THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

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

035 ENGINEERING SCIENCE

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FOREWORD

The Candidates’ Item Response Analysis (CIRA) report in Engineering Science subject for Certificate of Secondary Education Examination (CSEE) 2019 has been written in order to provide feedback to the education stakeholders about the performance of the candidates and the challenges they faced in attempting various examination questions.

The Certificate of Secondary Education Examination marks the end of four years of Ordinary Level Secondary Education in Tanzania. It is a summative evaluation which indicates the effectiveness of the education system in general and the education delivery system in particular. The candidates’ performance is a strong indicator of what the education system was able or unable to offer to the students in their four years of Ordinary Secondary Education.

The analysis presented in this report intends to contribute towards the understanding of the possible reasons behind the candidates’ performance in the Engineering Science subject. The report shows the factors that made the candidates to perform the way they did on different questions. Such factors includes candidates’ ability to identify the task on the questions they attempted, ability to follow instructions and candidates’ knowledge of the concepts related to the subject. The report also highlights factors which made some of the candidates fail.

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

Dr Charles E. Msonde

EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report presents the analysis of the performance of the candidates who sat for the Certificate Of Secondary Education (CSEE) 2019 in Engineering Science subject. The analysis shows how the candidates performed in each question. The analysis also identifies the questions which were performed well, those which were averagely performed and those who performed poorly. Furthermore, the report shows the questions which were attempted by most candidates and those which were mostly omitted.

The Engineering Science paper comprised 14 questions divided in three sections: A, B and C. The candidates were required to answer all questions in sections A and B and to choose three questions from section C. Section A carried 10 marks, while sections B and C carried 45 marks each.

A total of 1232 candidates sat for the Engineering Science Examination, of whom 667 (54.1%) candidates passed while 565 (45.9%) candidates failed. The candidates' performance in 2019 decreased by 14.6 percent compared to that of 2018. There were 1390 candidates who sat for the examination in 2018. Among them, 955 (68.7%) candidates passed while 435 (31.3%) candidates failed. Figure 1 shows the candidates' performance in Engineering Science in 2019 in comparison with the 2018 performance.

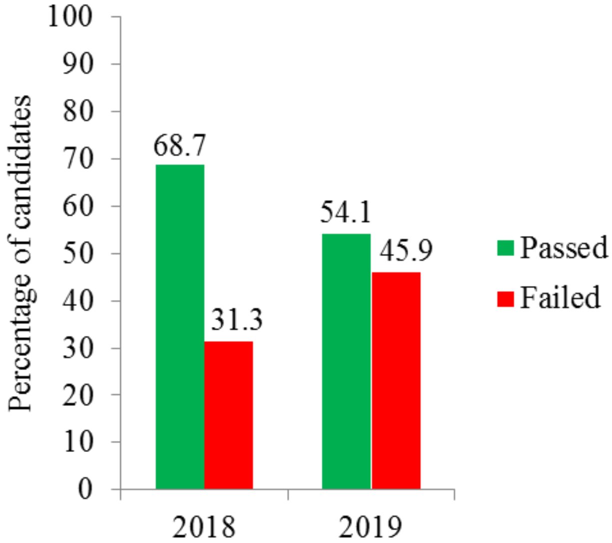


Figure 1: Comparison of candidates' performance in 2019 and 2018

Figure 1 shows the comparison of the candidates’ performance in 2019 and 2018. The colours present the percentage of performance of the candidates where red represents those who failed and green stands for those who passed.

The analysis presents the requirements for each question, the candidates’ strengths and weaknesses in their responses and the percentage of candidates in each group of scores. The analysis is accompanied with bar charts which summarise the candidates’ performance in particular questions. The report also provides the conclusion, recommendations and appendices A and B.

The performance in each question is rated as weak, average and good if the percentage of candidates marks are in the ranges of 0 – 29, 30 – 64, and 65 – 100 respectively. The pass mark for each question is 30% or above. Different categories of performance are also indicated by special colours where red, yellow, and green colours denote weak, average, and good performance respectively as seen in the charts and appendices.

2.0 ANALYSIS OF PERFORMANCE IN INDIVIDUAL QUESTIONS

2.1 SECTION A: Objective Type Questions

2.1.1 Question 1: Multiple Choice Items

This question had items (i) - (x) derived from the topics on *Periodic Motion; Friction; Strength of Materials, Optics (Light), Sound, Electricity and Magnetism; Measurements; Work, Energy and Power;* and *Heat*. The candidates were required to choose the correct answer from the given alternatives and to write their letter beside the item numbers.

A total of 1232 (100%) candidates attempted this question. Among them, 259 (21.0%) scored 0 to 2 marks; 806 (65.4%) scored 3 to 6 marks, and 167 (13.6%) scored 7 to 10 marks. This was the best performed question. The candidates’ performance is presented in Figure 2.

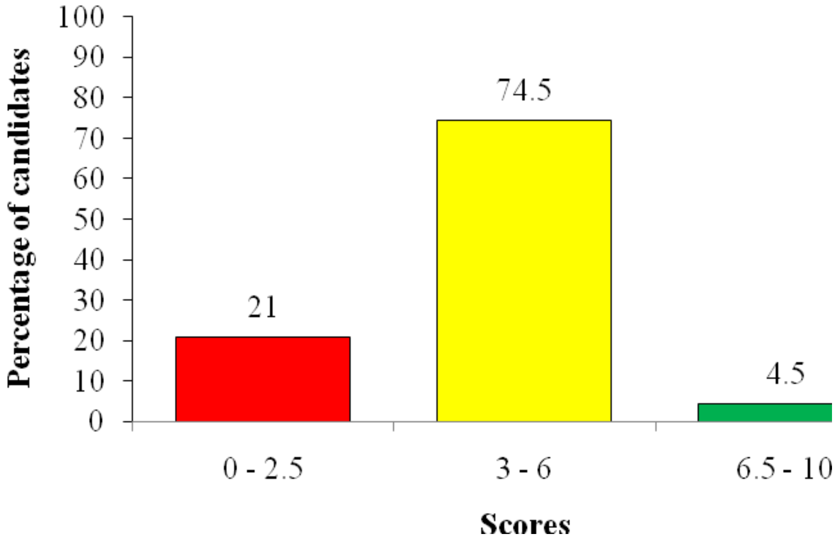


Figure 2: Candidates' Performance on Question 1

The analysis carried out indicates that most of the candidates were able to choose the correct answers in items (i), (ii) (ix), and (x). This indicates that the candidates had adequate knowledge on the concept tested. On the other hand, the candidates who failed to score high marks had a problem in item (v) which stated as follows:

(v) *Figure 2 shows an observation of the movement of a particle which moves in a form of wave. If the particle takes one second to move from original point 'P' to point 'Q', what is the frequency of this wave?*

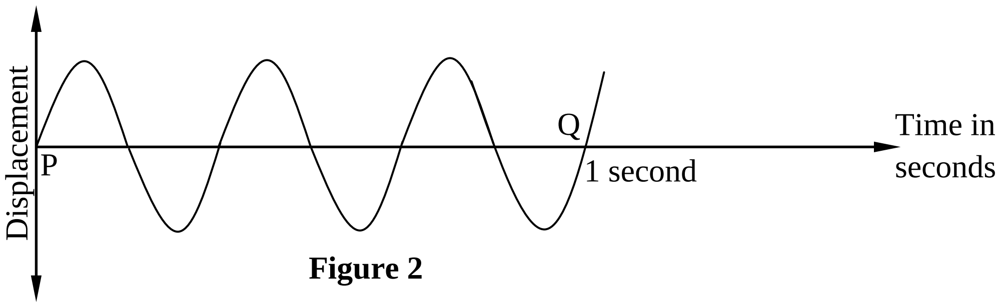


Figure 2

A 2.5 Hz B 3 Hz C 3.5 Hz D 1.5 Hz E 2 Hz

The majority of the candidates choose alternative "D" instead of "B". The response was wrong because option 'D' is obtained by dividing 3 cycles of wave by 2 seconds. These candidates failed to count the number of cycles in Figure 2 and to divide it by one second to get the correct answer.

2.2 SECTION B: Short Answer Questions

2.2.1 Question 2: Projectile Motion

The question required the candidates to estimate the maximum height that will be attained by the ball. The question stated as follows;

Two boys are standing 10 m apart south to North and one has to kick the ball to another boy. If the boy at North kicked the ball to the boy in south at an angle of 45^{o} to horizontal, estimate the maximum height the ball will attain.

The candidates who attempted this question were 1049 (85.1%). Among them, 763 (72.7%) scored 0 to 1 mark; 209 (20%) scored 1.5 to 3 marks; whereas 77 (7.3%) candidates scored 3.5 to 5 marks. Generally the candidates' performance in this question was weak. Figure 3 summaries the candidates' performance on Question 2.

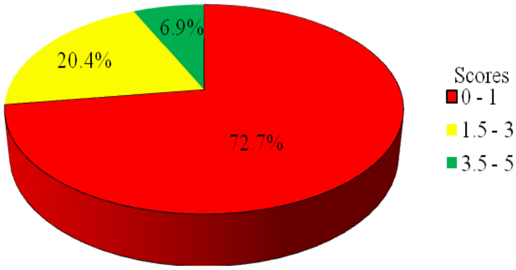


Figure 3: Candidates' performance on Question 2

The analysis shows that 72.7 percent of the candidates who scored 0 - 1 mark failed to apply the formula $H = \frac{u^2 \sin^2 \theta}{2g}$ or $R = \frac{u^2 \sin 2\theta}{g}$ to find the maximum height reached by the ball. Most of these candidates applied the formula which does not relate with the concept of projectile motion. Extract 2.1 provides a response of one of the candidates who performed poorly on this question.

2 Data given

Distance between two boys = 10 m

Angle which ball makes = 45°

Maximum height = x

Maximum height = sin α × ½ × 10m

= sin 45° × 5m

= √2/2 × 5m

= 5√2/2

Maximum height = 3.54 Metres

Extract 2.1: A sample of poor response on Question 2

Extract 2.1 shows a poor response as extracted from a script of one of the candidates who scored 0 mark. The candidate used a wrong formula in calculating the maximum height attained by the ball.

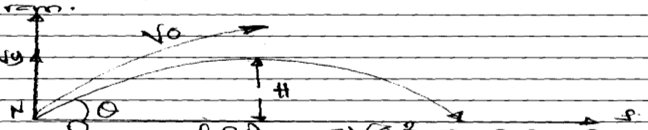
The candidates who scored 0.5 to 1 marks were noted to have carried out the computation for initial velocity ‘u’ without showing the formulas. Those who scored 1.5 to 3 marks were able to write the formula for maximum height, $H = \dfrac{u^2 \sin^2 \theta}{2g}$ but failed to carry out the calculation by using the given data to obtain the correct answer.

Further analysis shows that those who scored 3.5 to 4.5 marks were able to recall and apply the formula $H = \dfrac{u^2 \sin^2 \theta}{2g}$, or $u = \sqrt{\dfrac{2g}{\sin 2\theta}}$ but they made slight mistakes in computing the data. Therefore, they obtained high scores of 3.5 to 4.5 marks.

Despite those weaknesses, 5.7 percent of the candidates scored all 5 marks allotted to this question. These candidates were able to realize that in order to obtain the maximum height (H) attained by the ball, the use of the equation $H = \dfrac{u^2 \sin^2 \theta}{2g}$ was inevitable. They also realized that since the initial velocity

u was not provided, the equation $R = \dfrac{u^2 \sin 2\theta}{g}$ was also to be applied, from which they obtained $u = \sqrt{\dfrac{2g}{\sin 2\theta}}$. Extract 2.2 shows a sample of a good response as extracted from a script of a candidate who provided the correct response.

2 Data given.
Range (Horizontal distance) = 10m.
Angle formed (θ) = 45°.
Height = Req
Diagram.



From, Range (R) $= \dfrac{2V_0^2 \sin\theta\cos\theta}{g}$.

$R = \dfrac{V_0^2 \sin 2\theta}{g}$.

$(V_0)^2 = \dfrac{Rg}{\sin 2\theta}$.

$V_0 = \sqrt{\dfrac{10 \times 10}{\sin 90}}$

$V_0 = \sqrt{100}$

$V_0 = 10$ m/s.

Velocity of a ball is 10m/s.

then, From Maximum height (H)

$H = \dfrac{V_0^2 \sin^2\theta}{2g}$.

$H = \dfrac{(10)^2 (\sin 45)^2}{10 \times 2}$.

$H = 2.5$m

∴ Maximum heigh the ball will attain is 2.5m.

Extract 2.2: A sample of a good response to Question 2

In Extract 2.2, the candidate was able to deduce an equation for the horizontal range of a projectile to find the velocity of a ball and finally the maximum height reached by the ball.

2.2.2 Question 3: Electricity and Magnetism

This question consisted of two parts: (a) and (b). Part (a) measured the candidates' understanding of the magnetic field inside a solenoid and how its strengths can be made stronger. Part (b) required the candidates to explain why electrical cables are left loosen during installation of power transmission. The question read as follows:

(a) *Explain briefly how the strength of the magnetic field inside a solenoid can be made stronger.*

(b) *Why electrical cables are left loosen during installation of power transmission? Explain briefly.*

A total of 932 (75.6%) candidates attempted this question. Among them, 86.6 percent scored 0 to 1 mark; 12.1 percent scored 2 to 3 marks, and 1.3 percent scored 4 to 5 marks. Generally, the candidates' performance on this question was weak. Figure 4 summaries the performance.

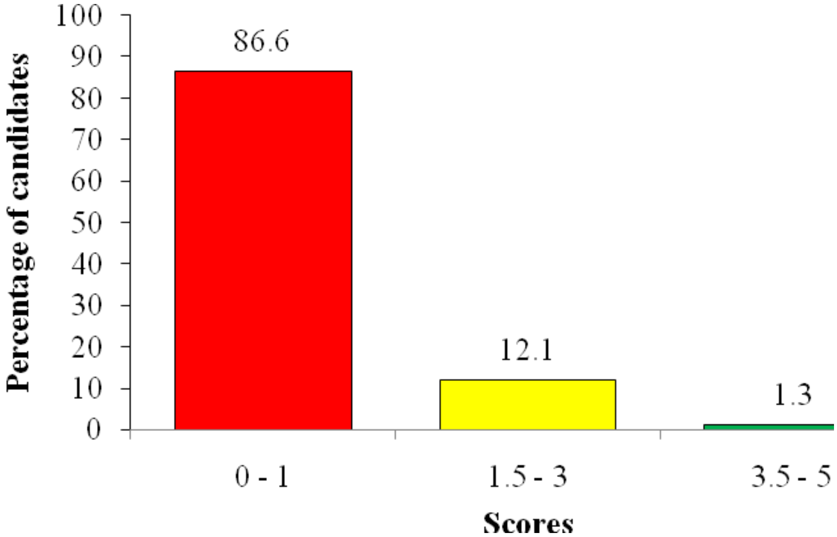


Figure 4: Percentage of candidates' performance on Question 3

There were 645 (69.2%) candidates who scored 0 mark in this question. Those candidates failed to realise that a magnetic field can be made stronger by increasing the strength of the current in the solenoid or placing a soft iron core within the solenoid and also by increasing the number of turns of the solenoid in part (a). From their responses, it was revealed that the candidates did not understand the proportionality of both the applied current and the number of turns per length as the major means of making magnetic field inside a solenoid stronger. In part (b) they failed to explain why electrical cables are left loose during installation of power transmission. Some of them wrote "*cables are left slacken during installation on a hot day in order to allow expansion*. This response was wrong because when the cables expand, they become more slacken. They confused between 'contraction' and *expansion*. Most of them did not understand that, the cables become taut and break due to decrease in length during a cold day. That is the reason why *electrical cables are left loose* because slackness offens a balance for the cable not to break during the contraction process. Extract 3.1 provides a sample of poor response as extracted from the script of a candidate.

3 a) magnetic field is the reflactive index of the glass

b) electrical cables is the physical quantities are obtained by dividing

Extract 3.1: A sample of poor responses to question 3.

In Extract 3.1 the candidate had misconception of ideas as he/she provided wrong responses using concepts of unrelated topic.

Apart from this poor performance, 12.1 percent of the candidates who scored 2 to 3 marks were able to provide answers to either part (a) or (b) and therefore scored average marks. Most of them lacked knowledge on how the strength of the magnetic field inside a solenoid can be made stronger.

On the other hand, the candidates who managed to score all the 5 marks allotted for this question had the ability to provide a clear and brief explanation on the three factors or ways by which the strength of the magnetic field inside a solenoid can be made stronger. The majority of them listed factors such as: (i) *increasing the size or magnitude of an electric current in the solenoid;* (ii) *increasing the number of turns of the solenoid; and* (iii) *placing a soft iron core inside the solenoid.* Also, in part (b), most of the candidates explained that electrical cables are left slacken during installation on a hot day in order to allow the cables to contract and avoid breaking during cold days or in the mornings and nights. That means if the cables were left taut during installation they would break on contraction during cold days or mornings and nights due decrease in length. Extract 3.2 shows a well presented response as from a script of a candidate who scored all 5 marks.

a) The strength of the magnetic field inside a solenoid can be made stronger by.

- Increasing the number of turns in a coil
- Increasing the current flow
- Placing an iron core at the axis of the solenoid

b) Electrical cables are left loosen during installation of power transmission so as to allow contraction during cold and expansion during hot days.

Extract 3.2: A sample of a good response to Question 3

In Extract 3.2, the candidate managed to outline three factors that can be used to increase the strength of magnetic field inside a solenoid but also give reasons why electrical cables are left loose during the installation of a power transmission system.

2.2.3 Question 4: Forces

This question required the candidates to use analytical method to determine the magnitude of the resultant force if the pulling forces of *8N due North; 10N due West; 6N 60° South of West; 5N 45° South of East and 3N 30° East of North* act on a body.

This question was attempted by 895 (72.6%) candidates. Among them, 855 (95.5%) scored 0 to 1 mark; 215 (24.7%), 35 (4.2%) scored 1.5 to 3 marks and 3 (0.3%) scored 4 to 5 marks. This is among the poorly performed questions. The graph in Figure 5 provides a summary of these scores in percentage.

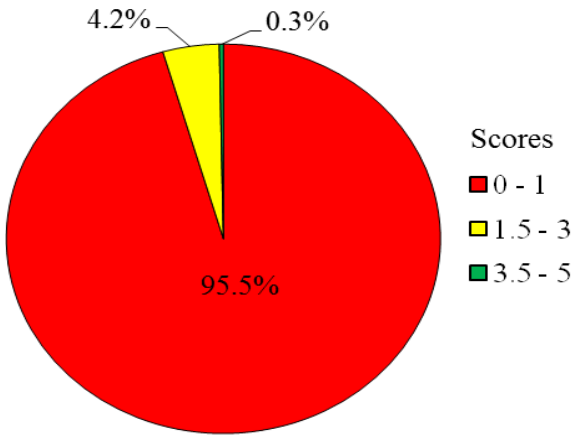
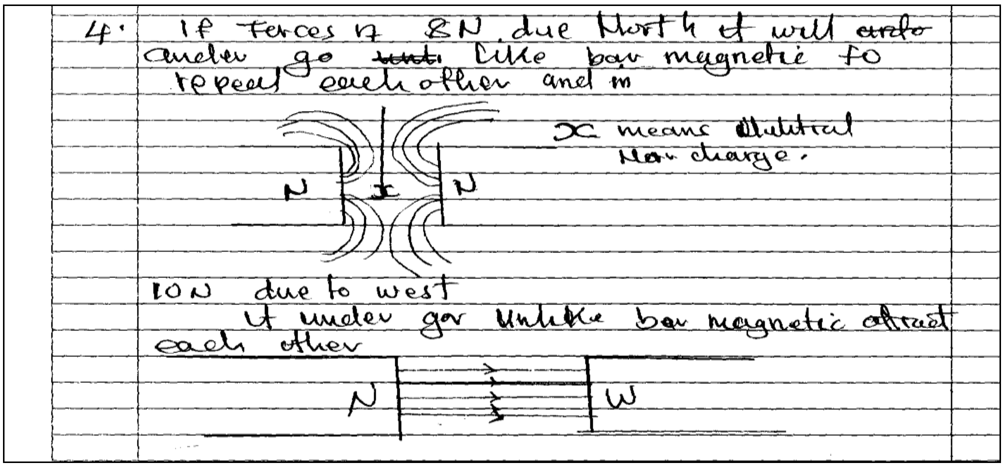


Figure 5: Percentage of candidates' performance on Question 4

The analysis shows that 71.2 percent of the candidates who scored 0 mark failed to present a sketch diagram and to show the directions of the given forces. They also did not understand how to solve the given forces into vertical and horizontal components using H.C = F x cos θ and V.C = F x sin θ. Furthermore, they failed even to state the equation concerning Pythagoras theorem, that is, $R = \sqrt{(H.C)^2 + (V.C)^2}$. Some of them confused the pulling forces given in the question with the forces due to magnetic line of forces. Instead of sketching the pulling forces acting on one point on a body, they drew a magnetic bar showing the magnetic line of forces. Extract 4.1 gives a sample of a poor response from one of the candidates.



Extract 4.1: A sample of a poor response to Question 4

In Extract 4.1 the candidate confused the pulling forces with the force due to magnet. He/she drew a sketch of magnetic forces instead of a sketch of a space diagram to show the directions of the five given forces.

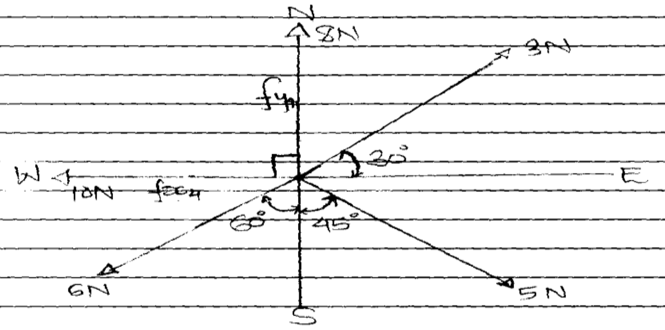
Most of the candidates who attempted this question scored 0 to 1 mark. The main challenge faced by these candidates was how to resolve the given forces in terms of horizontal and vertical components by using H.C = F x cos θ and V.C = F x sin θ respectively. Nevertheless, lack of mathematical skills, especially on Trigonometric Ratios, to find the cosines and sines of the angles 180°; 210°; and 315° was another challenge to most of the candidates. In addition, they failed to sketch the free force diagram in order to resolve the forces into vertical and horizontal components and hence obtain the resultant force. However, a few candidates were able to recall the Pythagoras theorem but failed to make the correct substitution of data to get the required magnitude of the resultant force.

The statistics show that 4.2 percent of the candidates scored 2 to 3 marks. Some of these candidates were able to draw the relevant sketch and managed only to make substitution without writing the formula of horizontal and vertical component of forces. Others sketched the diagram and wrote the formula for resultant force but failed to identify the negative or positive sign with respect to the direction of respective forces.

Moreover, 0.3 percent of the candidates who scored high marks (4 to 5) had enough knowledge and skills on the topic forces especially forces in equilibrium and sufficient mathematical skills particularly on Trigonometric Ratios. The candidates who scored 5 marks were able to draw the correct sketch of a free force diagram showing the correct directions of the given forces. They managed to resolve the values of forces into the horizontal and vertical components and finally applying the Pythagoras theorem to compute the resultant force (R) as $R=\sqrt{(H.C)^2+(V.C)^2}$ $R=\sqrt{(9.06)^2+(2.96)^2}$ = 9.53 N. Extract 4.2 provides a sample of well-presented responses as extracted from the script of one candidate.

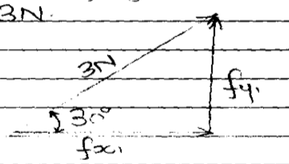
4 Solution

The given forces can be summarize by the figure below;



⇒ Resolution of forces into their vertical and horizontal

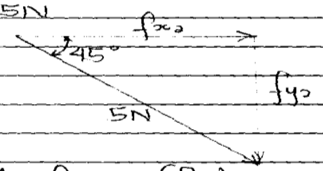
for 3N.



Vertical force $(f_{y1}) = 3\sin 30° = 1.5N$

Horizontal force $(f_{x1}) = 3\cos 30° = 2.598N$

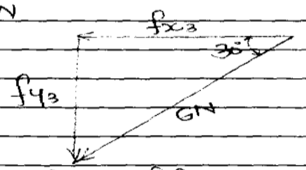
for 5N



Vertical force $(f_{y2}) = 5\sin 45 = -3.53N$.

Horizontal force $(f_{x2}) = 5\cos 45 = 3.53N$

for 6N



Vertical force $(f_{y3}) = 6\sin 30° = -3N$

Horizontal force $(f_{x3}) = 6\cos 30 = -5.196N$.

Sum of vertical forces $(\Sigma f_y) = f_{y1} + f_{y2} + f_{y3} + f_{y4}$

$= 1.5N - 3.53N - 3N + 8N$

$= 2.97N$

Sum of horizontal forces $(\Sigma f_x) = f_{x1} + f_{x2} + f_{x3} + f_{x4}$

$= 2.598N + 3.53N - 5.196N + (-10N)$

$= -9.068N$

then the magnitude of the resultant is given by ;

$R = \sqrt{(\Sigma f_y)^2 + (\Sigma f_x)^2}$

$= \sqrt{(2.97)^2 + (-9.068)^2}$

$= \sqrt{82.228 + 8.8209}$

$= \sqrt{91.0489} = 9.54N$

∴ The magnitude of the resultant $= 9.54N$

Extract 4.2: A sample of good responses to Question 4

Extract 4.2 is the correct response from one candidate who was able to perform all computation stages correctly and obtained the correct answer.

2.2.4 Question 5: Fluid Mechanics

This question was composed from the topic Fluid Mechanics. It consisted of parts (a) and (b) as follows:

(a) Suppose you have been assigned to measure the following quantities:

(i) Density or relative density of liquid such as milk

(ii) Atmospheric pressure

(iii)Gases such as the pressure of a steam in a boiler

(iv) A pressure of a gas supply

Identify the instrument that you would use in each case.

(b) Identify the principles that would be applied in the construction of a car hydraulic brake.

Data analysis indicates that 89.4 percent of the candidates who attempted this question had the following scores:

64 percent scored marks ranging from 0 to 1, while 32.4 percent scored 1.5 to 3 marks, and only 3.6 percent scored 3.5 to 5 marks. These scores imply that the candidates' performance on this question was weak as summarised in Figure 6.

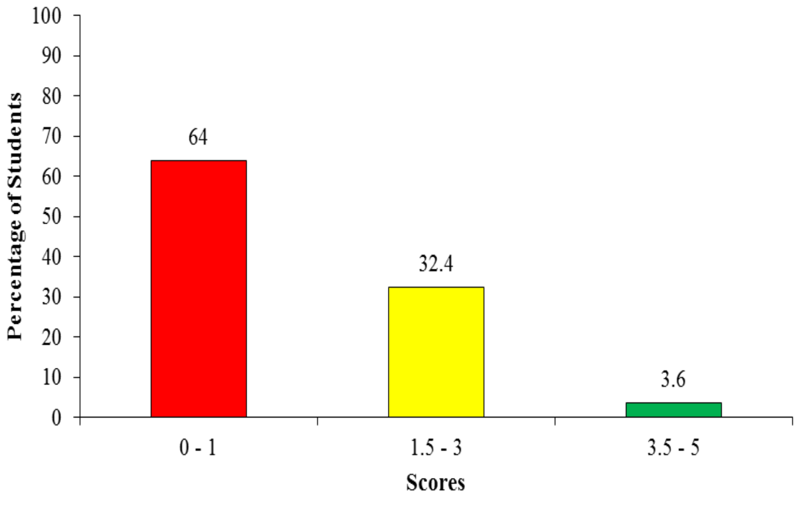


Figure 6: Percentage of Candidates' Performance on Question 5

From the analysis made on the candidates' responses it was revealed that some of the candidates who scored 0 to 1 mark failed to mention a specific instrument for measuring the given quantities, in part (a). They were also not able to identify the principles that would be applied in the construction of a car hydraulic brake. Their responses showed that they lacked knowledge and skills on how to measure the said quantities and had no experience on undertaking the required measurements. The candidates who scored 1 mark either managed only to identify the Pascal's Principle as the principle which is applied in the construction of a car hydraulic brake or identified one specific instrument for measuring one of the given quantities, in part (a) and failed the rest thus scoring 1 mark. Extract 5.1 shows a poor response.

5. a) i) Volume of liquid
ii) weather resistance
iii) Insulator
iv) Gold leaf

b) principles of hydraulic brake
i) Is Used in vabulation
ii) Is Used for spraying of paint powder

Extract 5.1: A sample of a poor response of a candidate to Question 5

Extract 5.1 shows a response of a candidate who failed to identify and mention a Hydrometer, Barometer, Bourdon gauge, and Manometer as the instrument for measuring density or relative density, atmospheric pressure, high gas pressure such as the pressure of steam in a boiler pressure, and pressure of a gas supply respectively. The candidate also, failed to mention the Pascal's Principle as the principle which is applied in the construction of a car hydraulic brake.

The candidates who scored 1.5 to 3 marks were able to identify two or three specific instrument for measuring the given quantities but some failed to attempt the remaining parts of the question. It was also noted that a few of them were able to identify the principles that would be applied in the construction of a car hydraulic brake which is Pascal's Principle of pressure transmission in fluid.

For those who scored 3.5 to 5 marks had high performance on this question. Some of them were able to identify all four specific instruments for measuring the given quantities, in part (a) but failed to attempt part (b) of this question. Others were able to identify three specific instruments for measuring the given quantities and were also able to identify and mention the principles that would be applied in the construction of a car hydraulic brake thus they scored high marks on this question.

There were only two candidates who scored all 5 marks on this question. These candidates managed to identify all four specific instruments in part (a) and mentioned the Pascal's Principle as the principle that is applied in the construction of a car hydraulic brake in part (b). It is revealed that these candidates had enough knowledge on the topic measurement and fluid mechanics. Extract 5.2 presents the correct response of question 5.

5\. a) i) Hydrometer
(ii) Barometer
(iii) Bourdon gauge
(iv). Manometer

b) Pascal's principle of Pressure

Extract 5.2: A sample of a good response.

In Extract 5.2 the candidate identified the instruments for measuring the given quantities as assigned but also the Pascal's Principle of pressure transmission in fluids which is applied in the construction of a car hydraulic brake.

2.2.5 Question 6: Linear Motion

This question was from the topic Linear Motion. The question was set to measure the competence of the candidates on how to employ some of the fundamental physical quantities. The question read as follows:
Two cars A and B situated 60 km apart all at rest started moving at the same time along a straight line in the same direction with uniform acceleration of 5 m/s^2 and 3 m/s^2 respectively. If car B was ahead of car A, how long in minutes will car A overtake car B?

A total of 1057(85.8%) candidates attempted this question. Out of whom, 809 (76.5%) scored 0 to 1 marks including 726 (68.7%) who scored 0; 183 (17.4 %) scored 1.5 to 3 mark and 65 (6.1%) scored 3.5 to 5 marks. The candidates' performance on this question was generally weak. The scores candidates are presented graphically in Figure 7.

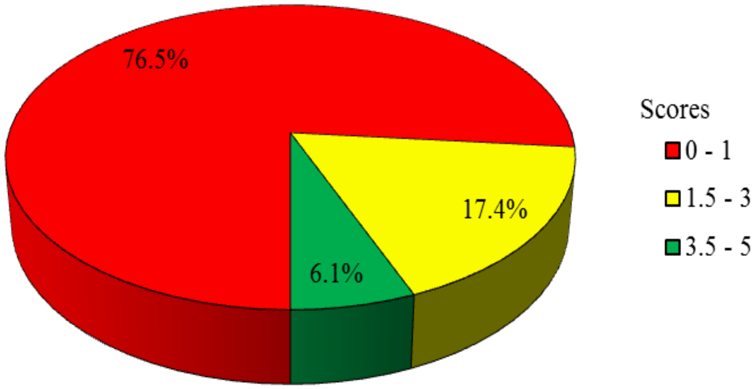


Figure 7: Candidates' performance on Question 6

The candidates who scored 0 had several weaknesses with regard to the linear motion topic. Some of them lacked knowledge and skills on computation on how one car would surpass the other car when they are travelling in the same direction at different speeds. Others failed to remember any linear motion formula. This question was typically competence based. The candidates failed to envision the way car A could overtake car B. They did not realise that car A would travel two distances to overtake car B. The first distance was from point of car A to point where car B was at rest. The second distance was the distance travelled by car B up to the point of overtaking. They also failed to remember the formula $S = t + \frac{1}{2}at^2$, which could lead them to compute the two distances travelled by car A. Some of these candidates made errors while calculating this question. They made computation of the given data in question by engaging simple arithmetic computation such as multiplication of the given data, summation of data and the like. Through their responses, it was noted that they either lacked the concept of the linear motion topic or did not remember the formula required. A sample of a poor response scanned from a script of one candidate is presented in Extract 6.1.

6 Solution

Data given.

60 km

Accelerations A $5m/s^2$ and $3m/s^2$

How long in minutes will car A overtake car B?

$A = 5m/s^2$

$B = 3m/s^2$

$5m/s^2 \times 3m/s^2 = 60$

$\sqrt{15m/s^2} = 60$

$\frac{15m/s}{15} = \frac{60}{5 \times 2}$

$m/s = 6$

$\therefore$ The minutes will car A overtake car B is 6-minutes.

Extract 6.1: A sample of the poor response

Extract 6.1 shows a poor response from the script of a candidate who failed to calculate the distances that could be taken for car A to overtake car B. Thus he/she was not able to calculate the time required.

Some of the candidates who scored more than 1 mark remembered the formula for finding the distance moved (*S*) in a given interval of time *(t*) which is given by $S = ut + \frac{1}{2}at^2$ but did not succeed to use that formula to form a new equation. Therefore, they scored low marks.

There were candidates who scored 1.5 to 3 marks. Some of these managed to write the formula for the distance taken by car A to overtake car B but they failed to add the distance of interval between car A and car B. Therefore, they scored average marks. Others managed to arrange the two equations required for this calculation but instead of adding the two distances which are 60000 mm and the distance travelled by car A, they wrongly subtracted from each other thus they scored average marks.

However, 11.4 percent of the candidates who scored all 5 marks were able to envision the way car A overtook car B. They were able to calculate the two distances travelled by car A to overtake the car B by applying the formula $S = t + \frac{1}{2}at^2$. Furthermore they were able to make t the subject to execute the time that would be taken for car A to overtake car B. Extract 4.2 shows a sample of good response from one candidate.

6. Data given

$a_1 = 5m/s^2$ $\qquad$ $a_2 = 3m/s^2$

A $\qquad$ B $\qquad$ •X•

60km

from: $S = ut + \frac{1}{2}at^2$

• In case of B; $S_b = ut + \frac{1}{2}at^2$ since $u = 0m/s$

$S_b = \frac{1}{2}at^2$

$S_b = \frac{1}{2} \times 3t^2$

$S_b = 1.5t^2$.

• In case of A $\Rightarrow$ $S_a = 60^{km} + S_b$

$\Rightarrow S_a = ut + \frac{1}{2}at^2$ since $u = 0m/s$

$\Rightarrow S_a = \frac{1}{2} \times 5t^2$

$S_a = 2.5t^2$

then

$S_a = 60{,}000m + S_b$

$2.5t^2 = 60000 + 1.5t^2$

$(2.5 - 1.5)t^2 = 60000m$

$t^2 = 60{,}000$

$t = \sqrt{60000}$

$t = 244.9$ seconds $= 4.1$ minutes.

$\therefore$ Car A will take 4.1 minutes or 244.9 seconds to overtake B

Extract 6.2: A sample of a good response

In the sample above the candidate managed to perform well on this question. He/she remembered the equation $S_A = u_A t + \frac{1}{2}a_A t^2$ for the distance moved by car A and $S_B = u_B t + \frac{1}{2}a_B t^2$ for the distance moved by car B. Then he/she was able to form the equation $S_A = S_B + 60000$ at the instant when car A overtook car B. Finally, he/she substituted the correct data into the equation created hence obtained the value of t as 244.95 seconds or 4.1 minutes.

2.2.6 Question 7: Optics (Light)

Question number 7 stated as follows:

An object of 10 cm high is placed at 30 cm away from a concave mirror. A 2 cm high image is formed on the same side as the object. Determine:

(a) the image distance from the mirror.

(b) the value of the focal length.

The analysis shows that 1168 (86.72%) candidates attempted this question. Among them, 390 (33.4%) scored 0 to 1 mark; 197 (16.9%) scored 1.5 and 3 marks and 581 (49.7%) scored 3.5 to 5 marks. The candidates' performance in this question was good. The graphical presentation of the groups of scores is summarised in Figure 8.

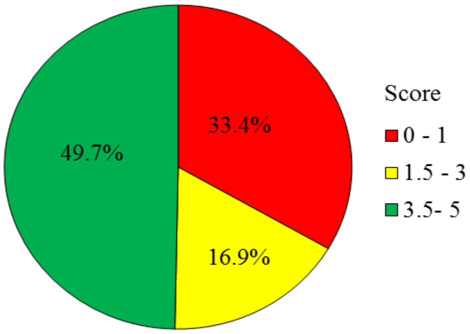


Figure 8: Candidates' performance on Question 7

The candidates who scored all the 5 marks were able to remember and apply the magnification formulae $m = \frac{v}{u}$ and $m = \frac{h_i}{h_o}$ to find the image distance (*v*) from the mirror and also managed to apply the mirror formula $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ to determine the value of the focal length *f* of the concave mirror as shown in Extract 7.1.

7. Data given

Object distance; u = 30cm

Object height; HO = 10cm

Image height; HI = 2cm

Image distance; V = ?

Focal length; f = ?

from

(a) Image distance; V = ?

From

$$\frac{V}{u} = \frac{HI}{HO} \quad \text{(magnification)}$$

$$\frac{V}{30} = \frac{2}{10}$$

$$10V = 30 \times 2$$

$$V = \frac{30 \times 2}{10}$$

$$V = 6\text{cm}$$

$\therefore$ Image distance from the mirror is; $V = 6$cm

(b) focal length; f = ?

from

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

$$\frac{1}{f} = \frac{1}{30} + \frac{1}{6}$$

7 (b) $\frac{1}{f} = \frac{1+5}{30}$

$$\frac{1}{f} = \frac{6}{30}$$

$$6f = 30$$

$$f = \frac{30}{6}$$

$$f = 5\text{cm}$$

$\therefore$ The value of focal length; $f = 5$cm

Extract 7.1: A sample of a good response to Question 7

In Extract 7.1, the candidate managed to recall and apply the correct magnification formula to determine the image distance (*v*). Also, he/she managed to determine the value of the focal length *(f)* of the concave mirror.

On the other hand, it was shown that some of the candidates who scored less than 5 marks seemed to be familiar with the magnification and the mirror formula but presented wrong substitution of data. For example, some of them instead of substituting the value of h_o into the equation $v = \frac{h_I}{h_O} x\, u$, they substituted the value of u. This made them score good marks but less than 5 given marks.

However, a few (16.9%) candidates scored 1.5 to 3 marks. Some of these candidates were only able to write the two formulae for magnification and mirror. Others wrote the formula and substituted wrong data in the formula. Therefore, they scored average marks.

There were also a considerable number (33.4%) of candidates who scored 0 to 1 mark. Some of these candidates presented only a mirror formula thus scored 1 mark. Others failed to present any correct formula between the magnification and mirror formula. Thus, they scored zero. Extract 7.2 shows a sample of a response from the script of a candidate who performed poorly.

7. (a) the image distance from the mirror

10cm B ~~60cm~~ 30cm A 2cm

Soln

30cm + 10cm

40cm + 2cm

60cm

∴ distance from image the mirror 60cm

(b) ~~60cm~~ distance image from the mirror 60cm

30cm x 10cm + 2

soln

60cm + 30cm

= 90cm + 10cm

= 100cm + 2cm

= 3000cm

∴ the value of focal length = 3000cm

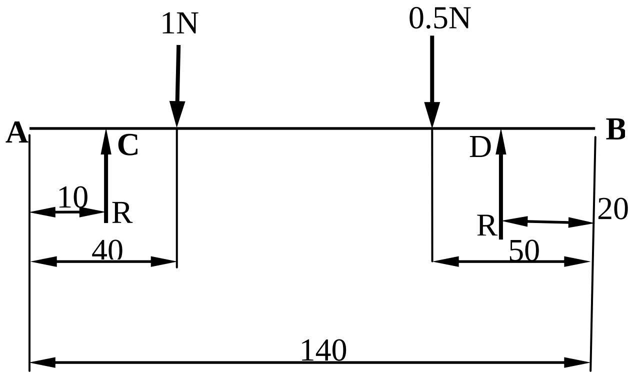
Extract 7.2: A sample of poor responses to Question 7

Extract 7.2 shows a candidate who failed to determine the image distance from the concave mirror and the focal length of the mirror. This candidate failed to remember any formula instead he/she computed unknown arithmetic to determine the image distance (v) and the focal length (f) and ended up with wrong answers.

2.2.7 Question 8: Turning Forces

This question was constructed in order to measure the ability of the candidates to make use of the principle of moments and its application. The question read as follows:

Figure 4 shows a uniform wooden lath AB, weighing 1 N rests on two sharp-edged supports C and D. Calculate the reactions at the supports R_1 and R_2.



This question was attempted by 75.7 percent of the candidates. Among them, 63.3 percent scored 0 to 1 mark, 38.4 percent scored 0 mark, 33.8 percent scored 1.5 to 3 marks and 2.9 percent scored 3.5 to 5 marks. This question was among those performed averagely. The graphical presentation of scores is summarised in Figure 9.

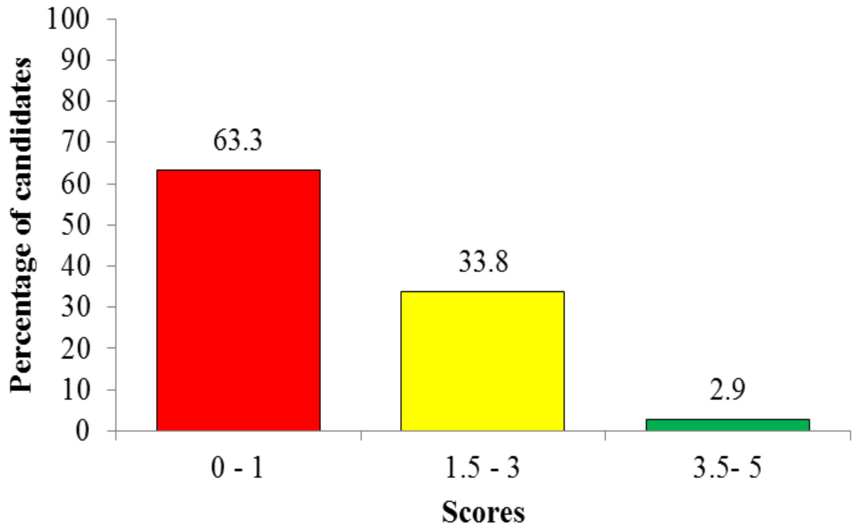
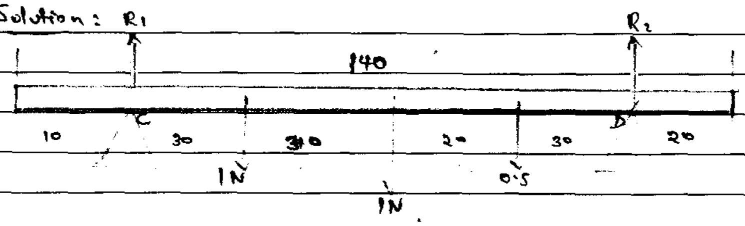


Figure 9: Candidates' performance on Question 8

It was observed that the candidates who scored 5 marks had the ability to state and apply two conditions for equilibrium when a number of parallel forces act on a body. This group were also able to realize that a uniform wooden lath has the same thickness and therefore its weight was 1N and acted at its centre. They managed to sum up the forces with regard to their direction and they applied the equation of the sum of the clockwise and anticlockwise moments to solve the required reactions. Extract 8.1 is a sample of a good response as scanned from a script of a candidate.

8: Solution:



~~Hacking~~ R_2 Fulcrum at R_2

From: Clockwise moment = Anticlockwise moment.

$R_1 \times 110 = 1N \times 80 + 1N \times 50 + 0.5N \times 30$

$110 R_1 = 80N + 50N + 15N$

$R_1 = \frac{145}{110}$

$R_1 = 1.4N$

From: Sum of Upward force = Sum of Downward force

$R_1 + R_2 = 1N + 1N + 0.5$

$R_2 + 1.4N = 2N + 0.5N$

$R_2 = 2.5N - 1.4N$

$R_2 = 1.1N$

∴ Reaction support $R_1 = 1.4N$ and $R_2 = 1.1N$.

Extract 8.1: A sample of a good response to Question 8

Extract 8.1 shows a sample of response from a candidate who managed to identify uniform beam with the same weight, and therefore its weight acted at its centre. Also, the candidate managed to apply the two conditions for equilibrium when a number of parallel forces act on a body, to solve the reactions R_1 and R_2 at supports C and D.

The analysis established from the script of the candidates shows that 2.9 percent scored below 3.5 marks but more than 1.5. They marks did not realize that a given weight of the wooden lath AB acts at its centre. This confused some of the candidates by placing the weight of lath at other positions rather than the middle of the lath and therefore they scored averagely on this question. Others were not able to include the weight of the lath (hidden downward force = 1N). As a result, their computation ended up with wrong answers. If these candidates had known the concept of including the weight of lath in their calculation they could have been able to compute this question and end up with correct answers.

There were 38.4 percent of the candidates who scored 0 mark. It was observed that, most of them failed to state the two conditions for equilibrium of parallel forces. Their computation on this question revealed they lacked the concept of the turning forces topic. Moreover, they lacked knowledge and skills of sketching the balanced parallel forces in a meter rule or lath. Others confused the principle of moments with that of determining the equivalent resistance connected in parallel electric current. Extract 8.2 shows a sample of a poor response extracted from the script of one candidate.

8 $R_{Total} = \frac{R_1 R_2}{R_1 + R_2}$

$R_{total} =$

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

$= \frac{40 \times 50}{40 + 50}$

$= \frac{200\cancel{0}}{9\cancel{0}}$

$= \frac{200}{9}$

The reaction support total resistance is 22.2 Ω

Extract 8.2: A sample of poor response to Question 8

Extract 8.2 shows the response from the script of a candidate who confused the formula of principle of moments with that of determining the equivalent resistance from the parallel electric current circuit. Instead of applying the two conditions for equilibrium when a number of parallel forces act on a body, he/she substituted the data (distances referring the position of downward forces) into the formula for equivalent total resistance of parallel resistance in an electric circuit thus ended up with wrong computation and responses.

2.2.8 Question 9: Angular Motion

The question read as follows:

A car moving with a velocity of 10 m/s accelerates uniformly for 0.5 km until its velocity is 18 m/s. If the rolling diameter of the wheels is 600 mm, determine the wheels angular acceleration.

The statistics show that 1141 (92.6%) candidates attempted this question. Among them, 67.6 percent scored from 0 to 1 mark with 42.2 percent being those who scored 0 mark, 15.6 percent scored from 1.5 to 3 marks and 18.8 percent scored from 3.5 to 5 marks. This analysis is summarized in Figure 10.

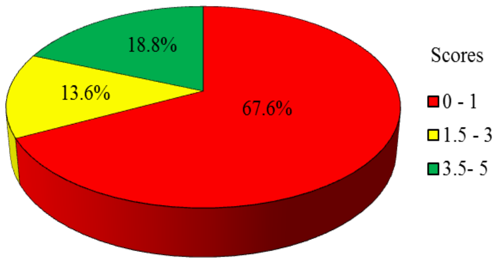


Figure 10: Candidates' Performance on Question 9

The candidates who scored 0 in this question were not able to identify linear motion equations. They failed to write the formula $v^2 = u^2 + 2aS$ and $a = \alpha r$ through which they could determine the wheels angular acceleration. Most of these candidates did not write any formula. Instead they did some arithmetic computation by using the given data thus presenting unknown calculation with wrong responses. Extract 9.1 provides a sample of poor response.

9 A car moving with a velocity m/s accelerates uniform ly per 0.5 km until its velocity is 18 m/s If the rolling diameter of the wheel is 600 mm. determine the wheels angular acceleration.

soln

Data given

velocity = 10 m/s

time = 18 m/s

Data = 0.5

soln

Velocity = $\frac{10 \text{ m/s} \times 18 \text{ m/s}}{0.5}$

$\frac{10 \text{ m/s} \times 18 \text{ m/s}}{0.5} = \frac{180}{0.5}$

$\frac{180}{0.5} = 36$ m/s

The wheels angular acceleration is 36 m/s

Extract 9.1: A sample of poor response to Question 9

In Extract 9.1 the candidate failed to write the formula $v^2 = u^2 + 2aS$ and $a = \alpha r$ and applied wrongly the given data to the calculation. Therefore, the candidate failed to attain good scores.

From the analysis point of view, it was seen that the candidates who scored 0.5 to 1 mark were able to write the formula $v^2 = u^2 + 2aS$ or $a = \alpha r$ but did not convert the dimensions of distance and diameter provided in the question to millimetres and metres. Therefore, their computation gave them wrong responses. Others managed only to convert the dimension but they failed to remember the formula and thus they ended up with low marks on this question.

The analysis shows that 13.6 percent scored 1.5 to 3 marks. Most of these candidates were able to convert the distance moved by the car from kilometre and millimetre to metres but they failed to remember the correct linear and angular motion formula so that they could compute the angular acceleration requested. Others managed only to remember either the correct linear or angular motion formula therefore their computation led them to perform averagely on this question.

Moreover, 18.8 percent of the candidates who scored high marks (3.5 - 5) were able to write both the formula $v^2 = u^2 + 2aS$ and $a = \alpha r$ and apply correctly the given data for the calculatin therefore some of them attained correct responses. Among these candidates, there were those presented all calculation steps correctly and scored all 5 marks. Others made some errors in the calculation of linear acceleration thus scored 3.5 and less than 5 marks. Extract 9.2 provides a sample of good response.

9. Data given

Initial velocity (u) = 10m/s

distance (s) = 0.5km = 500m.

final velocity (V) = 18m/s

diameter of wheel (d) = 600mm = 0.6m.

angular acceleration = ?

from

$a = \alpha r$

but

$v^2 = u^2 + 2as.$

$(18)^2 = (10)^2 + 2 \times a \times 500$

$324 = 100 + 1000a$

$324 - 100 = 1000a$

$224 = 1000a$

$\frac{224}{1000} = \frac{1000a}{1000}$

$a = 0.224 \text{ m/s}^2.$

then,

$a = \alpha r$

but

~~radius~~ $= \frac{\text{diameter}}{2}$

$= \frac{0.6m}{2}$

$= 0.3m.$

then

$a = \alpha r$

$\alpha = \frac{a}{r}$

$= \left(\frac{0.224}{0.3}\right)$ ~~rad/sec²~~

$\alpha = 0.7467 \text{ rad/sec}^2$

$\therefore$ angular acceleration = 0.7467 rad/sec²

Extract 9.2: A sample of good response to Question 9

Extract 9.2 contains a response of the candidate who was able to convert 0.5 km into metres and 600 mm into metres. He/she applied the formula $v^2 = u^2 + 2aS$ to obtain the linear acceleration *'a'*. Finally, the candidate managed to substitute the value of 'a' into $a = \alpha r$ to obtain the angular acceleration 'α' into radians per square second.

2.2.9 Question 10: Angular Motion

The question stated as follows:

One boy in the mechanical workshop has to tight a nut of a school lorry. A force of 50 N is to be applied at right angles to the end of a spanner 150 mm long. Find the work done by the boy if the spanner is moved through 150°.

The analysis shows that this question was attempted by 1101 (89.4%) candidates. Among them, 468 (42.5%) scored 0; 308 (28%) scored 0.5 to 1 mark; 165 (15.0%) scored 1.5 to 3 marks; whereas 160 (14.5%) scored 3.5 to 5 marks. Generally the candidates' performance in this question was weak. This performance is also signposted by Figure 11 which shows the percentage of the candidates' performance graphically.

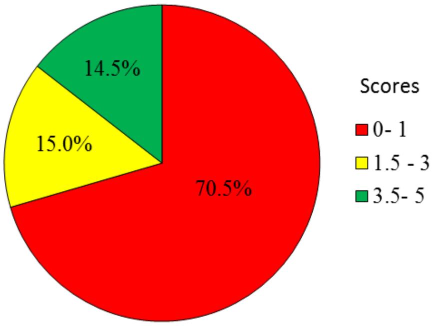


Figure 11: Candidates' Performance on Question 10

Most of the candidates (70.5%) did not perform well (as they scored less than 1.5 marks) on this question. Some of them were only able to remember the formula for work done which is the product of force and distance moved by the force and failed the rest. Others did not manage to convert the angle θ from degrees into radians. They just substituted 150° into the formula, Work done = $F \times r\theta$ thus ended up with an incorrect value of the work done by the boy. From the analysis, it was shown that about half of all the candidates (42.5%) who attempted this question scored zero because they failed to understand that from angular motion the distance (s) moved by a rotating particle is given by $S = r\theta$ (that is, distance = radius x angular displacement in radians). They also did not use the equation work done = $F \times r\theta$ or work done = $Fr \times \theta$ where Fr is equal to Torque 'T', thus work done = $T \times \theta$. It seems they lacked knowledge on the topic of work done especially on the subtopic Torque. Their computation engaged wrong formula. As a result, they scored zero. Extract

10.1 gives a sample of a poor response as extracted from a script of one candidate.

10. Data given ..

Force (F) = 50 N .

Length of Spanner (L) = 150 mm

Spanner Moved through angle = 150°

Required : The work done by the ~~bod~~ boy

Soln .

From ,

Workdone = $\frac{\text{Force}}{\text{distance}}$

= 50 N X 150 mm

= 50 N X 0.15 m

⇒ 7.5 Nm or Joules .

∴ The workdone by the boy = 7.5 Nm or Joules .

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

In Extract 10.1, the candidate failed to identify the appropriate formula for calculating the work done by the boy when turning a spanner through an angle of 150°. The candidate wrote work done = force x distance moved instead of writing work done = force x distance that is, Torque x angular displacement or work done =Fr x θ. He/she also failed to change the angle 150° into a radian.

Most of the candidates who scored averagely on this question (from 1.5 to 3 marks) were either able to convert the angle θ from degrees into radian or wrote the correct formula but substituted 150° into the work done = F x rθ. Thus, they scored average marks on this question. Others remembered part of the formula but failed to remember the angular distance travelled which is given by S = rθ. Therefore their computation operations had carried average scores.

The candidates who scored all the 5 marks allocated for this question understood that the work done by a rotating spanner is given by the equation *Work done = F x rθ*. They also, converted the angle θ into a radians before substituting it into the formula. They pursued all calculation steps successfully and obtained the correct answer. A sample of a good response as extracted from a candidate's scripts is depicted by Extract 10.2.

10. Data given.
force = 50N
radius = 150mm = 0.15M.
Angle = 150°
Work done = ?
From the formula.
Work done by the torque = Tθ.
but
Torque = Fr.
= 50 x 0.15
Torque = 7.5NM.
Work done = Tθ.
but
θ will be in radian.
From.
1 rad = 57.3°
? = 150°
= 2.6 rad.
Work done = 7.5 x 2.6
= 19.65
The work done = 19.65Joule.

Extract 10.2: A sample of a good response to Question 10

Extract 10.2 shows the candidate who understood that the work done by a rotating a rod is given by employing torque. He/she managed to convert the angle from degree into radian and managed to carryout all calculation steps successfully to obtain the intended response.

2.3 SECTION C: Structured Questions

2.3.1 Question 11: Heat

Question 11 stated as follows:

Suppose the equipment made up of 1 kg of aluminium, 1.5 kg of copper and 2.5 kg of iron is cooled from 50°C top 20°C at a rate of 1.9kJ/min. If the relative specific heat capacities are aluminium 0.21, copper 0.09 and iron 0.12.

(a) *Determine the thermal capacity of the equipment.*

(b) *How long would it take to cool down the given range?*

The candidates who attempted this question were 829 (67.3%). Among them, 756 (91.2%) scored from 0 to 4 marks where 674 (81.3%) scored 0 mark; 44 (5.3%) scored from 4.5 to 9.5 marks; whereas 29 (3.5%) scored from 10 to 15 marks. The candidates' performance on this question was generally weak. This performance is also presented by Figure 12 which shows the percentage of candidates' performance graphically.

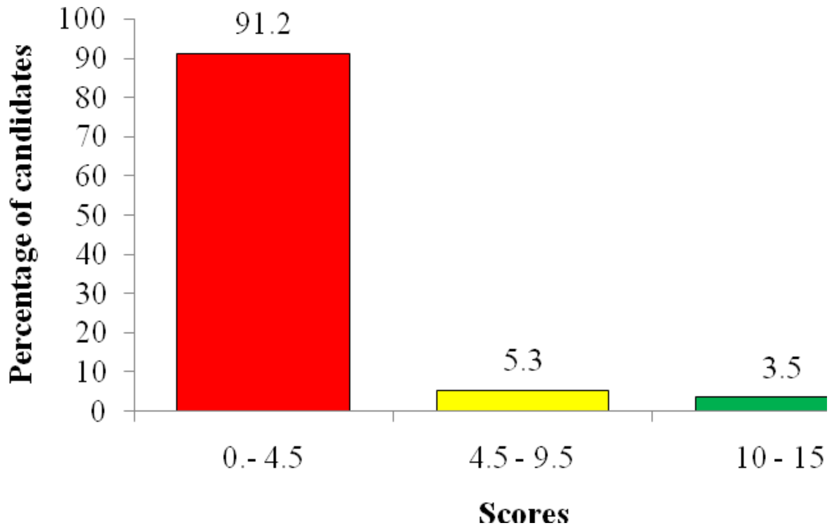


Figure 12: Candidates' Performance on Question 11

The data analysis shows that 91.2 percent of the candidates scored 0 to 4 marks out of which 81.3 percent scored 0. This indicates that most of the candidates who opted this question had insufficient knowledge on the topic Heat because they failed to remember the formula for Specific heat capacity and thermal capacity of aluminium, copper and iron respectively. Others presented wrong computation by substituting the given data into a wrong formula. Therefore, they finished their calculation with an incorrect answer in part (a) and (b). In part (a), most of them had no idea that Thermal capacity of the equipment is the summation of the Thermal capacities of all materials of aluminium, copper and iron. In part (b) they were not able to describe the formula of heat transmitted to the surroundings which is equal to thermal capacity of equipment times the fall in temperature of the equipment. Therefore, they scored 0. The major challenge to the candidates who attempted this question was on how to create a proper expression for computing the total thermal capacity of the equipment. Another challenge was on how to calculate the specific heat capacities of the aluminium, copper and iron in part (a). Extract 11.1 shows a sample of poor response from a script of one candidate.

11. Data.

Aluminium = 1kg

Copper = 1.5 kg

Iron = 2.5 kg

Initial temperature = 50°c

Final temperature = 20°c

rate = 1.9 kJ/min

heat capacity of aluminium = 0.21

heat capacity of copper = 0.09

heat capacity of iron = 0.12

Thermal capacity of the equipment = ?

Long would it take to cool down the given range = ?

a) Soln

$0.21 + 0.09 + 0.12$

$= 0.42$

$50°c + 20°c$

$70°c$

$0.42 \div 70°c$

$\frac{70°c \times 100}{0.42 \times 100}$

$\frac{7000}{42}$

$= 166.66$

$= 166.66 \approx 166.7$

There fore the thermal capacity of the equipment = 166.7

11. b) Soln

$\frac{166.7}{1.5 + 2.5 + 1}$

$\frac{166.7}{5}$

$\frac{166.7 \times 10}{5 \times 10}$

$\frac{1667}{50}$

33.34

The long would it take to cool down the given range = 33.34

Extract 11.1: A sample of a poor response to Question 11.

Extract 11.1 shows that the candidate failed to write the formula for finding specific heat capacity of a material using the equation: *specific heat capacity a material = relative specific heat capacity of the material x specific heat* *capacity of water*. He/she also failed to form the expression which could have been used to find the total thermal capacity of the equipment.

On the other hand, 9.9 percent of the candidates scored from 0.5 to 4 marks. These were able either to write one or two formulae for either thermal capacity of the equipment or the specific heat capacity of a substance but substituted wrong data and therefore they scored low marks. Others identified the fundamental formulae used to calculate the thermal capacity of the equipment or the specific heat capacity of a substance but failed to follow up the correct procedures to obtain the required answer. It seemed that they did not understand that thermal capacity and heat capacity have the same meaning. Furthermore, they failed to realize that the quantity of heat lost or transmitted to the surroundings per minute is equal to thermal capacity times the fall (change) in temperature of the equipment.

Those who scored averagely on this question (5.3%) were only able to identify the formula for thermal capacity of the equipment but failed to write the formula for the specific heat capacity of a substance which was equal to relative specific heat capacity times specific heat capacity of water. Others wrote all the formula correctly in part (a) but wrote the wrong one in part (b). For example, instead of writing “Heat transmitted to surroundings = Thermal capacity of equipment x fall in temperature in the equipment”, they wrote *Heat transmitted to surroundings = Specific heat capacity of aluminium+ thermal capacity of + thermal capacity copper + thermal capacity iron.* Thus ended up with average marks .

Some of the candidates who scored high marks (10 to 15 marks) were able to verify that in order to obtain the total thermal capacity of the equipment, the specific heat capacity of each material must be found first using the formula specific heat capacity = specific heat of capacity of water x relative specific heat of the material. They managed to calculate and substituted correct data to to obtain the specific heat capacity of material and their thermal capacity. A few (1.6%) failed to remember the formula $Q \times t = C\Delta\theta$ which could be used to calculate time‘t’ for the equipment when cooled from 50^oC to 20^oC. Therefore, their computation ended up with high marks but less than 15 marks.

The analysis shows that there were 16 (1.9%) who scored all 15 marks. These candidates were able to calculate all necessary parameters in part (a) and (b). Therefore, they managed to determine the thermal capacity of the instrument and the time that would be taken down the equipment to the given range of temperature change. Based on their responses, it was observed that, the candidate from this group had enough knowledge on the topic about heat especially when dealing with thermal heat capacity and specific heat capacity of a substance. Extract 11.2 shows a well presented answer of the candidates who scored all 15 marks.

11(a) Thermal capacity = 1.5Kg x 378J/Kg°C
Thermal capacity = 567J/°C

For Iron
Mass = 2.5Kg
C = Required
but C = 0.12 x 4200J/Kg°C
C = 504J/Kg°C
Thermal capacity = 2.5 x 504J/Kg°C
Thermal capacity = 1,260J/°C

Thermal capacity of equipment
= Summation of thermal capacities of Al, Cu and Fe

Thermal capacity of equipment
= 882J/°C + 567J/°C + 1260J/°C
= 2,709 J/°C
∴ Thermal capacity of equipment is 2,709J/°C

11. b)
From
$$\text{Rate} = \frac{\text{Heat energy}}{\text{Time}}$$
but (H) Heat energy = Thermal capacity x change in temperature
~~Δθ~~
change in temperature = Initial temperature − Final temperature
Change in temperature = 50°C − 20°C
change in temperature = 30°C
Heat energy = 2,709J/°C x 30°C
Heat energy = 81,270J

$$\text{Rate} = \frac{\text{Heat energy}}{\text{Time}}$$
whereby Rate = 1.9KJ/min (1900J/min)
H = 81,270J

$$1900\,J/min = \frac{81,270\,J}{time\ (t)}$$
$$\frac{1900\,J/min\ t}{1900\,J/min} = \frac{81,270\,J}{1900\,J/min}$$

t = 43min
∴ It would take 43 minutes to cool down the given range.

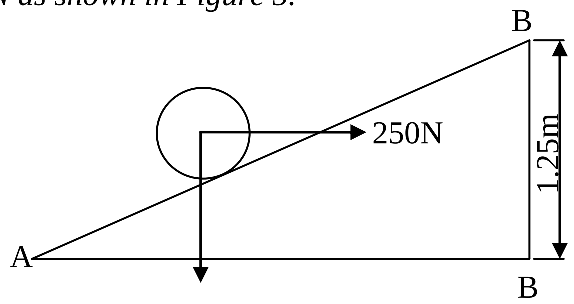
Extract 11.2: A sample of a good answer to Question 11

Extract 11.2, shows the response of one candidate who was able to attempt the question correctly in parts (a) and (b). The candidate managed to remember the formula and substituted the correct data and followed all calculation steps correctly and come up with correct responses in both parts of the question.

2.3.2 **Question 12: Simple Machine**

The question stated as follows:

(a) *A barrel weighing 1000N is raised from the ground to a platform 1.25m high by rolling it up on a plank. If the effort is applied in a horizontal direction (assuming that resistance due to friction is negligible), what length of plank is necessary to allow the barrel to be raised by a force of 250N as shown in Figure 5.*



(b) *Wooden windlass used by one of artisan miners has a crank of 30 cm long and a barrel of 15 cm diameter (assuming 80% efficient). What is the effort required to raise a load of 300 N?*

This question was opted by 947 (76.9%) candidates. Among them, 695 (73.4%) scored 0 to 4 marks and 161 (17.0%) scored 0; 248 (26.2%) scored from 4.5 to 9 marks; and 4 (0.4%) scored from 10 to 10.5 marks. From the analysis, it was found that only 3 candidates scored 10 marks and 1 candidate scored 10.5 marks. The candidates' performance on this question was generally poor. This performance is also presented in Figure 13 which shows the percentage of the candidates' performance.

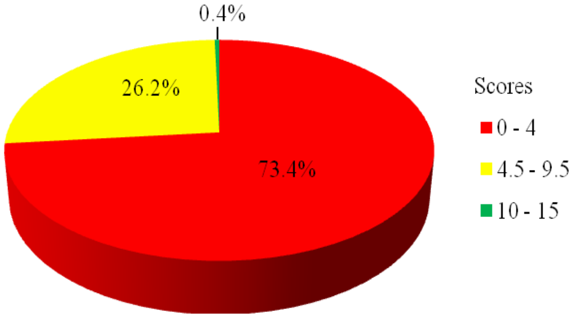


Figure 13: Candidates' Performance on Question 12

The analysis shows verified that the candidates who scored 0 were not familiar with the pulling forces on an inclined surface. Therefore, they failed to resolve the horizontal force of 250N into the component parallel to the plane in part (a). Also failed to present the formula "E= 250N x Cos θ" which was a parallel component to the plane acting upon the plane and represented the effective force that would raise the barrel of 1000N from A to B. They also did not realise that if the barrel of 1000 N was moved by an effort of $250cos\theta N$ from A to B, then the distance moved by the effort was AB (length of the plane) and the distance for the load of 1000N was 1.25 m (height of the plane). Furthermore, the candidates did not realize that since the resistance due to friction was negligible, hence they had to equate the mechanical advantage (M.A) and the velocity ratio (V.R) to form the first equation with unknown angle of the plane and length of the plane as follows: M.A = V.R. That was:

M.A = $\dfrac{1000\,N}{250\cos\theta\,N}$ and V.R = $\dfrac{AB}{1.25\,m}$. They failed to calculate the length AB in part (a) because they lacked the knowledge of identifying the minimum force parallel to the plane required to raise the load up the plane from A to B which is 250 Cos θ (N) and slightly greater than the opposing force acting down parallel to the plane which is 1000 x Sin θ (N).

In part (b), a considerable number of candidates failed to understand that crank of the windlass implied the handle of the windlass. Also, they failed to comprehend that the equation which applicable to calculate the velocity ratio of the windlass (V.R) is V.R = $\dfrac{R}{r}$ which is similar to the equation for calculating the velocity ratio of the wheel and axle with the wheel radius (R) and the axle radius (r). They failed to understand that 30 cm represented the radius (R) of the circle described by the crank (the handle) of the windlass.

Others took 15 cm as the value of the radius (r) of the barrel instead of 7.5 cm which could have been obtained by dividing the diameter of 15 cm by 2. Extract 12.1is a sample of poor response presented by one candidate.

10 a) Soln

data given

weight = 1000 mg

mass = 1.05

force = 250N

length = ?

From the formular

~~length =~~

Length = $\frac{\text{force} \times \text{mass}}{\text{weight}}$

length = $\frac{250N \times 1.05}{1000mg}$

length = $\frac{250N \times 1.05}{1000}$

legth = 31450

b) Data given

time = 30cm

diameter = 15cm

Efficency = 80%

load = 300N

Effort = ?

From the

Efficency = $\frac{\text{Load}}{\text{Effort}}$

Data given

time = 30cm

diameter = 15cm

Efficency = 80%

Effort = ?

Load = 300N

From the formular

Efficency = $\frac{\text{load}}{\text{Effort}}$

Efficency = $\frac{300}{100}$

Efficency = 3000

Effort = 200%

Effort = 200cm²

Extract 12.1: A sample of a poor response to question 12

Extract 12.1 shows a candidate who failed to comprehend that the minimum force, parallel to plane, required to raise the load up the plane from A to B was

250Cos θ (N). In part (b), the candidate failed to calculate the radius (R) of the circle described by the crank of the windlass which could be obtained by of dividing 15 cm by 2. Furthermore, he/she was unable to apply the equations M.A = $\frac{Load}{Effort}$ and Efficiency = $\frac{M.A}{V.R}$ to calculate the effort required to raise the load of 300N.

Some of the candidates who perfomed averagely (4.5 to 9.5 marks) on this question were only able to calculate the minimum force parallel to the plane required to raise the load up the plane from A to B in part (a) but failed to write the formula for the velocity ratio (V.R) of the windlass V.R = $\frac{R}{r}$. Others wrote the correct formula in both parts (a) and (b) but either failed to substitute the correct data either in part (a) or (b). Thus they scored average marks on this question.

There were those who scored high marks. The analysis shows that there was no candidate who scored full marks (15 marks). Only three candidates scored 10 marks and one candidate scored 10.5 marks. These candidates were able to compute correctly and followed appropriates most of the steps of the question except that they mixed up some substitution of data thus ended up with high marks but less than 15 marks allotted to this question. For example, one candidate managed to write all the formulae correctly in parts (a) and (b) and substituted correct data but in part (a) the candidate wrote *Mechanical advantage* = $\frac{Load}{Effort}$ = $\frac{1000\text{ N}}{250\text{ NCos}\theta}$ = $\frac{4\text{N}}{\text{Cos}\theta}$ *and Velocity ratio* = $\frac{Dis\tan ce\ moved\ by\ Effort}{Dis\text{tance moved by Load}}$ but did not carry out further calculation to obtain the velocity ratio and therefore did not score all the allotted marks. Extract 12.2 shows a part of correct response provided by one of the candidates.

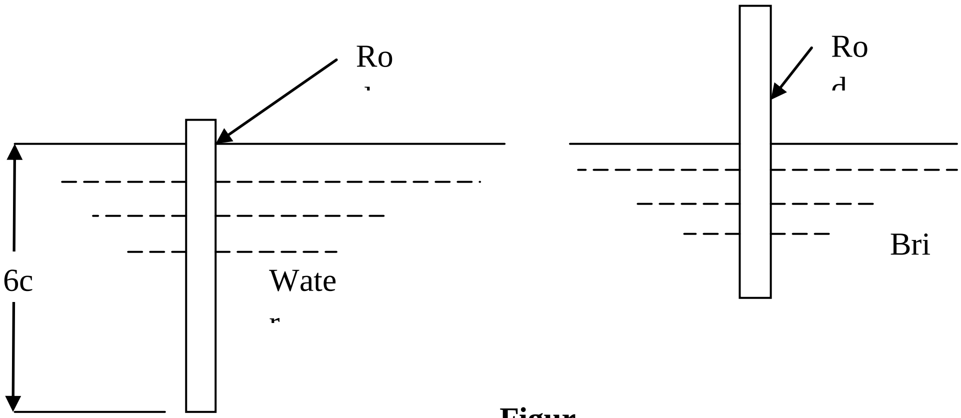
12(b)	Data:
	length of Crank, $L = 30cm$
	diameter of barrel, $d = 15cm$
	efficiency, $e = 80\%$
	Load, $L = 300N$
	Effort distance $= 30cm \times 2$
	$= 60cm$
	$V.R = \frac{Ed}{Ld} = \frac{60cm}{15cm}$
	$V.R = 4$
	$e = \frac{M.A}{V.R} \times 100\%$
	$100 \times M.A = e \times V.R$
12(b)	$M.A = \frac{80 \times 4}{100} = 3.2$
	Effort applied $= \frac{Load}{M.A}$
	Effort $= \frac{300N}{3.2}$
	$= 93.75N$
	∴ Effort applied is 93.75N
12(a)	Data:
	Horizontal Force, $P = 250N$
	Weight, $W = 1000N$
	Length, $BC = 1.25m$
	Friction force, $fr = 0N$
	From
	$P\cos\theta = Mg\sin\theta + \mu R_n$
	but since $Fr = 0$ and $\mu = 0$
	$P\cos\theta = Mg\sin\theta$
	$250\cos\theta = 1000\sin\theta$
	$\tan\theta = \frac{250}{1000}$
	$\tan\theta = 0.25$
	$\theta = 14.05° \approx 14°$
	Length $AB = \frac{BC}{\sin\theta}$
	$AB = \frac{1.25m}{\sin 14°}$
12(a)	$AB = \frac{1.25m}{0.2419}$
	$AB = 5.168m$
	∴ length of plane is 5.168m

Extract 12.1: A sample of a good response to question 12

Extract 12.1 the candidate was able to comprehend that the minimum force, parallel to plane in part (a), required to raise the load up the plane from A to B is 250CosθN. Therefore, the candidate accurately calculated the length of the plane. In part (b), the candidate managed to calculate the radius (R) of the circle described by the crank of the windlass where he/she divided 15 cm by 2. Furthermore he/she was able to apply the equations M.A = $\frac{Load}{Effort}$ and Efficiency = $\frac{M.A}{V.R}$ to calculate the effort required to raise the load of 300N.

2.3.3 **Question 13: Fluid Mechanics**

Question 13 consisted of two parts, (a) and (b). Part (a) was as follows:
The weighed rod in Figure 6 floats with 6 cm of its length under water of density 1000 kg/m^3. What length of the rod is under the surface when the rod floats in brine of density 1200 k/m^3?



Figur

In part (b), the question was as follows:

A cube of volume 7.2 cm^3 displaces 2000 N of water when floating in a swimming pool. What is the volume of the cube which is above the water surface?

The candidates who attempted this question were 729 (59.2%). Among them, 439 (60.2%) scored 0 to 4 marks; out of whom 290 (39.8%) scored 0 mark; 185 (25.4%) scored 4.5 to 9.0 marks; and 105 (14.4%) scored 10 to15 marks. The candidates' performance in this question was average. This performance is also indicated by figure 14 which shows the percentage of candidates' performance graphically.

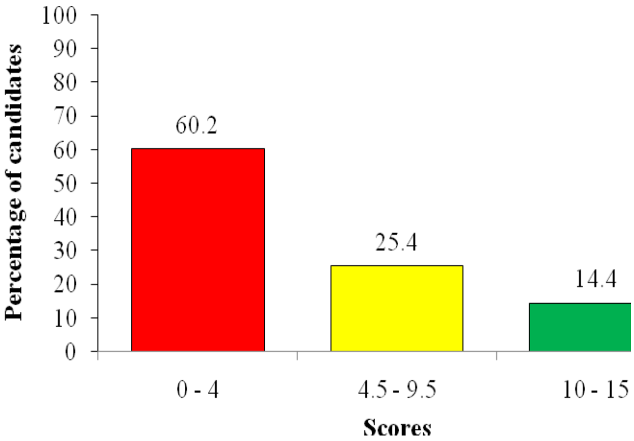


Figure 14: Candidates' Performance on question 13

Some of those who scored 0 to 4 marks were not able to remember the formula for density in which they could make the Volume 'V' the subject such as V = $\frac{m}{\rho}$ where V is the volume of the brine displaced. Furthermore the candidates failed to use this formula to calculate the volume of water displaced and therefore they failed to calculate the mass of the brine displaced in part (a). In addition to that, they failed to remember the law of floatation which could lead them to give the formula for mass of the brine displaced = mass of water displaced. They further failed to calculate the length 'L' by employing volume 'V' and area 'A'.

Likewise, in part (b), the candidates had to apply the law of flotation in order to get the mass of water displaced and hence the volume of the water surface which is equal to the volume of the cube below the surface of water. But some of them failed to subtract the volume of water displaced (that is, the volume of the cube below the surface) from the whole volume of the cube to get the volume of the cube above the surface of water which is 7.0 m^3. Therefore, these candidates scored 0 in this question. For candidates who scored 0.5 to 4 marks (20.4%) managed either to write only a formula for density or both density and volume in part (a) and therefore they scored low marks. Others were able to write both the formula and the law of floatation but failed to substitute correctly the data. They, thus ended up scoring between 0 and 4 marks. Extract 13.1 provides a sample of a poor response.

13. (a) Solution.

Data given.

Flots length = 6cm

Density of H_2O = 1000 kg/m³

Road float in brine of density = 1200 kg/m³

length of rod = ?

Relative dencity = $\frac{\text{Density of brine of road}}{\text{Denity of water.}}$

R.D = $\frac{1200\ kg/m^3}{1000\ kg/m^3}$ = 1.2

⇒ ∴ R.D = 1.2

∴ Relative density = 1.2

But.

length under the surface = relative density x length of water.

Length of under surface = 1.2 x 60cm

lengh of under surface = 72 Cm

∴ length of the rod is under the surface is 72cm

13. (b) Solution.

Data given

Volume = 7.2 m³

Force of water = 2000N

Volume of the cube = ?

The volume of the cube = $\frac{\text{Force of water}}{\text{Volume}}$

But Density of water = 1000 kg/m³

Density of water = $\frac{\text{Force of water.}}{(V_1 - V_2)}$

Volume of the cube = $\frac{2000N}{7.2\ m^3}$ = 28N/m³

Volume of cube = $\frac{28N/cm^3}{100}$

Volume = 2.8

∴ The volume of cube = 2.8 m³

Extract 13.1: A sample of a poor response given by one of the candidates to question 13.

In Extract 13.1, the candidate failed to apply the law of floatation to determine the length of the rod under the surface when it was floating in brine in part (a). Likewise, in part (b), the candidate failed to apply the same law of floatation to determine the volume of the cube which was above the water surface.

The analysis shows that, some of those who scored 5 to 9 marks were able to write a formula for the density only or for both density and volume in part (a). In part (b) they wrote correctly the formula for volume of the cube above water surface which is 'Total volume of the cube – Volume of the cube below the water surface' and substituted some of the data correctly but with some mistake in part (a) as they failed to apply the law of flotation. Thus, they obtained the length of the rod when it floats in brine. Others managed only to perform well in part (b) and therefore they scored average marks.

Despite that, the question was averagely performed. There were those who scored high marks (from 10 to 15 marks). Some of these candidates were able to write the law of flotation and correct formulae in parts (a) and (b) but made some mistakes in their computation. For example, one candidate did not substitute the value of the length of the rod under water and therefore he/she failed to calculate the correct length of the rod when it floats in brine thus the candidate scored below 15 marks. A few candidates (6.7%) from this group were able to score all 15 marks. These candidates managed to calculate the length of the rod under the surface when the rod floats in brine in part (a) and the volume of cube above the water surface. Analysis of their responses, it was shown that, these candidates had knowledge on fluid mechanics. They also had enough skills to compute different parameters with regard to fluid mechanics. Extract 13.2 indicates a response of a candidate who performed well in both parts of the question.

13 (a) Data.

Length under water = 6 cm = 0.06 m
Density of water = 1000 kg/m³
Density of brine = 1200 kg/m³
Length under brine = ?

solution;

Mass of rod = Volume of rod x Density.
Mass of water displaced = volume of rod under water x Density of water.

$M = V \times \rho$.
$M = 1000V$. (kg)
but Volume = Area x height under water
$= 0.06A$.
$M = 1000 \times 0.06A$ (kg).
$M = 60A$ (kg) → In water. — (I)

Mass of brine displaced = volume of rod under brine x Density of brine.
$M = V \times \rho$
$= V \times 1200$
$M = 1200V$ (kg).
But; Volume = Area x height under brine.
$= A \times h$.
∴ $M = 1200Ah$. (Kg) — Brine. — (II)

But Mass of rod in water = Mass of rod in brine.
$\therefore \frac{60A}{1200A} = \frac{1200Ah}{1200A}$
$h = \frac{60}{1200}$ (m).

$h = 0.05$ m.

$h = 5$ cm.

$\therefore$ The length of the rod under the surface of brine $= 5$ cm.

(b) Data.

Volume of cube $= 7.2 m^3$

~~Force~~ Weight of water $= 2000$ N

Volume of cube above the water surface $= ?$

solution:

From the ~~principal~~ law of floatation.

Weight of cube = Weight of water displaced

Weight of cube $= 2000$ N

from: $\frac{W}{g} = \frac{Mg}{g}$

$m = \frac{2000}{10} = 200$ kg.

$\therefore$ Mass of cube $= 200$ kg.

Volume of cube sinked in water $= \frac{\text{Mass of cube}}{\text{Density of water}}$

$= \frac{200 \text{ kg}}{1000 \text{ kg/m}^3} = 0.2 m^3$.

Volume of cube above the water = Total volume of cube − Volume of cube sinked in water.

$= 7.2 m^3 - 0.2 m^3 = 7 m^3$.

Volume $= 7 m^3$.

$\therefore$ The Volume of the cube above the water surface is $7 cm^3$.

Extract 13.2: A sample of a good response to Question 13

Extract 13.2, shows that the candidate was able to use mass (m) and cross-sectional area (A) of the rod as a constant when the rod floated in both liquids. The candidate applied the law of flotation to establish the equation weight of water displaced = weight of brine displaced, in part (a). The candidate then formed and presented all relevant equations to get the length of the rod below the surface of the brine as 5 cm. In part (b), the candidate applied the law of flotation to get the mass of the water displaced and hence the volume of the water displaced which was equal to the volume of the cube below the surface of water. He/she then subtracted the volume of water displaced from the whole volume of the cube to get the volume of the cube that was above the water surface.

2.3.4 Question 14: Electricity and Magnetism

This question consisted of three parts: (a), (b) and (c). The aim of the question was to measure the candidates' understanding on Electricity and Magnetism. It required the candidates to estimate and make analysis of the usage of domestic/industrial power in terms of time, energy, efficiency and cost. The question read as follows:

(a) *A new type of light bulb has recently been invented. It produces the same amount of light as an ordinary (old) 1000 W bulb but uses only 25 W of electrical power. It is expected to last for 5000 hours.*

- *(i)* *How many kilowatt - hour does a 1000 W lamp use in 5000 hours?*
- *(ii)* *How much will it cost if TANESCO charges 300 Tanzanian shillings for 1 kilowatt – hour?*

(b) *A house is on the main supply of 230 volts which supplies voltage to 1.5 kW hot plates, six 60 W lamps and a 100W refrigerator. The hot plates are on a different fuse line from the lighting circuit which include the refrigerator. What amount of current flows through the fuses in each line when all appliances are in use?*

(c) *A transformer in the Cement Factory, receives 0.55A from 240 volts mains, it is used to light 12 volt – 40 watt lamps in parallel, find:*

- *(i)* *efficiency*
- *(ii)* *the total cost of using it for 10 hours at Tsh 300 per kilowatt – hour.*

The question was attempted by 817 (66.3%). Among them, 334 (40.9%) scored between 0 and 4 marks and 124 (15.2%) scored 0; 305 (37.3%) scored 4.5 to 9.5 marks; while 178 (21.8%) scored 10 to 15 marks. The candidates' performance in this question was average**.** Figure 15 presents the scores of the candidates in percentage.

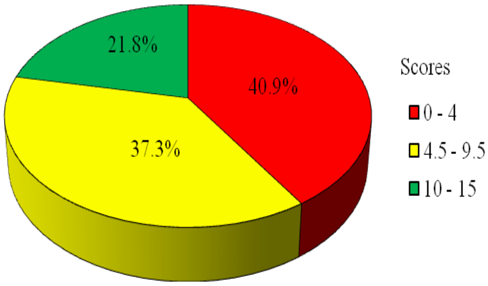


Figure 15: Candidates' Performance on Question 14

The performance of the candidates on this question indicates three groups of scores attained. The group with weak performance scored from 0 to 4 marks. The average scored from 4.5 to 9.5 marks and those with high performance scored from 10 to 15 marks. For those who scored 0 marks (15.2%) were not able to write any correct formula with respect to Electricity and Magnetism in parts (a), (b) and (c). In part (a), they did not manage to covert the 5000 hour to kilowatt hours and to calculate the charges that could be incurred if 300 Tanzanian shillings which were charged for every 1 kilowatt-hour. In part (b), they failed to write the formula '$Current = \frac{Power}{Voltage}$' so that they could calculate the amount of current which was flowing through the fuses in each line when all appliances were in use. Furthermore, the candidates failed to compute efficiency and the total cost of using a transformer for 10 hours at 300 Tanzanian shillings per kilowatt – hour in part (c). From the responses provided by this group of candidates, it was concluded that they had inadequate knowledge on the topic on Electricity and Magnetism. Some of those who scored from 0.5 to 4 marks (25.7%) were only able to write kWh for 5000 hours = 1000 x 5000 hours but did not continue to finish this question and thus they scored 0.5 marks. Others partially did part (a) (i) by writing kWh for 5000 hours = 1000 x 5000 hours and 5000000 Wh = 5000 kWh. Therefore, they scored 1 mark. The analysis shows that those who scored more than 1 mark but less than 4.5 marks (16.7%) were able to answer correctly part (a) or partially part (b) or (c) and therefore they scored how marks.

Most of the candidates who scored less than 4.5 marks failed to apply properly the equations: $Current = \frac{Power}{Voltage}$ and $Current = \frac{Power\ Output}{Power\ Input} \times 100\%$

though they succeeded to remember them. Others multiplied 125000 Wh by 300 instead of 125kWh by 300 when they were computing the cost of electricity consumed in part (a)(i), while other candidates applied inappropriate equations for power such as P = I^2R or $P = \frac{V^2}{R}$ or instead of P = VI. Extract 14.1 gives a sample of a poor response as scanned from the script of a candidate.

14 Data

$P = 1000W$

$P' = 25W$

$t = 5000$ hours

From

(i) $1000W \rightarrow 5000$ hours

$25W \rightarrow x$

$\frac{\cancel{1000}x}{\cancel{1000}} = \frac{25 \times 5000}{1000}$

$\therefore t = 125h$

(ii) To find cost (charges 300 sh / 1 hour)

$t = 5000$ hour

Charg = 300 Shi / 1 hour

Cost = ?

$1h = 300$ shi

$5000h = x$?

$\frac{1h\,x}{1} = \frac{5000 \times 300}{1}$

$\therefore$ cost = 150000 ~~hours~~ Shilings

14 b Data

$V = 230$

$P = 1.5kW$

Nlamp = 60 w 100 w

$I = ?$

From

$I = VP$

$I = 230 \times 1.5 \times 1000$

$I = 230 \times 1500$

$I = 34500A$

Extract 14.1: A sample of a poor responses to Question 14

In extract 14.1 the candidate failed to remember the formula P = VI in order to calculate the electric power. Also, this candidate failed to recall the equation for the efficiency of the transformer which is: $efficiency = \frac{Power\ Output}{Power\ Input} \times 100\%$. This candidate did not understand how to find the total cost of electrical energy if if you are provided with the cost per kWh and the electrical energy in watt-hour. Besides, the candidate did not understand how to convert electrical power from watts to kilowatts.

Some of those who scored from 4.5 to 9.5 marks were able to attempt only two parts of the question and failed to compute accurately in all other parts and therefore they scored average marks. For example, some of these candidates calculated the 5000 kWh and amount of current 'I' correctly in parts (a) and (b) respectively but failed to calculate the efficiency and the total cost of using a transformer for 10 hours in part (c). Therefore, their performance was average. This result shows that they lacked knowledge on the electrical power consumption and the input (Power taken from mains) and output electrical power.

However, 21.8 percent of the candidates who scored high marks (10-15) managed to write the correct formula in part (b) and (c) but they failed to follow few calculation steps. Thus, they ended up with high marks but less than 15 marks. Others manage to compute and covert the 1000 W and 5000 hour to kilowatt hours in part (a)(i) and calculated the charges incurred in part (a) (ii) and (c)(ii). In part (b) they managed to write the formula $Current = \frac{Power}{Voltage}$ and therefore they calculated the amount of current which was flowing through the fuses in each line when all appliances were in use. Furthermore the candidates managed to compute efficiency in part (c)(i). Thus they scored all the marks. These candidates showed that they had adequate knowledge and skills on computing electrical problems as seen in Extract14.2.

SECTION C

14. (a) Data given.
Electrical power = 25 W
Time = 5000 hours.
Required
i) kilowatt-hours ~~and~~ an 1000W lamp uses.
From.
1kW = 1000W
? = 25 W
$\frac{25\text{ W}}{1000} = 0.025\text{ KW}$

For kilowatt hours
KW x hours.
0.025 x 5000
125 KWhours

∴ A 1000 W lamp uses 125 KWhours.

ii) From
1 KW-hour = 300 Tshs.
125 kw-hours = ?
$\frac{125\text{ kwhrs} \times 300\text{ Tshs}}{1\text{ kwhrs}}$
125 x 300
37500 Tshs
∴ It will cost 37,500 Tshs.

14 (b) Data given.

Total volts = 230 volts.

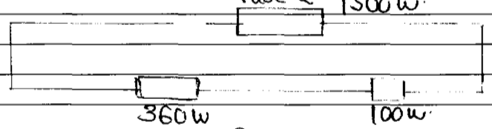
hot plates power = 1.5 kW (1500w)

lamps = 60 x 6 = 360 w

Refrigerator = 100 w.

From

Power = Voltage x Current.



Volts is constant used in all the fuses.

From

Total power = 360 w + 100 w

= 460 w

Power = V x I

$\frac{460 w}{230 V} = \frac{230 \cancel{V} \times I}{2\cancel{3}0 V}$

I = 2 A.

Current = 2A.

But.

Power in hotplates.

= ~~1500 W~~ X

P = VI

$\frac{150\cancel{0} w}{23\cancel{0} V} = \frac{230\cancel{0} \times I}{2\cancel{3}0 V}$

$I = 150/23 = 6.52 A$

14 (b) Current in hot plate = 6.52 A.

∴ The current in fuse line containing hot plate is = 6.52 A and The current in fuse line containing lamps and refrigerator = 2 A.

14 (c) Data given.

main volts = 240 Volt Power output = 40 W.

main current = 0.55 A

releasing volt = 12 Volt

Required

i) Efficiency.

Soln Efficiency = $\frac{\text{Power output}}{\text{Power input}} \times 100\%$

Efficiency =

From Power = Current x Volt

0.55 x 240

= 132 W.

Efficiency = $\frac{40}{132} \times 100\%$

$\frac{1~~4~~,000}{~~132~~ \; 33}$ %

$\frac{1000}{33}$ %

= 30.3 %

∴ The efficiency = 30.3 %

14 (c) ii) total cost required

from

Power = Volt x Current

240V x 0.55A

= 132 W.

1 kW ≈ 1000 W

? = 132 W

$\frac{132 \text{ W}}{1000}$ = 0.132 KW

From

Kilowatt-hour

= KW x hour

0.132 KW x 10 hrs.

1.32 ~~0~~

1.32 kwhour.

1 kilowatt-hour ≈ 300 Tshs

1.32 kilowatt-hour = ?

$\frac{1.32 \text{ ~~kilowatt hour~~} \times 300\text{Tsh}}{1 \text{ ~~kilowatt-hour~~}}$

1.32 x 300 Tsh

396 Tshs.

∴ The total cost attained = 396 Tshs.

Extract 14.2: A sample of good responses to Question 14

In Extract 14.2 the candidate multiplied 1 kW (1000 watts) by 5000 hours to obtain 5000kWh, in part (a) (i). He/she managed to compute and obtain the cost for using one new bulb for 5000 hours, in part (a)(ii). Furthermore, the candidate calculated correctly the current flow in each fuse lines of the hot plate and the refrigerator and the lighting in part (b). In part (c) the candidate was able to calculate the efficiency of the transformer and the total cost of using it for 10 hours at Tsh 300 per kilowatt – hour.

3.0 THE CANDIDATES' PERFORMANCE ON EACH TOPIC

The analysis of performance based on individual topics shows that on the multiple choice questions from various topics the performance was good which is 79.7 percent of the candidates who performed above average. The performance of candidates on the Light (Optical) topic (66.6%) was good as candidates performed above average on this topic.

The topics which were performed averagely were *Fluid Mechanics* (39.8%), *Turning Forces* (36.7%), *Electricity and Magnetism* (36.3%) and *Angular Motion* (32.4%).

The candidates performance is weak on the following topics *Work, Energy and Power* was 29.5 percent. *Projectile Motion* the performance was 27.3 percent. *Simple Machine* is 26.6 percent of the candidates scored below average: On *Linear Motion* 17.4 percent of the candidates scored below average on *Heat*, 8.8 percent of the candidates scored below average and *Forces* 4.5 percent of the candidates scored below average, thus performance on these topics were weak. Appendix B provides the summary of the candidates' performance per topic in Engineering Science subject.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

In 2019, the performance of the candidates in the Engineering Science subject for the Certificate of Secondary Education Examination (CSEE) was average.

The analysis of the candidates' responses indicates a number of factors that seemed to affect the performance of the candidates.

(a) Some of the candidates could not identify the demands of the questions.

(b) Some of the candidates were not knowledgeable about different topics in the subject. It was revealed that the candidates lacked knowledge on the following areas:

   (i) general skills such as arithmetic computation and drawing;
   (ii) heat energy, fundamental heat equations, and heat problems;
   (iii) fluid mechanics;
   (iv) basics of turning forces laws governing forces to be in equilibrium and the diagram of moments of forces; and
   (v) the fundamentals of electricity and electrical power.

4.1 Recommendations

Considering the conclusion made above, this report presents the following recommendations to improve performance in Engineering Science subject in future.

(a) Candidates are advised to read questions carefully before answering them. This will enable them to understand the requirement of questions before they attempt them. It will also help them to provide the correct answers in accordance to the requirement of the questions.

(b) Candidates are advised to practise a lot by doing many exercises on arithmetic computation using different formulae and by sketching different Engineering Science diagrams. This will help to equip them with skills and knowledge about the key concepts in the subject.

(c) The candidates should cover all topics in the O-Level syllabus by reading various books, journals and published articles to make sure they understand the application of formulae, concepts and laws involved in Engineering Science to solve various questions. Education stakeholders including teachers should facilitate that.

(d) Since candidates indicated lack of knowledge in some aspects, the education stakeholders should make sure there is an effective teaching and leaning before the candidates sit for the examinations.

Appendix A

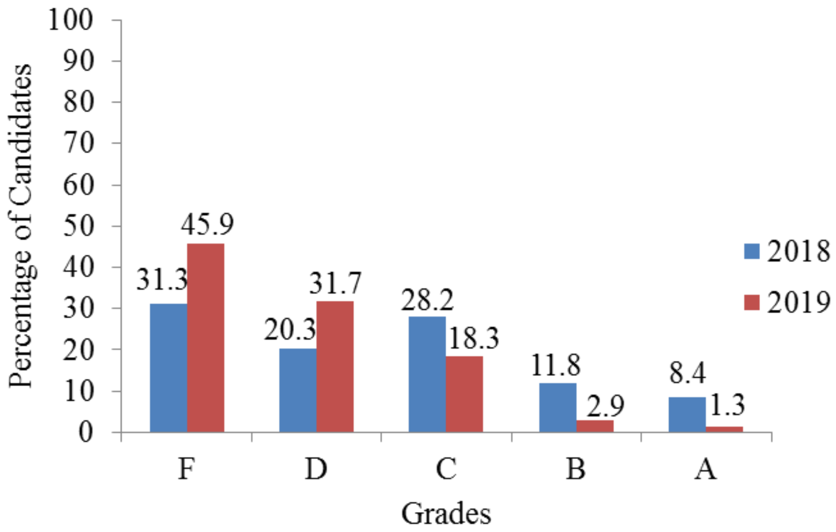


Figure 16: The comparison of candidates' performance between 2019 and 2018

Appendix B

Analysis of the Candidates' Performance Topic in CSEE 2019 Engineering Science Subject

S/N	Topics	Question Number	Percentage of candidates who scored 30 percent or more.	Recommendations
1	Periodic Motion; Friction; Strength of Materials, Optics (Light), Sound, Electricity and Magnetism; Measurements; Work, Energy and Power and Heat	1	79.7	Good
2	Light (Optics)	7	66.6	Good
3	Fluid Mechanics	13	39.8	Average
4	Turning Forces	8	36.7	Average
5	Electricity and Magnetism	14 & 3	36.3	Average
6	Angular Motion	9	32.4	Average
7	Work, Energy and Power	10	29.5	Weak
8	Projectile Motion	2	27.3	Weak
9	Simple Machine	12	26.6	Weak
10	Linear Motion	6	17.4	Weak

S/N	Topics	Question Number	Percentage of candidates who scored 30 percent or more.	Recommendations
11	Heat	11	8.8	Weak
12	Forces	4	4.5	Weak
13	Measurement	5	3.6	Weak