on cathode instead of electrolysis equation.

On the other hand, the candidates who scored good marks (10.5 – 15.0) mastered properly the properties of Ohmic and non-Ohmic conductors in relation to Ohm's law. They knew that variation of temperature affects verification of Ohm's law using filament lamp. Moreover, they had adequate knowledge of electrical conductivity behavior of free electrons in metals and ions in electrolytes. Most of them explained that ions have larger mass compared to that of electrons, therefore ions move slowly than the electrons as result the conductivity in metal is more than that in electrolyte. Further, they correctly applied the first Faraday's law of electrolysis equation and other required formula to determine time used to deposit 0.254 kg of copper on the cathode electrode. Extract 11.2 displays an example of good responses from one of the candidates.

11 (a) Ohm's law cannot be verified using filament lamp because the filament lamp produce light with dependence on temperature or heat energy generated by electricity, therefore the mode of action of filament lamp depend on the amount of heat produced to heat the filament, this makes difficult for ohm's law to be verified because ohm's law is valid when the temperature kept constant 'or remain constant'

(b) Electrical conductivity of electrolytes is less than that of metals because metals have a free moving electrons which conduct the electricity easily while electrolyte conduct electricity when therefore

[redacted]

$$t = \left(\frac{254 \times 193000}{6350}\right) \text{sec}$$

$$t = \frac{49{,}022{,}000}{6350} \text{ sec}$$

[redacted]

Extract 11.2: A sample of a good response in Question 11.

2.1.12 Question 12: Heat

In part (a), the candidates were required to estimate the steady temperature of the filament when the tungsten filament of an electric lamp has a length of 0.5 m and a diameter of 6×10^{-5} m and the power rating of the lamp is 60 W. Assuming that the radiation from the filament lamp is equivalent to 80% of a perfect black body radiator at the same temperature. In part (b), they were asked to determine the thickness of brick which conduct the same quantity of heat per second per unit area as 0.1 m of air given that a cavity wall is made of a 0.1 m thick bricks with an air space of 0.1 m thick between them. Assuming the thermal conductivity of brick is 20 times that of air.

The question was attempted by 180 (47.1%) candidates. The data analysis indicates that the question had weak performance as 146 (81.1%) candidates scored 0.0 to 5.5 marks. The data is summarised in Figure 12.

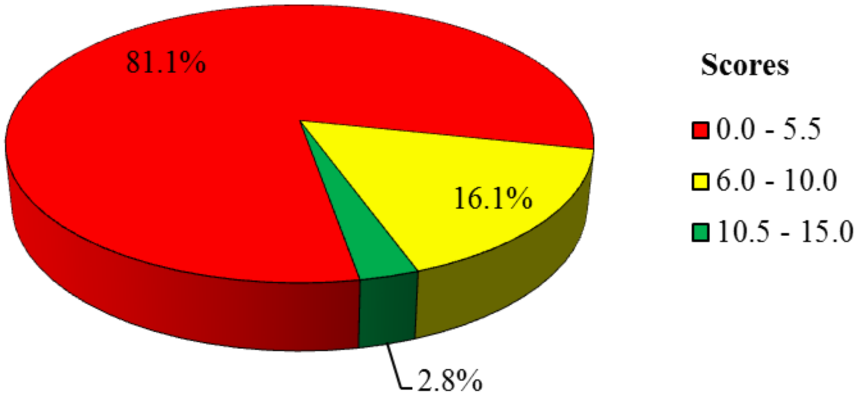


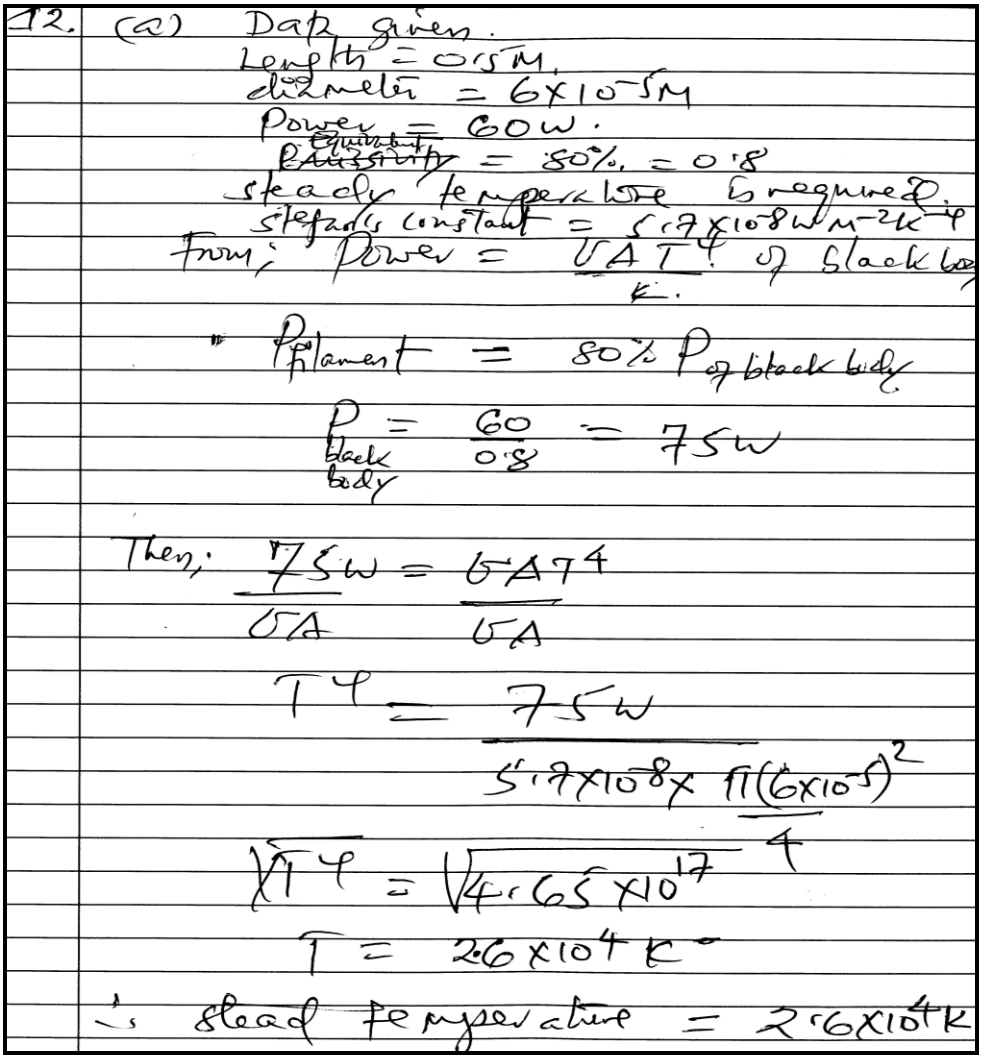
Figure 12: *Candidates' Performance on Question 12*

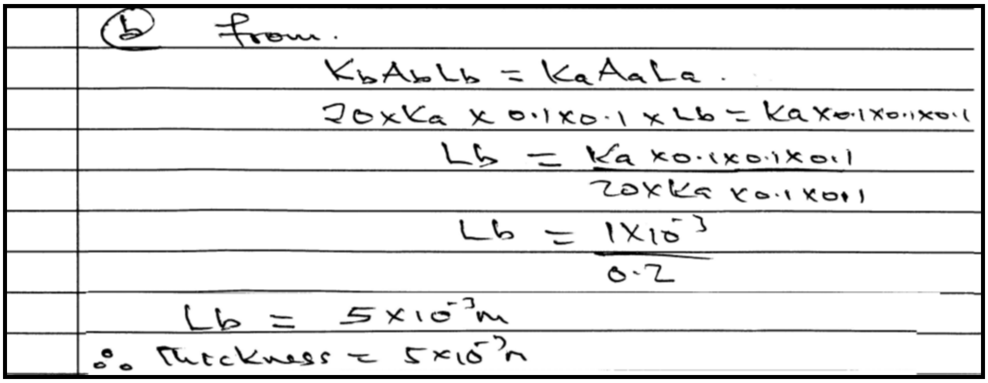
The data in Figure 12 shows that 29 (16.1%) candidates scored 6.0 to 10.0 marks and 5 (2.8%) scored 10.5 to 15.0 marks.

Analysis of candidate's responses shows that candidates with low scores had inadequate knowledge about the topic of heat, particularly the concepts of thermal radiation and conduction. For example, in part (a) some candidates thought that 60W was the total power of the black body. These candidates failed to understand that the given 80% was the emissivity of the perfect black body.

Further analysis reveals that the candidates lacked skills of applying the formula of power radiated from the filament ($EA\sigma T^4 = 60$ W) which could help them to obtain the formula to calculate the steady temperature of the filament T which is $T=\left(\frac{\text{Power received}}{EA\sigma}\right)^{\frac{1}{4}}$. In addition, they failed to recognize that $2\pi rh$ is formula to calculate surface area A of tungsten filament of an electric lamp (cylinder shape) which could finally be substituted into the formula of steady temperature of the filament; instead they used the formula $A=\frac{\pi d^2}{4}$ which is for surface area A of the circle.

Moreover, most candidates responded incorrectly in part (b) due to inability to comprehend that, the rate of thermal conductivity in brick is equal to the rate of thermal conductivity in air $\left(k_{Brick}A\frac{\theta_1-\theta_2}{l_B}=k_{Air}A\frac{\theta_1-\theta_2}{l_A}\frac{1}{2}\right)$. Also some of them wrote the thermal conductivity equation as $\frac{dQ}{dt}=kA\theta$ instead of $\frac{dQ}{dt}=\frac{kA\Delta\theta}{l}$. This led them to manipulate and obtained the incorrect value of thickness of brick. Extract 12.1 represents one of the incorrect responses in this question.


12. (a) Data given.
Length = 0.5M,
diameter = 6×10⁻⁵M
Power = 60W.
Equivalent emissivity = 80% = 0.8
steady temperature is required.
stefan's constant = 5.7×10⁻⁸ Wm⁻²K⁻⁴
From; Power = σAT⁴ of black body
P filament = 80% P of black body
P black body = 60/0.8 = 75W
Then; 75W/σA = σAT⁴/σA
T⁴ = 75W / (5.7×10⁻⁸ × π(6×10⁻⁵)²/4)
⁴√T⁴ = ⁴√(4.65×10¹⁷)
T = 2.6×10⁴ K
∴ steady temperature = 2.6×10⁴ K



(b) from.

$K_b A_b L_b = K_a A_a L_a$.

$20 \times K_a \times 0.1 \times 0.1 \times L_b = K_a \times 0.1 \times 0.1 \times 0.1$

$L_b = \frac{K_a \times 0.1 \times 0.1 \times 0.1}{20 \times K_a \times 0.1 \times 0.1}$

$L_b = \frac{1 \times 10^{-3}}{0.2}$

$L_b = 5 \times 10^{-3}$ m

∴ Thickness = 5×10^{-3} m

Extract 12.1: A sample of weak response in Question 12

In Extract 12.1; the candidate applied irrelevant formula to calculate thickness of brick.

Only 18.9 per cent of the candidates had good scores (6.0 marks and above). These candidates correctly applied the Stefan’s radiation equation to determine the temperature of the tungsten filament under the given emissivity. Also they succeeded to make correct mathematical interpretation and computation of the relation between thermal conductivity of a brick and air. Thus, they calculated the required thickness of a brick which conduct the same heat as 0.1m of air. Extract 12.2 illustrates good responses from one of the candidates.

12: Data given

a/ Length (L) = 0.5 m

diameter (d) = 6×10^{-5} m

Power (W) = 60 w

Emissivity = 80% = 0.8

Required = Temprature (T)

from

Stefance

$$\frac{E}{e\sigma A} = \frac{e\sigma A T^4}{\sigma e A}$$

$$T = \left(\frac{E}{e\sigma_A}\right)^{1/4}$$

$$T = \left(\frac{60}{0.8\times5.7\times10^{-8}\,Wm^{-2}K^{-4}\times A}\right)^{1/4}$$

T = But $A = \frac{2\pi dL}{2} + \frac{2\pi d^2}{4}$

Area of cylinde (wire) = $\pi dL + \frac{\pi d^2}{2}$

$A_1 = \pi\times d = 1.884\times10^{-4}$

$A_2 = \frac{\pi d^2}{2} = 5.652\times10^{-9}$

$A_1 + A_2 = 9.42\times10^{-4}$

Then

$$T = \left(\frac{60}{0.8\times5.7\times10^{-8}\times1.884\times10^{-4}}\right)^{1/4}$$

T = 1933.2 K

∴ temprature of fillament 1933.2 K

12b) Thickness of brick $(X_1) = 0.1m$

Air space of $(x_2) = 0.1$ m

Given

$K_{brick} = 20 K_{air}$

from

$$\frac{dQ}{dt} = KA\left(\frac{d\theta}{dx}\right)$$

Let $\left(\frac{dQ}{dt}\right)_I$ for air $\left(\frac{d\theta}{dt}\right)_{II}$ = brick

for brick

$$\left(\frac{dQ}{dt}\right)_I = K_bA\left(\frac{\theta}{X_1}\right) \quad \text{and} \quad \left(\frac{dQ}{dt}\right)_{II} = K_{air}\left(\frac{\theta}{x_2}\right)$$

$$\left(\frac{dQ}{dt}\right)_I = \left(\frac{dQ}{dt}\right)_{II} \quad \text{(Given)}$$

$$K_b\frac{(\theta-\theta_0)}{X_1} = K_{air}\frac{(\theta-\theta_0)}{x_2}$$

Require thickness of brick (x_1)

Make subject (x_1)

$$X_1 = \frac{K_b X_2 A(\theta-\theta_0)}{K_{air}(A)(\theta-\theta_0)}$$

$$X_1 = \frac{K_{brick}}{K_{air}}(X_2) \quad \text{but } K_b = 20K_{air}$$

$$X_1 = \frac{20 K_{air}}{K_{air}} X_2$$

$X_1 = 20X_2 = 20 \times 0.1 m$

$X_1 = 2m$

∴ Thickness of brick required is **2m**

Extract 12.2: A sample of a correct response in Question 12.

2.1.13 Question 13: Electronics

This question had three parts: (a); (b) and (c). In part (a), the candidates were asked to explain the basic condition for proper functioning of transistor as an amplifier. In part (b), they were required to use the circuit shown in Figure 1 to calculate the load resistor R_L, base current I_B and the base resistor R_B, given $\beta = 100$.

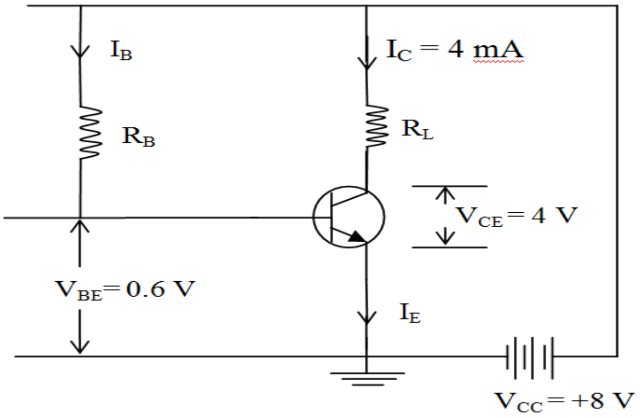


Figure 1

Part (c) required the candidates to derive a truth table for the circuit shown in Figure 2.

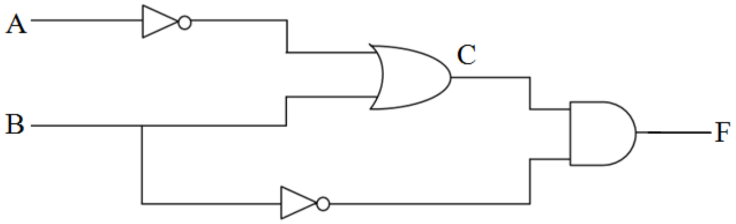


Figure 2

A total of 263 candidates corresponding to 68.8 per cent attempted the question. The candidates' performance was average as illustrated in Figure 13.

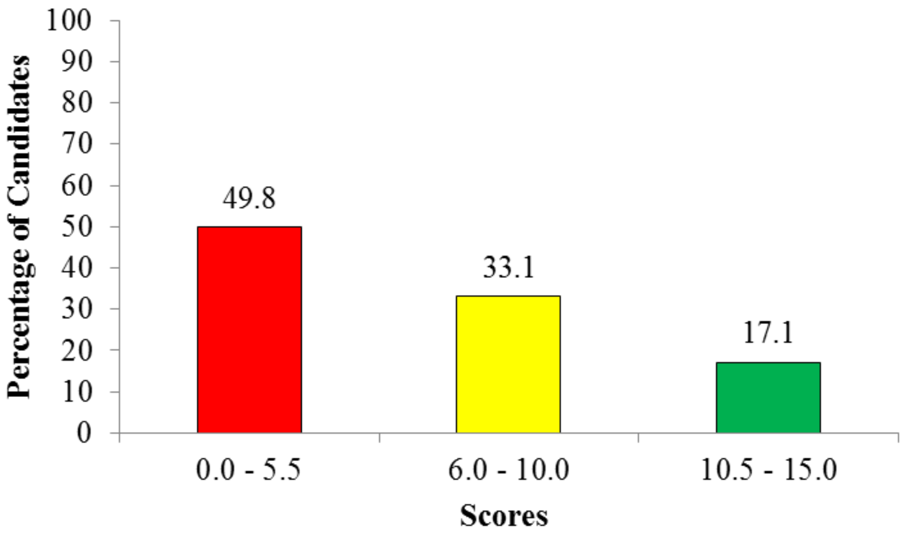


Figure 13: *Candidates' Performance on Question 13*

Figure 13 shows that 131 (49.8%) candidates scored low marks (0.0 to 5.5); 132 (50.2%) candidates scored 6.0 to 15.0 marks, among them 45 (17.1%) scored 10.5 to 15.0 marks and 87 (33.1%) scored 6.0 to 10.0 marks.

The candidates who scored high marks in this question were able to calculate values of load resistor R_L, base current I_B and the base resistor R_B. They wrote appropriate description, formula and mathematical substitution to support their responses. This justified their richness in the concepts of transistor as they studied and analysed the given figure to obtain the correct responses. In part (c), the candidates proved to have mastered properly the concept pertaining logic gate, since they derived correctly the truth table for a given circuit. Extract 13.1 is a sample of good responses.

13 (b) $I_B = I_C/\beta$

$= \frac{4\mu A}{100}$

$= 0.04\mu A$

$= 4\times10^{-5} A$

∴ Base current (I_B) is 4×10^{-5} A

⇒ Required Base resistor (R_B)

from

$I_BR_B + V_{BE} + I_ER_E = V_{CC}$

But $R_E = 0$

~~$I_BR_b + V_{BE} = V_{CC}$~~

$\frac{I_BR_B}{I_B} = \frac{V_{CC} - V_{BE}}{I_B}$

$R_B = \frac{8 - 0.6}{4\times10^{-5}}$

$= 185,000\ \Omega$

∴ The base resistor (R_B) is 185000 Ω

(c) from the diagram

~~F = C+~~

$F = C \cdot \bar{B}$

but $C = \bar{A} + B$

$F = (\bar{A} + B)\bar{B}$

$F = (\bar{A} + B)\bar{B}$

∴ The equation is $F = (\bar{A} + B)\bar{B}$

13 (c) The truth table from the diagram

In puts Signs		Out put			
A	B	$\bar{A}$	$\bar{B}$	C	F
0	0	1	1	1	1
0	1	1	0	1	0
1	0	0	1	0	0
1	1	0	0	1	0

Extract 13.1: A sample of good responses in Question 13.

However, the candidates who scored low marks did not understand that for a transistor to function as an amplifier either the base-emitter junction should always be forward biased and a collector-emitter junction reversed biased or the emitter collector voltage V_{CE} should half the supply voltage V_{CC}. These candidates described wrongly the concept asked. For example, in part (a), one of the candidates responded that "*large current gain is the property functioning of transistor as an amplifier.*" other candidates responded as "*should have input and output signals and its connection of common emitter transistor.*" This indicates that he/she had inadequate knowledge about transistor especially in the area of current gain β; collector current I_C; emitter current and on the application of the equation $\beta = \frac{I_C}{I_B}$.

In part (b), some candidates failed to use the Kirchhoff's laws to analyse current flows in the given circuit diagram. Consequently, they failed to calculate the load resistor and base resistor from the equations $V_{CC} - I_C R_L - V_{CE} = 0$ and $V_{CC} - I_B R_B - V_{BE} = 0$ respectively. Moreover, some of them failed to derive the truth table for the given circuit which signifies their incompetence in the concept of a logic gate. Extract 13.2 is illustrative.

13 (a) (i) transistor should have ~~Low~~ high voltage gain to perform as amplifier
(ii) Should have high Current gain
(iii) There is no heating effect in the transistor
(iv) Transistor operate at low voltage and Current gain

(c). Truth table.
$n = 3$.
$2^n = 2^3 = 8$.

A	B	C	$\bar{A}$	$\bar{B}$	$C = \bar{A} + B$	$F = C \cdot \bar{B}$
0	0	0	1	1	1	1
0	0	1	1	1	1	1
0	1	0	1	0	1	0
0	1	1	1	0	1	0
1	0	0	0	1	0	0
1	0	1	0	1	0	0
1	1	0	0	0	1	0
1	1	1	0	0	1	0

(b). $V_{cc} + R_L I_c + I_E + V_{CE}$.
But $I_E = \beta I_c$.
$V_{cc} + R_L I_c + \beta I_c + V_{CE}$.
$8 + 4 R_L + 100 \times 4 + 4 = 0$.

Extract 13.2: A sample of a weak response in Question 13.

In Extract 13.2; the candidate wrote incorrect number of inputs of a given logic gate circuit diagram. He/she derived incorrect truth table of 6 inputs and 6 outputs instead of 4 inputs and 4 outputs signals.

2.1.14 Question 14: Planning for Teaching

In part (a), the candidates were asked to differentiate between general instructional objectives and specific instructional objectives as used in a lesson plan. In part (b), candidates were required to explain by giving three reasons, why the "instructional objectives" and "reinforcement stage of a lesson plan" are important in teaching Physics.

This question was attempted by 289 (75.7%) candidates. The general performance was good as 281 (97.2%) candidates scored 6.0 marks and above. The data are summarised in Figure 14.

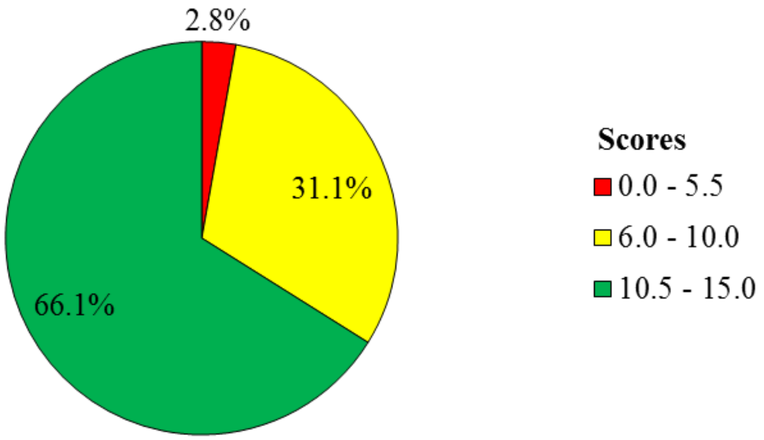


Figure 14: *Candidates' Performance on Question 14*

The data in Figure 14 indicates that 66.1 per cent scored between 10.5 to 15.0 marks, 31.1 per cent scored 6.0 to 10.0 marks and 2.8 per cent scored 0.0 to 5.5 marks.

The candidates with good performance provided appropriate explanation on the differences between general and specific instructional objectives when responding in part (a) of the question. Some of them supported their explanation by giving different examples of general and specific objectives and their uses in preparation of a lesson plan.

Similarly, in part (b), most of the candidates were systematic and precise on explaining the importance of instructional objectives and reinforcement stage of a lesson plan. This was an indication that these candidates were familiar with the concept of preparation of a lesson plan in teaching Physics. Extract 14.1 represents one of the correct responses in this question.

14. (a)(i) General instructional objectives refers
to the general statement exhibited
by the learner at the end of the
topic while
Specific instructional objectives refers
to the behaviour to be exhibited
by the learner at the end of the
period.

(ii) General instructional object doesnot
change at the whole topic while
Specific instructional objectives changes
at every period.

(iii) General instructional objectives does
not measured ~~[illegible]~~ it generalizes the
topic while
Specific instructional objectives measure the outcom

14 (a)(iii) of the learner by using SMART, Specific, Measurable, Attainable, Realistic and Time bound.

(iv) In general instructional objectives the evaluation is done when the whole topic was taught while In Specific instructional objectives the evaluation is done at every period.

(b) Instructional objectives and reinforcement stage are important in teaching physics of the following.
Starting with instructional objectives it is important because.
It measure the cognitive ability to exhibited by the learner to what the teacher taught the learner. The instructional objectives helps the teacher to measure the cognitive ability of the learner.
It is used to evaluate students learning, the ~~speci~~ instructional object measures and evaluate the learning outcome. of the learner at the end of the topic or a period.
It generalize the behaviour to be exhibited by the learner at the end of the period or at the end of the topic and make decision about the teachings process.

14 (b) Reinforcement stage of a lesson plan is important because

It arouse the interest of the learner, the reinforcement arouse the learner to be interested to what the teacher is teaching and makes him(her) understand well the topic (Lesson).

It makes students to be active during the teaching and learning process because the teacher will ask questions to the learner according to what he(she) is teaching the learner.

It clear the misconception of the learner by adding new knowledge to the existing knowledge or adjusting new knowledge to the learner. The reinforcement stage reinforces the knowledge to the learner by asking question from the teacher and the learner answer what the teacher asked the students (learners).

Instructional objectives and reinforcement stage of a lesson plan is important because it measures the cognitive ability of the learner and simplifies the teaching and learning process to take place also increasing the performance of the students.

Extract 14.1: A sample of a good response in Question 14.

In contrast, few (2.8%) candidates had weak performance in this question. It was noted that, most of these candidates attempted correctly only part (a) of the question which had 3.0 marks and skipped part (b) which had 12.0 marks. Those who attempted part (b) provided one or two correct and missed the other points. For example, one candidate wrote: "*instructional objectives cannot use teaching aid while use teaching aid*;" and another candidate wrote: "*instruction objectives helps to know the establishment of goal of lesson to perform during a lesson while reinforcement help to cover the whole topics.*" This indicated lack of knowledge in the topic of Planning for teaching especially the concepts of preparation of lesson plan. Extract 14.2 shows one of the incorrect responses to the question.

14 (b) i. Reinforment help. to provide ~~exercise~~ questions ~~concern~~ about a lesson so as to improve understanding of learners

ii. Reinforcement stage help to make group discussion to a students so as to share their ideas about a lesson

(a) i. General instructional objective this involve a behaviours that will taught in a certain the whole topic WHILE specific objectives this involve the behaviours that will be taught in a specific sub-topic

Extract 14.2: A sample of incorrect responses in Question 14.

In Extract 14.2; the candidate wrongly attempted part (a) and missed the other part of the question.

2.1.15 Question 15: Assessment in Physics

In part (a), the candidates were required to five give advantages of using multiple choice items in Physics test. In part (b), they were asked to study a table of specification and to answer the questions that follow:

Contents	Learning Instructional Objectives					
	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Forces in equilibrium	1	1	1	-	1	1
Simple machines	-	1	2	2	-	2
Motion in a straight line	1	1	1	-	1	-
Temperature	2	1	1	2	-	1
Sustainable energy sources	1	1	1	-	-	-

(i) Which learning objectives were given equal emphasis in the test

(ii) Which content were least emphasized in the test

(iii) How many test items were set on Forces in equilibrium and Temperature?

(iv) How many test items were set for the summative test?

(v) What percentage of the test items was devoted to simple machines?

(vi) What percentage of the test items was devoted to analyzing?

(vii) Explain three criteria that have been considered to determine the relative weight of each learning objective and area content.

A total of 342 candidates corresponding to 89.5 per cent attempted this question. The overall performance of the candidates was good as 90.4 per cent passed the question by scoring 6.0 to 15.0 marks. The performance is summarised in Figure 15.

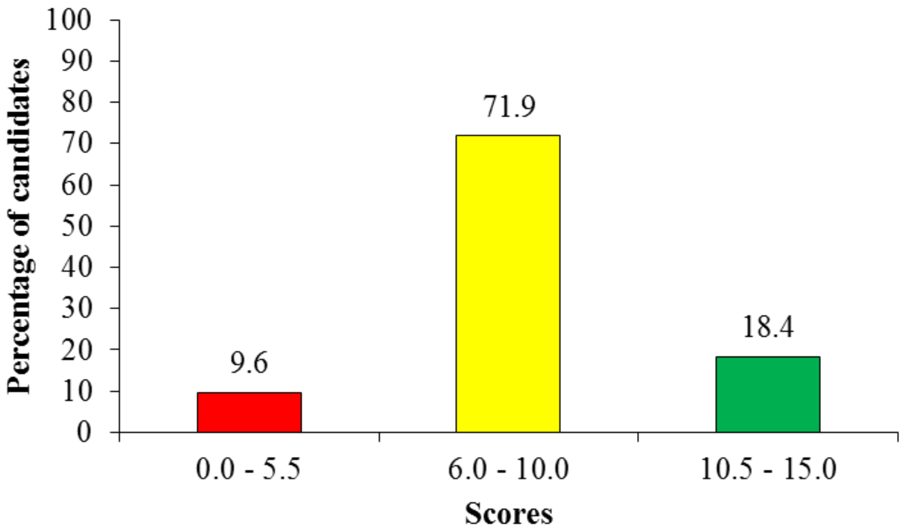


Figure 15: *Candidates' Performance on Question 15*

The analysis of data in Figure 15 indicates that 18.4 per cent of candidates scored 10.5 to 15.5 marks, 72.0 per cent scored 6.0 to 10.0 marks and the rest 9.6 per cent scored 0.0 to 5.5 marks.

The candidates with average performance correctly provided three to four advantages of multiple choice items. Some of them gave correct responses to some questions in part (b) which required simple mathematical computation. However, some candidates mixed few incorrect points in their explanations concerning the criteria used to determine the relative weight of each learning objectives and the area content in part (b) (vii). For example one of the candidates explained some of the criteria as: "*application of the topic in daily life and availability of material for teaching and learning content.*"

Besides, the candidates who scored good marks explained properly the advantages of using multiple choice items in a Physics test. They highlighted that a multiple choice item covers large learning instructional objectives. The candidates also responded correctly to the questions related to a table of specification in part (b). They correctly applied mathematical manipulation to calculate the number of test items of each content and their respective percentage. Extract 15.1 is a sample of good responses to this question.

15. (a) Multiple choice items are objective test items prepared in a table containing premises and question of two sides.

The following are the advantages of using multiple choice items in a physics test.

They cover a large domain of learning task in which the students are measured by short time with many areas of contents covered.

They are easy to score and mark because they contain the same answers for every question or item, does not need more explainations.

They are cost-effective because large content areas are presented on a small piece of paper and the material pen is used in small quantity.

They reduce the chance of guessing, students are owed to be competente so as they can answer properly not by guessing ~~bebe~~ because they can guess the answers and fails because the items are many with many answers to choose

They increase students desire to deep learning because they cover large area of content so students could want to answer correctly as a result they learn intensively for preparation.

To sum up, the multiple choice items are difficult to prepare, they should be prepared with care to avoid confusion of items

15. (b) From the table of specification.

(i) The Learning objectives given equal emphasis were

- Remembering and understanding which Contain 5 items each.

- Analyzing and Creating which Contain 4 items each.

(ii) The Content which was Least emphasized in the test ~~was~~ is Sustainable energy Sources which contain 3 items.

(iii) Items which were set in
- Equilibrium were 5 items
- Temperature were 7 items

(iv) The ~~test~~ items which were set ~~for~~ Summative test were 26 items

(v) Required percentage of test items ~~in~~ devoted to Simple machine

~~fran~~

$$\text{Simple machine } \% = \frac{\text{Items number}}{\text{Total number}} \times 100\%$$

$$= \frac{7}{26} \times 100\%$$

$$= 26.92\%$$

∴ The percentage required is 26.92%

15(b)(vi) Required the percentage of the test items Which was devoted to Analyzing
from
Analyzing % = $\frac{\text{number of items}}{\text{Total items}} \times 100\%$

$= \frac{4}{26} \times 100\%$

$= 15.39\%$.

∴ The percentage required is 15.39%.

(vii) The following are criteria that have been used or considered to determine the relative weight of each learning objectives and area content.

- Cognitive level of the learners if they are able to perform the item test or not.

- Number of periods, the number of items is proportional to the periods or lesons. The large number of periods used to learn determine the large the content area.

- Time, is considered when preparing of table of specification because the short time will have small number of item while the large will have many items

Extract 15.1: A sample of correct response in Question 15.

Further analysis shows that, the candidates who scored low marks (0.0 – 5.5) exhibited the following weaknesses: Some candidates provided few correct points without explanations or they mixed correct and incorrect points in their responses. For example, one of the candidates stated that the advantages of multiple choice items as "*increases students memory, thinking accuracy speed, expectable marks.*" A similar phenomenon was provided by a candidate who argued that multiple choice items "*help to measure what is teacher taught and promote learners to choose a right answer.*" These responses were irrelevant to the requirement of the question in part (a).

Another case of misconception was observed when some of the candidates explained criteria to determine the relative weight of each learning objectives and area content as "*simplest to complex one, amount of knowledge, relevant to real life situation*." This was contrary to the fact that determination of relative weight of each learning objectives and area contents is based on content coverage, time spent on delivery, number of items and a level of cognitive abilities. Moreover, some candidates failed to calculate the number of test items and their corresponding percentages of either contents or learning instructional objective. Extract 15.2 is a sample of a weak response from one of the candidates.

15 (a) Therefore multiple choice item in physics test is simplest test done a shortly time and it is emmedeatly result to the student and help them to learn more effective

(b)

Conten	Learning instructional objective								
	Remembering	Understanding	applying	Analyzing	Evaluating	creating	Number of items	Parcentage	Total
Force in equilibrium	1	1	1		1	1	5	19.2%	
Simple machine		1	2	2		2	7	26.9%	
Motion in straight line	1	1	1		1		4	15.4%	
Motion Temperature	2	1	1	2		1	7	26.9%	
Sustainable energy soure	1	1	1				3	11.5%	
Nomber of item	5	5	6	4	2	4	26	100%	
Parcentage	19.2%	19.2%	23.1%	15.4%	7.7%	15.4%			

Extract 15.1: A sample of incorrect response in Question 15.

In Extract 15.1; the candidate filled in the number of items and their corresponding percentages in a given table of specification instead of answering the tested concepts in part (b) (i) – (vii).

2.1.16 Question 16: Teaching

In this question the candidates as prospective physics teachers were required to show six steps to be followed when teaching the topic of "global warming" using cooperative and participatory methods to Form Four students.

A total of 133 candidates equivalent to 34.8 per cent, attempted the question. The general performance of the candidates was good as summurised in Figure 16.

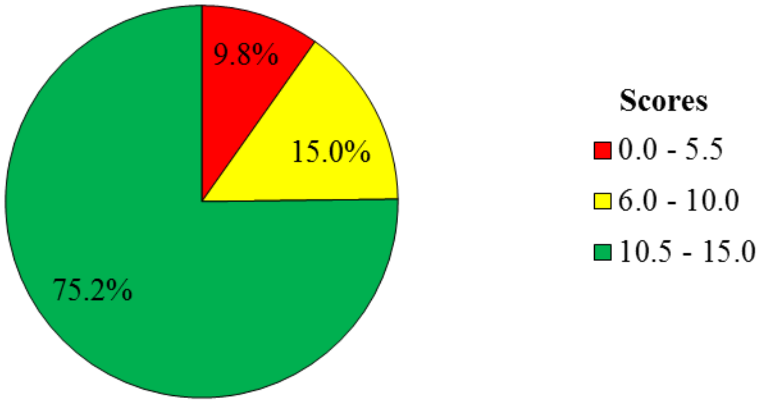


Figure 16: *Candidates' Performance on Question 16*

Figure 16 indicates that 75.2 per cent of the candidates scored 10.5 to 15.0 marks, 15.0 per cent scored 6.0 to 10.0 marks and 9.8 per cent scored 0.0 to 5.5 marks.

The analysis of the candidates' responses shows that 90.2 per cent of the candidates passed the question. Among them, 75.2 per cent had good performance and 15.0 had average performance. Those with average scores introduced the activities that reflected learner's participation in some steps of teaching but failed to show how the activities should be executed. Further analysis reveals that the candidates with good scores were able to describe correctly the six steps to follow when teaching the concept "global warming" by cooperative and participatory methods. They properly explained teachers and learners activities as well as assessment procedures in each steps. Extract 16.1 illustrates a sample of such a good response.

> 16. Physics - is the branch of science which deals with the study of matter in re lation to energy. Cooperative and participatory method means both teacher and learner Interact in the teaching and learning pro cess. The following are the steps to be followed by a teacher when teaching the topic of "global warming" using Cooperative and participa tory method which are.
>
> Prepare a ~~number~~ the of questions about the topic, a teacher should prepare first ~~the~~ question concerned with the topic this is the first steps to be done with the teacher so as to teach the global warming using Cooperative and parti cipatory method.
>
> Prepare the groups within the class, also a teacher after preparing the questions he/she suppose to prepare the gro upse in the class and in each group selec t a chair and ~~sec~~ secretary
>
> Provide those question to the grou p prepared, the teacher after getting the group in the class should give the questions to the groups during the teaching process

16. Allow the group to discuss those question, a teacher should of allowed the learner to discuss the question that provided with him/her so as to make interactive and during discuss the teacher should pass to each group to ensure are they discussing.

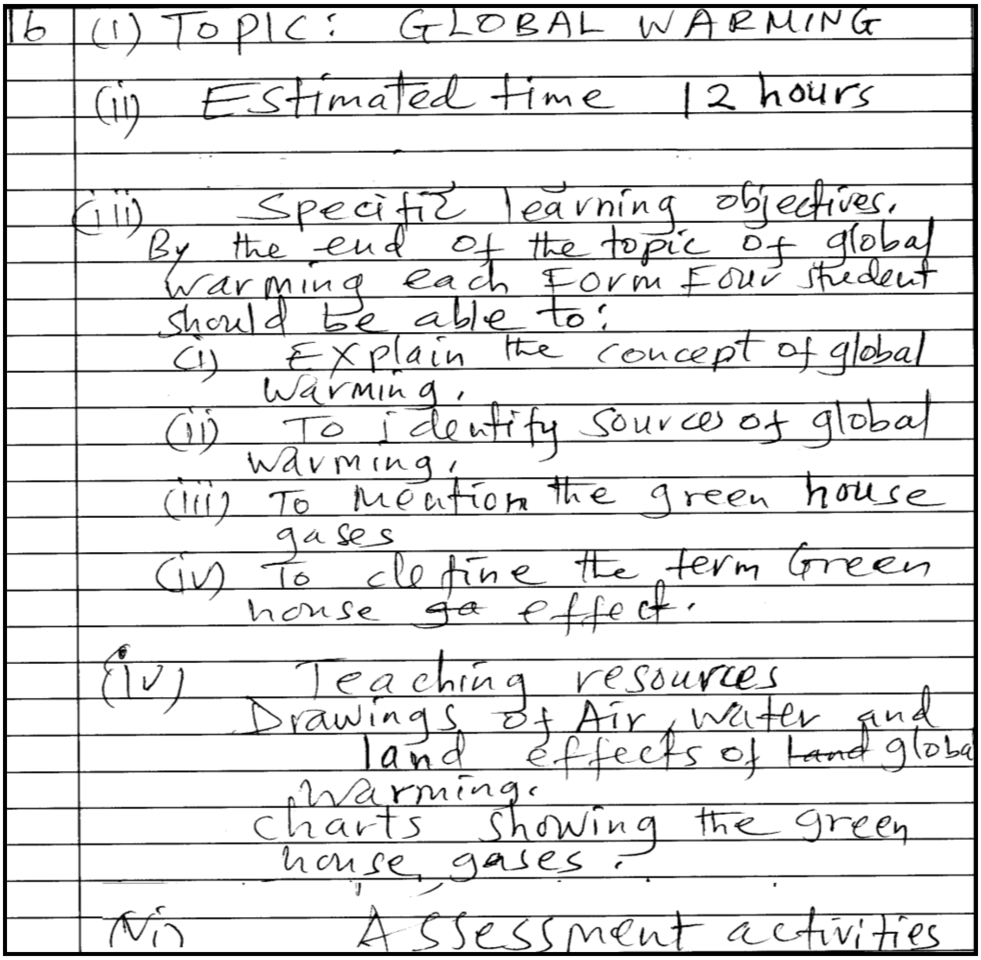
Select one ~~mber~~ member from each group for presentation what have been discussed in their groups and the teacher must allow other groups to ask the question ~~to~~ the representer if the representer fail to answer the group membe should be support him/her.

Teacher should make summary and conclusion on the topic discussed, also after all presentation the teacher should make conclusion and summary and to answer the question asked with the learner about the topic concerned which is global warming.

Generally, through the steps explain above a teacher can teach a topic of ~~globalz~~ global warming by using the cooperative and participatory method by doing the activities which make both learner and teacher interactive during the period.

Extract 16.1: A sample of correct response in Question 16.

Despite the good performance by the majority (90.2%) of the candidates, further analysis revealed that, few (9.8%) candidates faced difficulties in analysing the procedures to be followed as demanded in the question. Some candidates approached the question from the lesson plan point of view. For example, one the candidates wrote "*to preview a previous period to build correlation of the contents and to brainstorm the students about global warming."* Some candidates wrote either a lesson plan for the topic of global warming or an essay on global warming. They failed to write numerous classroom based activities that could be carried out by the teacher to enhance participation of learners when teaching the topic of global warming. Other candidates' responses reflected on the general issues of global warming. For example, one of them wrote: *meaning of global warming, causes of global warming, ways of preventing and advantages of global warming*. Their responses did not reflect participatory approach to the topic as shown in Extract 16.2.


16 (i) TOPIC: GLOBAL WARMING

(ii) Estimated time 12 hours

(iii) Specific learning objectives.
By the end of the topic of global warming each Form Four student should be able to:
(i) Explain the concept of global warming.
(ii) To identify sources of global warming.
(iii) To mention the green house gases
(iv) To define the term Green house ~~ga~~ effect.

(iv) Teaching resources
Drawings of Air, water and land effects of ~~Land~~ globa warming.
Charts showing the green house gases.

(vi) Assessment activities

(i) ~~To~~ define the term global warming

(ii) Mention five green ~~hou~~ houses you know,

Extract 16.2: A sample of incorrect response in Question 16.

In Extract 16.2; the candidate outlined the specific objectives and assessment activities of a topic global warming instead of showing six steps of teaching the particular topic by cooperative and participatory methods.

2.2 731/2A Physics 2A (Actual Practical)

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

2.2.1 Question 1: Mechanics

In this question the candidates were required to determine the acceleration due to gravity. They were provided instructions as follows:

(a) Tie a piece of thread to a pendulum bob.

(b) Fix the free end of the thread between the cork pads with the help of a retort stand clamps as shown in Figure 1.

(c) Ensure that the length of the thread from the fixed point to the bob is exactly 20 cm.

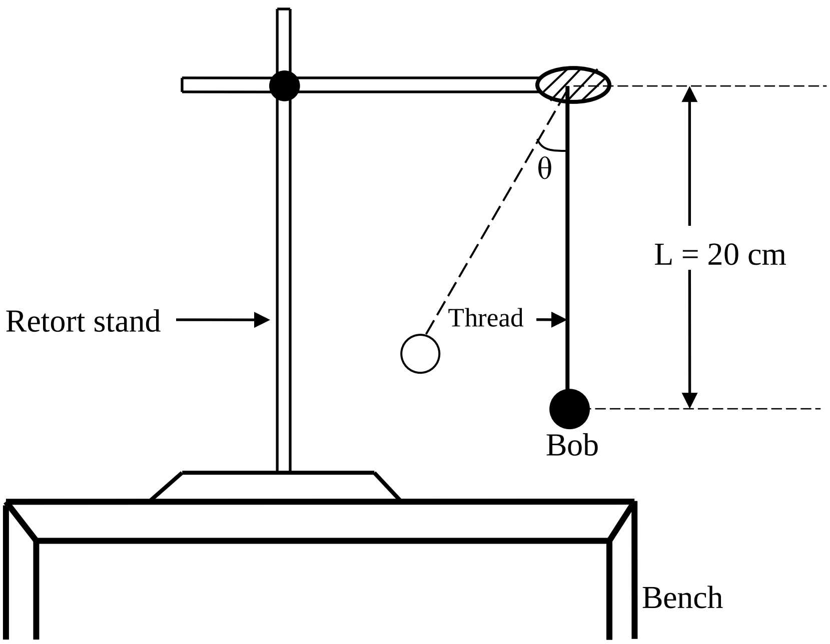


Figure 1

(d) Pull the bob aside at small angle θ and then release it such that the bob oscillates.

(e) Record the number of oscillations (n) after 5 seconds.

(f) Repeat procedure (d) and (e) for time t = 10 sec, 15 sec, 20 sec, 25 sec and 30 sec.

Questions

(i) Tabulate the results obtained in 1e and 1f including the columns for log (t) and log (n).

(ii) Plot the graph of log(t) against log(n).

(iii) Deduce the relation used to plot a graph in (ii), if $t^2 = kn^2$.

(iv) Determine the value of y-intercept from the graph.

(v) Find the value of quantity 'a' from the equation: $a = -218\,ms^{-3} \times b$, where b is y-intercept.

(vi) Give the physical meaning of quantity 'a' found in 1(v)?

(vii) State any three sources of error.

A total of 382 candidates corresponding to 100 per cent attempted this question. Generally, the candidates' performance was good as shown in Figure 1.

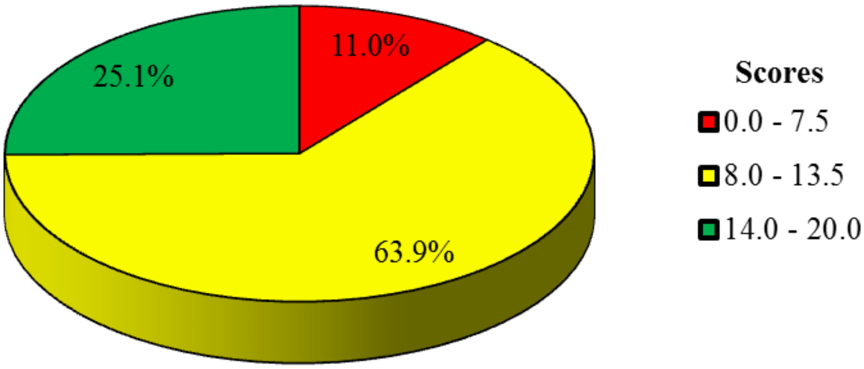


Figure 1: *Candidates' Performance on Question 1*

Figure 1 shows the candidates' scores were as follows: 96 (25.1%) candidates scored 14.0 to 20.0 marks; 219 (63.9%) scored 8.0 to 13.5 marks and 42 (11.0%) candidates scored 0.0 to 7.5 marks.

The analysis of candidate's performance shows that the candidates with average scores provided incorrect responses in some parts of the question. Some of these candidates collected data, tabulate the results and plotted the graph correctly but failed to draw the best line of a graph. Others chose incorrect scale which was difficult to determine accurately points plotted on a graph. In addition, some candidates calculated correctly the quantity 'a' but they wrote wrong units. Some of these candidates stated correctly one or two sources of errors of the particular experiment.

Furthermore, the candidates who scored high marks (14.0 – 20.0) were able to set the apparatus, prepare a table of results, and record the data correctly. They derived properly the question which used to plot a graph of log(t) against log(n). These candidates also made correct interpretation of the physical quantities either from equation or graph. Analysis shows that few of them were accurate in this question especially in the part of data collection. Also they understood that air resistance, time reaction and approximation of small angle were the sources of error pertaining to the experiment. The candidates' responses implied that they had good knowledge of performing experiment to determinate the acceleration due to gravity. Extract 1.1 represents a sample of good responses.

01. (iii). If $t^2 = Kn^2$

Deducation of relation from graph (ii)

that is log(t) against log(n)

$t^2 = Kn^2$

Our equation is $t^2 = Kn^2$

Applying logarithim both sides.

$\log t^2 = \log Kn^2$

$\log t^2 = \log K + \log n^2$

$\frac{2\log(t)}{2} = \frac{\log K}{2} + \frac{2\log(n)}{2}$

$\log(t) = \frac{1}{2}\log K + \log(n)$

$\log(t) = \log(n) + \log(K)^{1/2}$

01. (i) Table of results.

time (sec)	number of ossilations (n)	log(t) (sec) x10⁻¹	log(n) (x10⁻¹)
5	6	6.9	7.8
10	11	10.0	10.0
15	16	11.8	12
20	21	13.0	13.2
25	26	14.0	14.2
30	31	14.8	15.0

(ii) from graph, determine value of y-intercept

value of intercept is -0.5 sec $(\times 10^{-1})$ or -0.5×10^{-1} sec

(v) Value of quantity (a)

from equation $a = -218 m/s^3 \times b$

where:

b = y-intercept

$b = -0.05$ sec

$a = -218 m/s^3 \times -0.5$ sec

~~a = (218x[illegible]) m/s~~ $a = (218 \times 0.05) m/s$

$a = 10.4 m/s^2$.

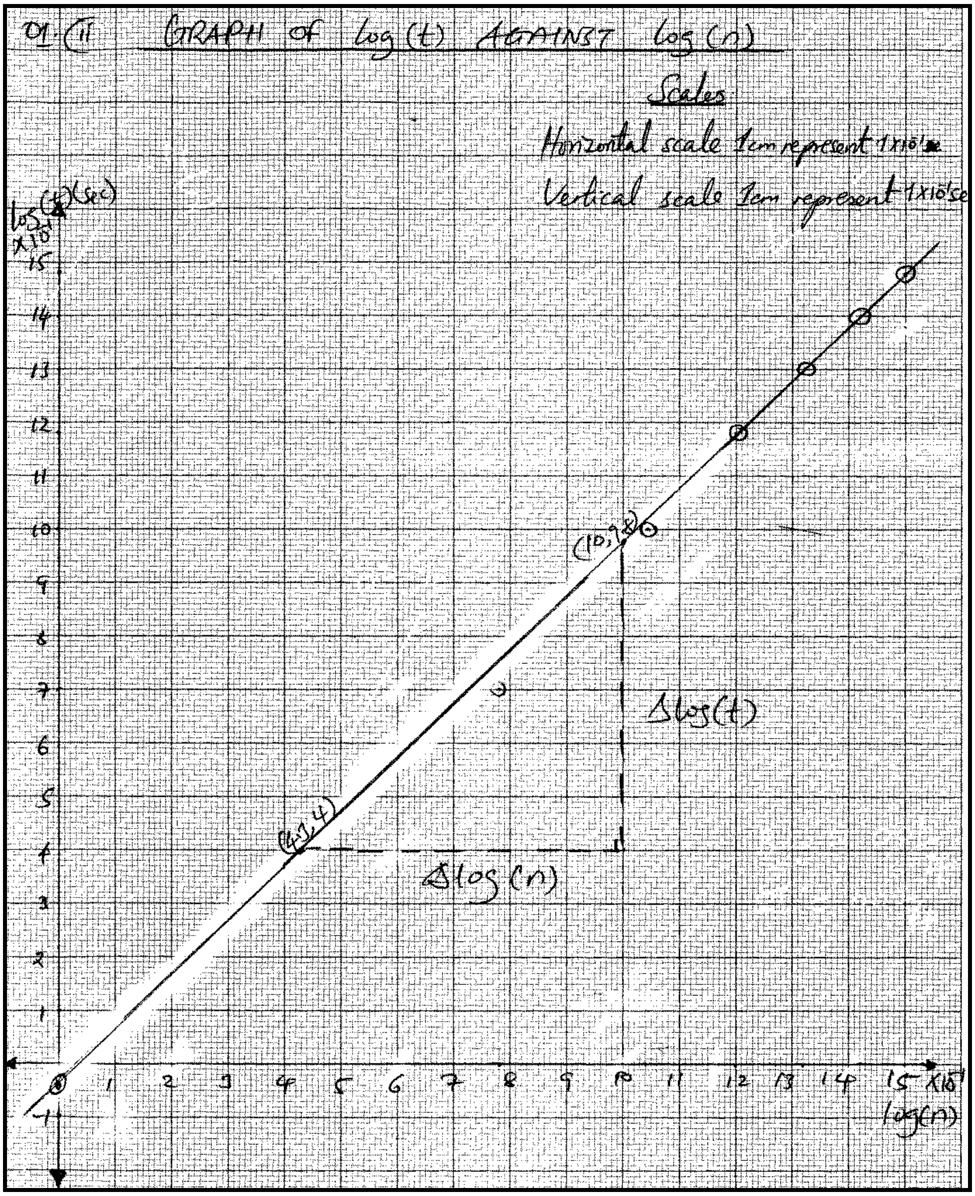
(vi) Physical meaning of quantity 'a' found is acceleration due to gravity $(10.4 m/s^2)$

(vii) Sources of errors

(a) Air resistance

(b) Poor timing of stopwatch

(c) Zero error of meter rule.



Extract 3.1.2: A sample of correct response in Question 1.

However, the candidates who scored low marks (0.0 – 7.5) lacked skills of conducting Simple Pendulum experiments to determine acceleration due to gravity. These candidates failed to follow the proper procedures of assembling apparatus for the experiment, which led them the fail to collect and record the data in the table of results. For example, one of the candidates obtained the number of oscillation (n) as: *224.7, 280.9* and *337.07* which corresponding to time 20 sec, 25 sec and 30 sec respectively.

The candidate’s responses show that he/she failed to count and record the number of oscillations as integer.

Furthermore, some of candidates failed to deduce the equation $t^2 = kn^2$ in relation to the linear equation and axis (x, y) used to plot a graph of log(t) against log(n). For example one of them derived the given equation as:

$\sqrt{t^2} = \sqrt{kn^2}$

$t = \sqrt{k} \times n$

Instead of $\log t^2 = \log\left(kn^2\right)$

$2\log t = 2\log n + \log k$

$\log t = \log n + \frac{1}{2}\log k$. These shows that the candidate had inadequate knowledge about logarithms which could help them to derive the correct equation. Other candidates failed to state the sources of error based on a particular experiment. For example, some candidates stated the sources of errors as; “*poor setting of instruments, instrument error and environmental error.”* These responses indicated that they had insufficient knowledge about errors analysis. Extract 1.2 illustrates an example of incorrect responses supplied by one of the candidates.

PRACTICAL REPORTS

01. (i) Table of results.

Oscillations (n)	Time t(sec)	log(t) (sec)	log(n)
5	4.57	0.6599	0.6989
10	9.22	0.9647	1
15	14.00	1.1461	1.1761
20	18.44	1.2658	1.3010
25	23.18	1.3651	1.3979
30	27.81	1.4442	1.4771

(iii) $t^2 = kn^2$

from the graph.

Slope $M = \frac{\Delta \log(t)}{\Delta \log(n)}$

$M = \frac{1.3 - 0.9}{1.3 - 0.9} = \frac{0.4}{0.4}$

$M = 1.0$ sec

from

$t^2 = kn^2$

$t^2 \propto n^2$

∴ This indicate that the square of time (t) is directly proportional to the square of number of oscillation (n).

And therefore:

K indicate the slope of the graph

$t^2 = kn^2$

$y = mx$

(iv) The value of y-intercept is zero (0)

(v) $a = -218 ms^{-3} \times b$

$a = -218 ms^{-3} \times 0$

$a = 0$

∴ Value of $a = 0$

(vi) The physical meaning of quantity 'a' is that: The graph cuts to origin.

Extract 1.1: A sample of weak response in Question 1.

In Extract 1.1, the candidate exchanged data of oscillation (n) column with that of time (t) column. This led to incorrect answers to other parts of question.

2.2.2 Question 2: Heat

The question required the candidates to determine the specific heat capacity of a liquid labelled Q. They were tasked to follow the procedures as follows:

(a) Weigh the empty calorimeter with its lid and stirrer, record as M_1

(b) Fill the calorimeter with hot liquid Q heated to 85°C to about three quarters.

(c) Insert the copper calorimeter into its jacket and place on a bench, cover it with its lid and insert the thermometer. Start stopwatch and gently stir the hot liquid Q while recording the temperature after every 2 minutes. Take your readings until when liquid Q cools to about 55°C.

(d) Remove the thermometer and weigh the calorimeter with its contents, (liquid Q, lid and stirrer) record it as M_2.

Questions

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

Time (sec)	Temperature (°C)

(ii) Find the mass of liquid Q, recorded as mass M_2.

(iii) Plot a graph of temperature (°C) against time for liquid Q.

(iv) Draw the tangent at the temperature of 70 °C and obtain the rate of cooling of the liquid Q.

(v) Solve for the specific heat capacity of liquid Q (C_Q) using the relation:

$$(M_2C_Q+400M_1)\frac{d\theta}{dt}=10.096\ Js^{-1}$$

A total of 382 (100%) candidates attempted this question. The performance in this question was average since 55.8 per cent scored 6.0 marks and above as summarised in Figure 2.

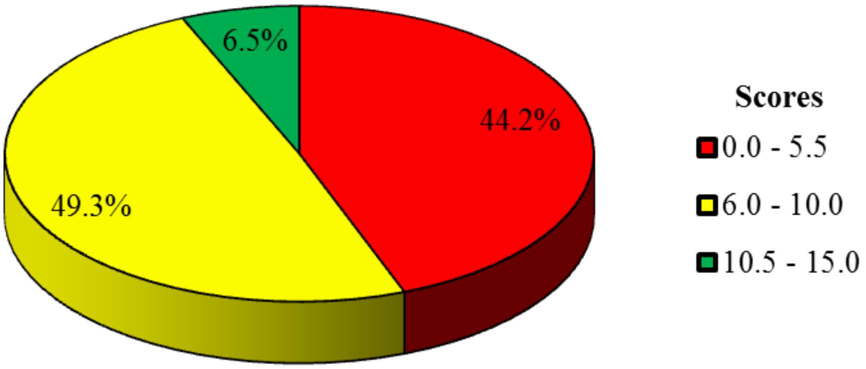


Figure 2: *Candidates' Performance on Question 2*

Figure 2 indicates that 25 (6.5%) candidates scored 10.5 to 15.0 marks, 188 (49.3%) scored 6.0 to 10.0 marks and 169 (44.2%) candidates scored 0.0 to 5.5 marks.

The data analysis reveals that the candidates with average marks provided correct responses to some parts of the question and missed or skipped the other parts. Analysis made on their responses indicated that they managed to assemble the copper calorimeter into its jacket and correctly recorded the data of time (sec) and their corresponding temperature (°C). But some of them faced challenges to use a beam balance as a result they got wrong readings of mass of empty calorimeter and calorimeter when filled with its contents. This implies that they had inadequate knowledge about measurement of quantities.

However, 6.5 per cent of the candidates who scored good marks were knowledgeable in the concepts of specific heat capacity of liquid, measurement of physical quantities and Newton's law of cooling. These candidates had knowledge on how to assemble apparatus and record data using stop watch, thermometer and beam balance. On the other hand, they followed the procedures clearly and obtained the desired results. They plotted the graph well and used the equation given to get the specific heat capacity of the liquid Q to good approximate value. Extract 2.1 represents one of the good responses in this question.

02. The aim of experiment is to determine the specific heat capacity of the liquid labelled Q

a) Mass of empty calorimeter M_1 = 81.16g.
Mass of calorimeter with water = 155.23g

Table of results

(i)

Time (min)	Time (sec)	Temperature (°C)
0	0	85
2	120	82
4	240	79
6	360	76
8	480	74
10	600	71
12	720	69
14	840	67
16	960	64
18	1,080	62
20	1200	59
22	1320	57
24	1440	55

(ii) Mass of Liquid Q.
Mass (M_2) = 155.23g.
Mass M_1 = 81.16g.

Mass of Q = 155.23g − 81.16g
= 74.57g.
∴ Mass of liquid Q = 74.57g

(ii) Graph.

(iii) Gradient from the graph.

$$\text{slope} = \frac{\text{Change Temp } (^{\circ}C)}{\text{change in time (sec)}}$$

$$= \frac{76.8 - 70^{\circ}C}{340 - 594}$$

$$= {}^{-}0.027\ ^{\circ}C/\text{sec}$$

∴ Rate of cooling $= {}^{-}0.027\ ^{\circ}C/\text{sec}$

(i) $(M_2 C_Q + 400 M_1)\frac{d\theta}{dt} = 10.096\ Js^{-1}$

$(155.73 \times C_Q + 400 \times 81.16) \times {}^{-}0.027 = 10.096$

$\frac{(155.73 C_Q + 32464)\ {}^{-}0.027}{0.027} = \frac{10.096}{0.027}$

${}^{-}(155.73 C_Q + 32464) = {}^{-}373.9$

$-155.73 C_Q = 373.9 - 32464$

$\frac{155.73 C_Q}{155.73} = \frac{32090}{155.73}$

$C_Q = 4200\ Js^{-1}$

∴ Specific heat capacity of liquid Q $= 4200\ Js^{-1}$

Extract 2.1: A sample of good response in Question 2.

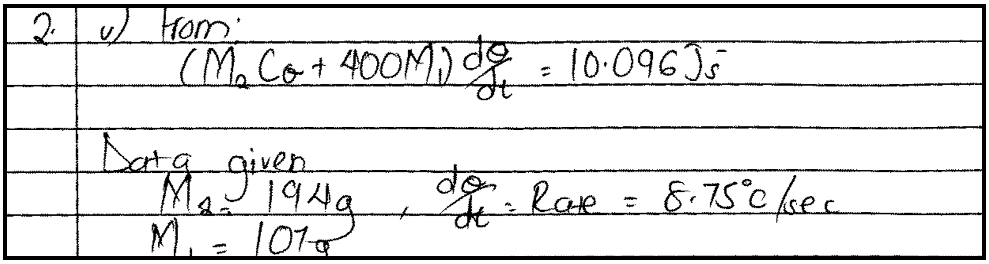
Further analysis of candidates' performance shows that, most of the candidates who scored low mark (0.0 to 5.5) were unable to perform a number of tasks in this experiment. Some of them failed to follow instructions as per given question. In addition, other candidates treated the given time interval of 2 minutes as seconds. They were supposed to convert the 2 minutes intervals into 120 seconds intervals. For example one candidate wrote the column of time (sec) as; *2, 4, 6, 8, 10, 12, 14 and 16* instead of 120, 240, 360, 480, 600, 720, 840 and 960 respectively. As a result, they missed marks allocated for the table of results while others failed to plot proper graph. This was attributed to weak choice of scale and lack of carefulness during drawing of the graph.

It was further noted that, some candidates lacked skills in measuring mass by using beam balance. For example, one candidate measured the mass of the empty calorimeter as *69.5 g* and the mass of calorimeter with water and stirrer as *64.5 g* instead of 59 g and 138 g respectively. This candidate failed to reason that mass of calorimeter with water and stirrer cannot be less than that of an empty calorimeter. Moreover, other candidates responded incorrectly in part (c) due to inability to grasp the given relation to calculate the specific heat capacity of liquid Q. They could not derive specific heat capacity C_Q from relation $(M_2C_Q + 400\,M_1)\dfrac{d\theta}{dt} = 10.096\,Js^{-1}$.

Extract 2.2 represents one of the incorrect responses in this question.

2. THE AIM OF THE EXPERIMENT IS TO DETERMINE THE SPESPICHEAT CAPACITY OF THE LIQUID.

APPARATUS:
Beaker.
Calorimeter
Themometer
Water.
Boiled Water
Stirrer.
Electronic beam balance.
PROCEDURES:
To measure the mass of empty ~~Calorimeter~~ Calorimeter and to record as Mo.
To measure the mass of water or liquid f Calorimeter to record as M,
To measure the temperature of the surrounding as θo(oc)
To find the final temperature of the liquid and to record it as θf


2. v) From:
$(M_2 C_\theta + 400M_1)\frac{d\theta}{dt} = 10.096 J/s$

Data given
$M_2 = 194g$, $\frac{d\theta}{dt}$ = Rate = 8.75°C/sec
$M_1 = 107g$

Extract 2.2: A sample of weak response in Question 2.

In Extract 2.2, the candidate wrote a list of apparatuses and procedures which were already in the question paper and not the responses required.

2.2.3 Question 3: Current Electricity

In this question candidates were required to determine the value of unknown resistor R on the bases of the following procedures;

(a) Connect all the components as shown in a circuit diagram in Figure 2. The voltmeter (V) and unknown resistor (R) should be connected in parallel.

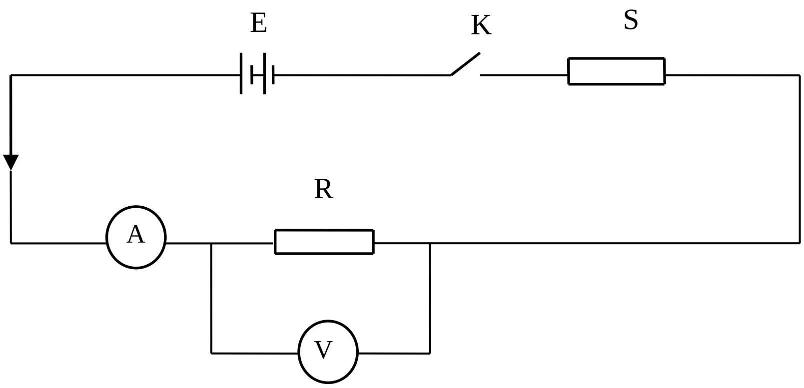


Figure 2

(b) Adjust the resistance to 15 Ω and record the readings of the ammeter and voltmeter.

(c) Repeat procedure 3(b) to obtain six more readings for resistance box tuned to 20 Ω, 25 Ω, 30 Ω, 35 Ω, 40 Ω and 45 Ω.

Questions

(i) Tabulate the results obtained in 3 (c) as shown in the following table;

S (Ω)	15	20	25	30	35	40	45
V(v)							
I(A)							

(ii) Plot the graph of voltage (V) against current (I).
(iii) Find the slope (m) of the graph.
(iv) State the SI unit of the slope found in part (iii).
(v) What physical quantity does the slope of the graph indicate?

The question was attempted by 382 candidates equivalent to 100 per cent. The data analysis shows that overall performance was average as illustrated in Figure 3.

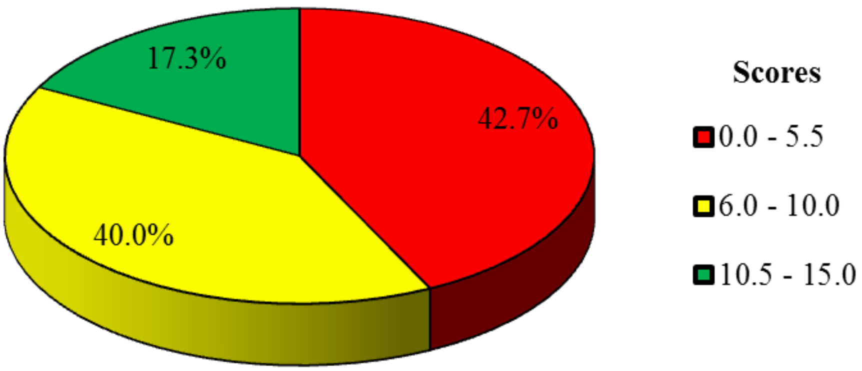


Figure 3: *Candidates' Performance on Question 3*

The data in Figure 3 shows that the candidates' scores were as follows: 17.3 per cent scored 10.5 to 15.0 marks; 40.0 per cent scored 6.0 to 10.0 marks and the rest 42.7 per cent scored 0.0 to 5.5 marks.

The 57.3 per cent of the candidates who scored 6 marks and above had knowledge about the concepts of a simple electric circuit particularly, on how to determinate the resistance of resistors. They connected the simple electric circuit properly, which enabled them to collect the correct data values of voltage (V) and current (I). These candidates had good skills in drawing the graph of voltage (V) against current (I) and on calculating the slope (m). The candidates also identified correctly the physical meaning represented by a slope of as resistance R. However, those who scored the average marks collected few data which could not enable them to draw a graph of V-I correctly. Extract 3.1 displays an example of good responses from one of the candidates.

3. (ii). Graph of voltage (v) against current I ploted on the graph pad.

(iii). slope (m) of graph.

From the graph

Points (0.58, 1.42) and (0.30, 0.8).

$$\text{Slope} = \frac{\Delta V\ (v)}{\Delta I\ (A)}$$

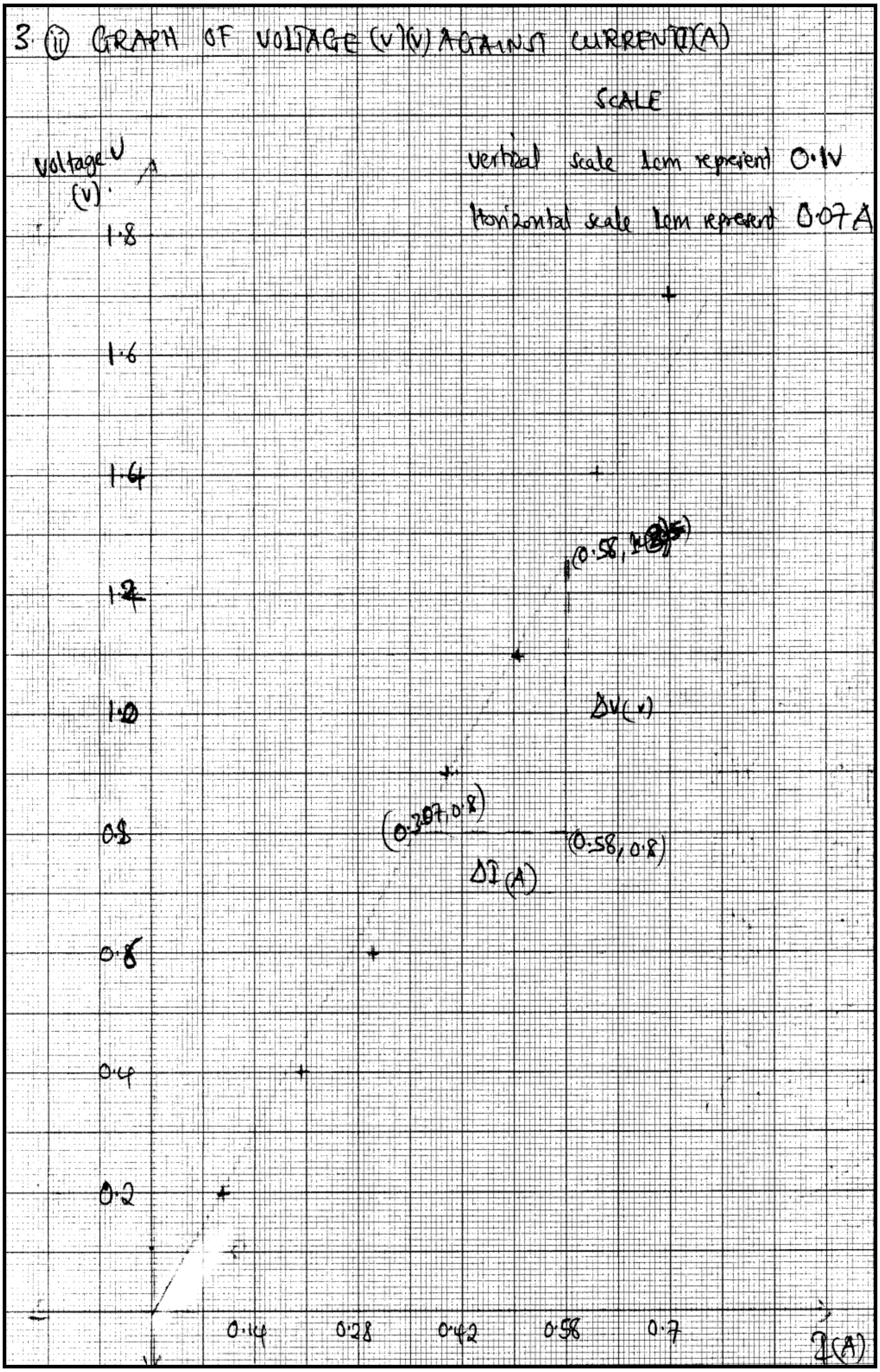
$$= \frac{(1.42 - 0.8)\,v}{(0.58 - 0.30)\,A}$$

$$= 2.2\Omega$$

∴ Slope of the graph (m) = 2.2Ω.

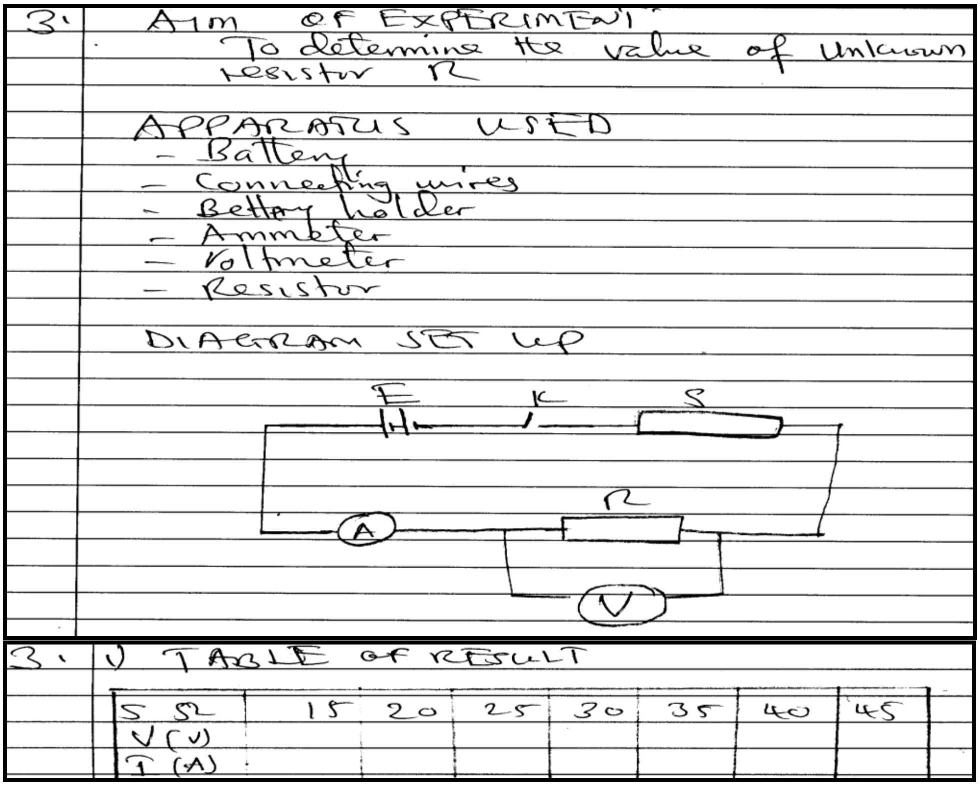
(iv) SI unit of the slope is Ohm's (Ω).

(v) Physical quantity does the slope of the graph present is Resistance.



Extract 3.1: A sample of good responses in Question 3.

In contrast; the candidates who scored low marks (0.0 – 5.5) were incompetent in connecting simple electric circuit. These candidates failed to record data from either ammeter or voltmeter which led them to tabulate the results with incorrect data. For example, one of the candidates drew a table of values with only one column of current (I) readings and ignored the column of voltage (V). In this case, the candidates failed to plot graph due to the missed data. Others drew graphs which did not reflect the Ohm’s law because the variation of voltage (V) and current (I) was not linearly. For example, one of the candidates drew incorrect graph by using the following data; *value of V (2.8, 2.8, 2.6, 2.4 and 2.2) and their corresponding value of I were (0.01, 0.02, 0.05, 0.06 and 0.1) respectively*. In these data the value of voltage is inversely proportional to current I which in turn gave negative slope (R) of the graph instead of positive slope (R) as required. Therefore, failure to get the data correctly led most of candidates to draw wrong graphs and subsequent decline in the overall score of the question. Extract 3.2 represent an incorrect response from one of the candidates.


3. AIM OF EXPERIMENT
To determine the value of unknown resistor R

APPARATUS USED
- Battery
- Connecting wires
- Bettary holder
- Ammeter
- Voltmeter
- Resistor

DIAGRAM SET UP

3. i) TABLE OF RESULT

S Ω	15	20	25	30	35	40	45
V (V)							
I (A)							

Extract 3.2: A sample of incorrect response in Question 3.

In extract 3.2, the candidates responded wrongly by listing the apparatus used. She/he drew the circuit diagram and unfilled table of results.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH TOPIC

A total of 14 topics were examined in Physics examination papers. These topics were: *Measurements, Atomic Physics, Mechanics, Properties of Matter, Waves, Analysis of O-Level Physics Curriculum Materials, Physics Laboratory Management, Planning for Teaching, Fundamental of Teaching and Learning Physics, Current Electricity, Heat, Electronics, Assessment in Physics* and *Teaching*.

The analysis of the candidates' responses in each topic in Physics 1 shows that good performance was reflected on the topics of *Planning for Teaching* (98.5%), *Analysis of O-Level Physics Curriculum Materials* (96.3%), *Physics Laboratory Management* (93.7%), *Assessment in Physics* (90.4%) and *Teaching* (90.2%). On the other hand, average performance was observed in the topics of *Mechanics* (54.5%), *Electronics* (50.2%), *Measurements* (49.0%) and *Fundamental of Teaching and Learning Physics* (45.5%). Moreover, the topics of *Properties of Matter* (28.8%), *Current Electricity* (24.5%), *Atomic Physics* (21.5%), *Waves* (20.7%) and *Heat* (18.9%) had weak performance (See appendix I).

Further analysis shows that, the performance in the topics of *Planning for Teaching, Analysis of O-Level Physics Curriculum Materials, Physics Laboratory Management* and *Teaching* have maintained good performance in 2020 and 2021. The performance in the topics of *Assessment in Physics, Mechanics* and *Measurements* has improved from weak performance in 2020 to good and average performance in 2021 respectively. However, the performance in the topics of *Properties of Matter, Current Electricity, Atomic Physics, Waves* and *Heat* remained weak in 2020 and 2021 (See appendix III).

On the other hand, the analysis in Physics 2A (Actual Practical Paper) revealed that, the topic of *Mechanics* had good performance while the topics of *Heat* and *Current Electricity* were averagely performed (See appendix I and II).

4.0 CONCLUSION

In general, the candidates' performance in Physics was good as 94.95 per cent of the candidates passed the examination and only 5.05 per cent failed. The good performance was due to the candidates' ability to identify the task of the questions, candidates' knowledge and skills on the subject matter, good mathematical skills and correct application of the principles in interpreting scientific observation. They were able to explain and elaborate the points using appropriate Physics principles and theories.

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

5.0 RECOMMENDATIONS

In order to improve the performance of prospective candidates in Physics subject tutors are strongly advised to:

(a) use demonstration method in teaching the concept of elasticity, production of mechanical waves and occurrence of interference of waves. This will help learners to differentiate progressive and stationary waves and to derive relationship between tensile stress, tensile strain and stored energy of materials.

(b) emphasize by doing through conducting various experiments in the topics of *Heat* and *Current Electricity*. The experiment should base on the concepts of thermal radiation and electric conduction in electrolytes. This will help the candidates to acquire skills about absorption by radiation and conductance of some electrolytes.

(c) apply deductive inquiry method in teaching and learning processes of *Properties of Matter* topic especially the subtopic of *Elasticity*. The method helps learners to develop competencies and skills of derivation of formula of stress, stain, elastic force and stored energy of elastic materials.

(d) use think-pair-share, questions and answer, group discussion and presentation methods when teaching the topic of *Heat*, *Current Electricity*, *Atomic Physics* and *Waves* specifically in the concepts of thermal radiation, electric conduction in electrolyte, thermionic emission and mechanical waves respectively.

Appendix I

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

S/N	Topic	Question Number	Performance in each question (%)	Average performance per topic (%)	Remarks
1.	Planning for Teaching	9	99.7	98.5	Good
		14	97.2		
2.	Analysis of O-Level Physics Curriculum materials	7	96.3	96.3	Good
3.	Physics Laboratory Management	8	93.7	93.7	Good
4.	Assessment in Physics	15	90.4	90.4	Good
5.	Teaching	16	90.2	90.2	Good
6.	Mechanics	3	56.8	54.5	Average
		5	52.2		
7.	Electronics	13	50.2	50.2	Average
8.	Measurements	1	49.0	49.0	Average
9.	Fundamentals of Teaching and Learning Physics	10	45.5	45.5	Average
10.	Properties of Matter	4	28.8	28.8	Weak
11.	Current Electricity	11	24.5	24.5	Weak
12.	Atomic Physics	2	21.5	21.5	Weak
13.	Waves	6	20.7	20.7	Weak
14.	Heat	12	18.9	18.9	Weak

Appendix II

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

S/N	Topic	Question Number	Performance in each question (%)	Average performance per topic (%)	Remarks
1.	Mechanics	1	89.0	89.0	Good
2.	Current Electricity	3	57.3	57.3	Average
3.	Heat	2	55.8	55.8	Average

Appendix III

Comparison of the Candidates' Performance in each Topic in 731 Physics DSEE between 2020 and 2021

		2020			2021		
S/N	**Topic**	**Question Number**	**Average performance per topic (%)**	**Remarks**	**Question Number**	**Average performance per topic (%)**	**Remarks**
1.	Planning for Teaching	7 &14	96.4	Good	9&14	98.5	Good
2.	Analysis of O-Level Physics Curriculum materials	9	71.8	Good	7	96.3	Good
3.	Physics Laboratory Management	10	95.1	Good	8	93.7	Good
4.	Assessment in Physics	8	13.4	Weak	15	90.4	Good
5.	Teaching	15	81.5	Good	16	90.2	Good
6.	Mechanics	3	27.0	Weak	3&5	54.5	Average
7.	Electronics	11	74.5	Good	13	50.2	Average
8.	Measurements	1	17.4	Weak	1	49.0	Average
9.	Fundamentals of Teaching and Learning Physics	16	96.2	Good	10	45.5	Average
10.	Properties of Matter	4	5.5	Weak	4	28.8	Weak
11.	Current Electricity	2	37.5	Weak	11	24.5	Weak
12.	Atomic Physics	12	2.4	Weak	2	21.5	Weak
13.	Waves	5	33.7	Weak	6	20.7	Weak
14.	Heat	6	33.4	Weak	12	18.9	Weak
15.	Geophysics	13	21.3	Weak			