



THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA



**CANDIDATES' ITEM RESPONSE ANALYSIS
REPORT ON THE CERTIFICATE OF SECONDARY
EDUCATION EXAMINATION(CSEE) 2021**

BASIC MATHEMATICS



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041 BASIC MATHEMATICS

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FOREWORD

The National Examinations Council of Tanzania has prepared the Candidates' Item Response Analysis Report (CIRA) showing the performance of the candidates who sat for the Certificate of Secondary Education Examination (CSEE) 2021 in Basic Mathematics Examination. This report was purposely prepared in order to give feedback to students, teachers, policy makers and all other education stakeholders about the candidates' performance.

The candidates' performance in Basic Mathematics subject in CSEE 2021 was weak because only 19.54 per cent of the candidates passed the examination. When compared to that of CSEE 2020, the analysis portrays a declining trend by 0.58 per cent in 2021. The main factors that contributed to weak performance include the candidates' inability to: recall and apply the correct formulae, rules, theorems, properties and procedures; formulate mathematical inequalities, expressions and equations from word problems and figures; employ appropriate procedures when performing calculations; sketch correct diagrams and graphs; and interpret the information from diagrams and graphs.

The National Examinations Council expects that, students, teachers and other educational stakeholders will take appropriate measures to improve the performance in Basic Mathematics subject by using the recommendations given in this report.

Finally, the Council is grateful to express its sincere thanks to the examination officers, subject examiners and all others who participated in the preparation of this report.



Dr. Charles E. Msonde

EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report is based on the candidates' item response analysis for the Certificate of Secondary Education Examination (CSEE) 2021 in Basic Mathematics subject. The analysis mainly focused on strengths and weaknesses of the candidates' responses to each questions.

Data analysis shows that out of 487,365 candidates who sat for Basic Mathematics in CSEE 2021, only 94,677 (19.54%) candidates passed. In CSEE 2020, only 87,582 (20.12%) candidates passed out of 437,333 candidates who sat for the paper. Therefore, in comparison with the performance of CSEE 2020, there was a relative decline by 0.58 per cent in CSEE 2021.

As per the examination rubric in Basic Mathematics, the paper comprised sections A and B. Each question in Section A weighed **six (06)** marks while each question in Section B weighed **ten (10)** marks and the candidates were required to answer all questions from both sections.

The analysis of the national examination results were categorized into five score intervals which are: 75 – 100, 65 – 74, 45 – 64, 30 – 44 and 0 – 29 to mean *excellent*, *very good*, *good*, *satisfactory* and *fail* respectively. However, the candidates' performance in each question is considered *good*, *average* or *weak* if the percentage of the candidates who scored at least 30 per cent is 65 – 100, 30 – 64 or 0 – 29 respectively.

2.0 ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH QUESTION

This section entails the analysis of the candidates' performance in each question. The analysis entails the descriptions of the requirements of the question, summary on how the candidates attempted the question and the sample extracts of the candidates' correct and incorrect responses. It also shows the reasons for the success or failure to get the correct responses in each item. The description of data and charts was done using a criterion of score intervals: 6.0 – 4.0, 3.5 – 2.0 and 1.5 – 0.0 out of 6 marks in Section A; and 10 – 6.5, 6.0 – 3.0 and 2.5 – 0 out of 10 marks in Section B for each question representing *good*, *average* and *weak* performance, respectively.

2.1 Question 1: Numbers and Approximations

This question consisted of parts (a) and (b). In part (a), the candidates were required to find the Lowest Common Multiples (LCM) of 15, 35, and 40. In part (b), they were required to find the approximate value of the expression by rounding off each number in the expression $\frac{0.0695 \times 19812}{6.8125}$ to one significant figure.

The analysis reveals that, this question was attempted by 487,122 (99.9%) candidates out of whom 218,900 (44.9%) candidates passed. This indicates that, the candidates' performance in this question was average. Further analysis shows that, only 15,347 (3.2%) candidates scored full marks in this question. Figure 1 shows the summary of candidates' performance in question 1.

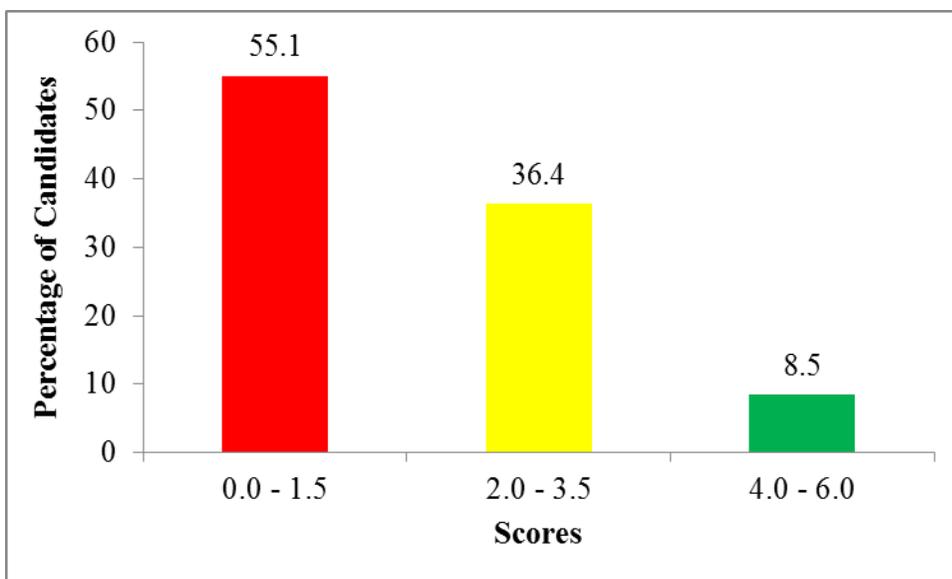


Figure 1: *Candidates' performance in question 1*

The analysis shows that, the candidates who answered this question correctly demonstrated the required competences. In part (a), the candidates correctly applied the knowledge of prime factorization or repeated division method to obtain the lowest common multiple of 15, 35 and 40. This indicates that, the candidates had adequate knowledge of the lowest common multiples of numbers. In part (b), they were able to round off each number into one significant figure, that is, $0.0695 \approx 0.07$, $19812 \approx 20000$

and $6.8125 \approx 7$ and hence obtained the correct results by writing $\frac{0.07 \times 20000}{7} \approx 200$. Those candidates were competent in rounding off numbers based on significant figures. Extract 1.1 shows a sample of a correct response from one of the candidates who answered this question.

1.	(a)	solution			
		Required to find LCM of 15, 35 and 40.			
		2	15	35	40
		2	15	35	20
		1	15	35	10
		3	15	35	5
		5	5	35	5
		7	1	7	1
			1	1	1
		LCM of 15, 35 and 40 = $2 \times 2 \times 2 \times 3 \times 5 \times 7$			
		= $2^3 \times 3 \times 5 \times 7$			
		= $8 \times 3 \times 5 \times 7$			
		= 840			
		\therefore LCM of 15, 35 and 40 is 840			
	(b)	solution			
		0.0695 to one significant figure is 0.07			
		19812 to one significant figure is 20000			
		6.8125 to one significant figure is 7			
		$\therefore \frac{0.0695 \times 19812}{6.8125} \approx \frac{0.07 \times 20000}{7}$			
		$\approx \frac{1400}{7}$			
		≈ 200			
		$\therefore \frac{0.0695 \times 19812}{6.8125} \approx 200$ to one significant figure			

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

In Extract 1.1, the candidate calculated correctly the product of the prime factors, that is $2^3 \times 3 \times 5 \times 7$ and ended up with 840 which was the required LCM in part (a). In part (b), the candidate approximated correctly to one significant figure each number given in the expression and hence calculated the final value.

On the other hand, a total of 196,270 (40.3%) candidates scored zero in this question. In part (a), most of them calculated the Greatest Common Factor (GCF) of 15, 35 and 40 which was contrary to the requirement of the question. The candidates confused between the multiples and factors of numbers. Other candidates committed errors when performing repeated division or multiplication of prime factor due to lack of arithmetic skills. In part (b), the candidates failed to round off the number into one significant figure. In most cases, they wrote incorrect approximations like $0.0695 \approx 0.06$ instead of 0.07; $19812 \approx 19810$ instead of 20000; and $6.8125 \approx 6.8$ instead of 7. This justifies that, the candidates lacked knowledge of rounding off decimal places and approximating numerals to a given number of significant figures. Extract 1.2 shows a sample of an incorrect response in this question.

01 @	Solution			
	2	15	35	40
	2	15	35	20
	2	15	35	10
	- 5	15	35	5
	3	3	7	1
	7	1	7	1
		1	1	1
	= 5			
	∴ the lowest common multiple is = 5			

1	b)
	$= 0.0699 \times 19812$
	0.8125
	$0.0699 \approx 0.1$
	$19812 \approx 2$
	$0.8125 \approx 7$
	$= \frac{0.1 \times 2}{7}$
	$= \frac{0.2}{7}$
	$= 0.0286$
	\therefore The answer is 0.0286.

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

In Extract 1.2, the candidate found the greatest common factor instead of lowest common factor as required in part (a). In part (b), the candidate was unable to approximate the given numbers to one significant figure.

2.2 Question 2: Exponents and Logarithms

The question consisted of parts (a) and (b). Part (a), required the candidates to express the equation $3^{(2y-1)} + 2 \times 3^{(y-1)} = 1$ in terms of P given that $P = 3^y$ while part (b) required them to determine the value of y in the equation $\log_{10}(3y+2) - 1 = \log_{10}(y-4)$.

The analysis shows that, this question was attempted by 487,365 (99.8%) candidates out of them, 24,977 (5.1%) candidates passed. This shows that, the candidates' performance in this question was weak. The analysis also points out that, only 6,022 (1.2%) candidates scored full marks while 453,510 (93.3%) scored a zero mark. Figure 2 shows the summary of candidates' performance in question 2.

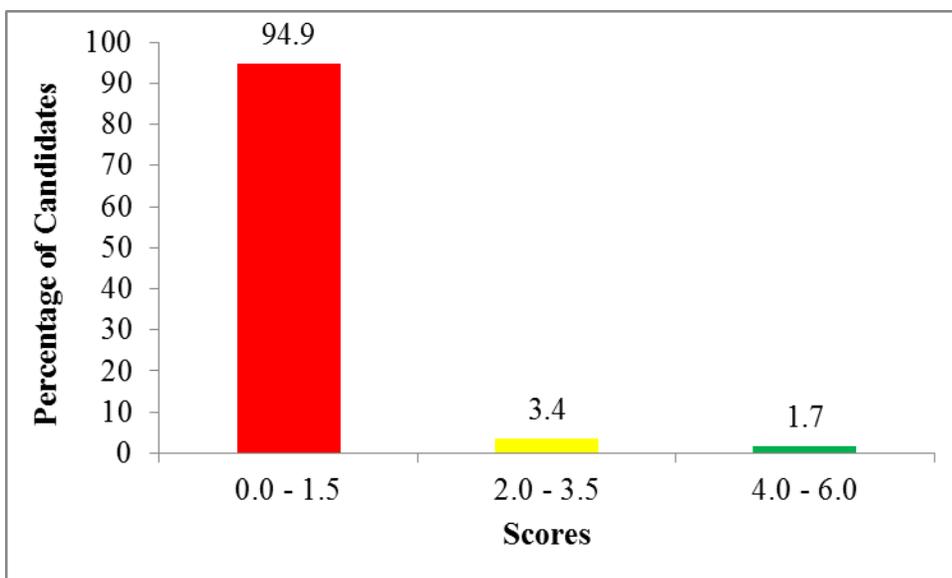


Figure 2: Candidates' performance in question 2

The analysis reveals that, the majority of the candidates scored low marks in this question due to various reasons. In part (a), the candidates failed to express $3^{(2y-1)} + 2 \times 3^{(y-1)} = 1$ in terms of 3^y so that they later substitute $3^y = P$. For example, they expressed $3^{(2y-1)} + 2 \times 3^{(y-1)} = 1$ as $3(2y-1) + 2 \times 3(y-1) = 1$ instead of $(3^y)^2(3^{-1}) + 2 \times (3^y)(3^{-1}) = 1$. Most of them lacked knowledge of simplifying exponents by using the laws of product or quotient. For example, some candidates expressed the term $3^{(2y-1)}$ incorrectly as $3^y \times 3^{-1}$ and $3^{2y} \times 3^1$ instead of $(3^y)^2 \times 3^{-1}$; and $3^{(y-1)}$ as $3^y - 1$ instead of $(3^y)(3^{-1})$ which was an initial step to arrive at the required results.

In part (b), most of the candidates were not capable of applying the laws of logarithms correctly to solve the equation $\log(3y+2) - 1 = \log(y-4)$. For

example, they expressed the equation $\log(3y \times 2) \div \log 10 = \log\left(\frac{y}{x}\right)$

instead of $\log_{10}\left(\frac{3y+2}{y-4}\right) = 1$. Also, some candidates expressed the given

equation as $\log\left(\frac{3y+2}{1}\right) = \log(y-4)$ which however violates the laws of

logarithms. Moreover, some of the candidates divided by *log* on both sides

of the equation $\frac{\log(3y+2)}{\log} - 1 = \frac{\log(y-4)}{\log}$ indicating lack of knowledge of simplifying the logarithms. Others wrote $\log(3y+2)-1 = \log(y-4)$ as $\log_{10} 3y + \log_{10} 2 - 1 = \log_{10} y - \log_{10} 4$ which is a wrong approach. In other cases, there were some candidates who factored out \log as a common term and the equation turned into $\log_{10}(3y+2-y+4)=1$ which is incorrect step. Extract 2.1 shows a sample of an incorrect response from one of the candidates in this question.

2a	$3^{2y} 3^{-1} + 2 + 3^y - 3^{-1} = 1$
	let $p = 3^y$
	$p^2 + 3^{-1} + 2 + p + 3^{-1} = 1$
	$p^2 + p + 3^{-2} + 2 = 1$
	$p^2 + 3^{-2} = 1 - 2$
	$p^2 + 3^{-2} = -1$
	$p = 0.5 \text{ or } 1$
	$p = 3^y \quad 3^0 = 1$
	$y = 0$
2b	$\log_{10}(3y+2) - 1 = \log_{10}(y-4)$
	$\frac{\log(3y+2)-1}{\log 10} = \frac{\log y-4}{\log 10}$
	$\log(3y+2) - 1 = \log(y-4)$
	$-3y - 2 - 10 = y - 4 - 10$
	$-3y - 12 = y - 14$
	$-3y - y = -14 + 12$
	$-4y = -2$
	$y = \frac{1}{2}$
	$\therefore \text{the value of } y = \frac{1}{2}$

Extract 2.1: A sample of an incorrect response in question 2

In Extract 2.1, the candidate in part (a), failed to express the given equation in terms of P by making incorrect computations. In part (b), the candidate incorrectly divided the equation by “log to base ten” on both sides and cancelled the word log, something that led to incorrect answer.

Notwithstanding that the performance was weak, few candidates managed to answer the question correctly. In part (a), the candidates were able to use the laws of product, quotient and power to re-write $3^{(2y-1)} + 2 \times 3^{y-1} = 1$ in the form $(3^y)^2 \times \frac{1}{3} + 2 \times \frac{3^y}{3} = 1$. Lastly, they correctly substituted $3^y = p$ and obtained the required result. In part (b), they correctly applied the law of quotient to simplify the given equation to obtain $\log_{10} \left(\frac{3y+2}{y-4} \right) = 1$.

Then, they converted the resulted logarithmic equation into exponential equation $\frac{3y+2}{y-4} = 10^1$ or $3y+2=10y-40$. Then, they solved the equation

for y. This shows that, the candidates had enough knowledge and skills of simplifying and solving problems related to exponents and logarithms. Extract 2.2 shows a sample of a response from a certain candidate who answered the question correctly.

2a	$3^{(2y-1)} + 2 \times 3^{y-1} = 1$
	$\frac{3^{2y}}{3} + 2 \times \frac{3^y}{3} = 1$
	$\left(\frac{3^y \times 3^y}{3} \right) + 2 \times \left(\frac{3^y}{3} \right) = 1$
	But $p = 3^y$
	$\frac{p \times p}{3} + 2 \times \frac{p}{3} = 1$
	$3 \left(\frac{p^2}{3} + \frac{2p}{3} \right) = (1) 3$
	$p^2 + 2p = 3$
	$p^2 + 2p - 3 = 0$

2.	b/ $\log_{10}(3y+2) - 1 = \log_{10}(y-4)$
	$\log_{10}(3y+2) - \log_{10}(y-4) = 1$
	$\log_{10}\left(\frac{3y+2}{y-4}\right) = 1$
	Into exponential form:
	$\frac{3y+2}{y-4} = 10^1$
	$\frac{3y+2}{y-4} = 10$
	$10(y-4) = 3y+2$
	$10y - 40 = 3y + 2$
	$30y - 3y = 2 + 40$
	$7y = 42$
	$y = 6$
	<u>∴ The value of y is 6.</u>

Extract 2.2: A sample of a correct response in question 2

In Extract 2.2, the candidate expressed correctly the given equation in the terms of P which is $P^2 + 2P - 3 = 0$. He/she also applied the laws of logarithms to solve the given logarithmic equation and obtained $y = 6$ which was the required value.

2.3 Question 3: Sets and Probability

This question had parts (a) and (b). Part (a) stated that “in a class of 45 students, 30 study Chemistry, 20 study Physics and 5 study neither of the two subjects”. In part (a), the candidates were required to represent this

information in a well labeled Venn diagram. In part (b), they were required to use the results obtained in part (a) to find (i) the number of students studying both subjects and (ii) the probability that a student selected at random from the class will be studying Chemistry only.

The analysis shows that, this question was attempted by 486,704 (99.9%) candidates out of whom 88,300 (18.1%) passed. This shows that, the candidates' performance in this question was weak. Further analysis points out that, only 20,128 (4.1%) candidates scored full marks while a total of 326,936 (67.2%) scored zero. Figure 3 summarizes the candidates' performance in question 3.

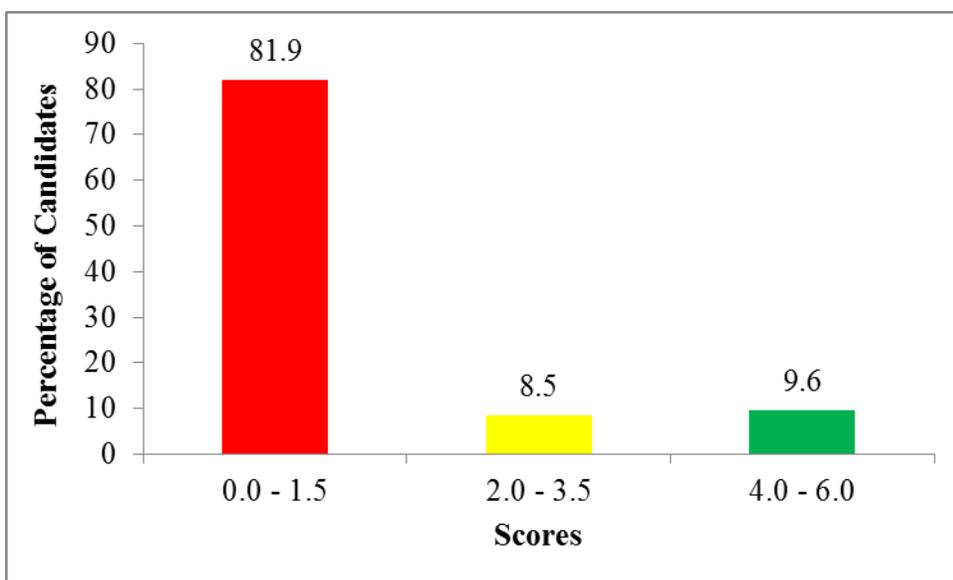


Figure 3: *Candidates' performance in question 3*

The analysis shows that, the candidates who scored low marks faced various challenges in answering the question. In part (a), the candidates were unable to correctly represent the given information in a Venn diagram. Most of them regarded 30 as the number of students studying Chemistry only and 20 as the number of students studying Physics only. They were not aware that, the number of students studying both subjects was not yet subtracted from 20 and 30. Others wrongly considered 5 to be the number of students studying both subjects. They failed to understand that, the stated 5 students do not study those subjects. It was also identified that, some candidates regarded the stated 45 as the number of students who study neither Chemistry nor Physics due to lack of knowledge of the concept of

universal set. Generally, most of the candidates were not conversant with the rules of sets and Venn diagrams in solving problems. In part (b) (i), the majority of the candidates used formulae instead of Venn diagram as it was instructed when calculating the number of students studying both subjects. It is evident from the analysis that, the candidates failed to interpret the information represented in Venn diagram in order to solve the given problem. In part (b) (ii), the candidates failed to identify the number of events and that of sample space. Those candidates termed the number of students studying Chemistry as the number of events. For example, they wrote

$$P(\text{Chemistry only}) = \frac{n(\text{Chemistry})}{n(\text{Sample space})} = \frac{30}{45} = \frac{2}{3} \quad \text{which was}$$

incorrect. Others failed to recall the correct formula for finding the probability of occurrence of events. They wrote incorrect formulae like:

$$P(E) = \frac{n(S)}{n(E)}, \quad P(E) - n(E) = n(S), \quad P(E) = n(S), \quad \text{instead of}$$

$$P(E) = \frac{n(E)}{n(S)}, \quad \text{where } n(E) \text{ } n(S) \text{ and } P(E) \text{ represent the number of}$$

events, number of ample space and probability of an event E to occur respectively. Extract 3.1 is the sample from one of the candidate's incorrect response in question 3.

03	(a)	solo
	Data given	
	All students = 45	
	Chemistry = 30	
	Physics = 20	
	Both two subject = 5	
	By using Venn diagram.	

	(b) (i) The total number of student who studying both subject are 5 students
	(ii) $n(S) = n(E)$.
	$n(P) = n(S) + n(E)$
	$n(P) = 30 + 45$
	$P = 75$
	\therefore The probability will be 75

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

In Extract 3.1, the candidate incorrectly posted the entries in a Venn diagram in part (a). In part (b), the candidate failed to recall the formula for finding the probability of an event.

On the other hand, the candidates who attempted this question correctly were able to; (a) represent the given information in Venn diagram using two sets which were; set of students studying Chemistry and that of the students studying Physics. They were able to identify and label the regions for union, intersection, universal and complement of two sets. This helped them to correctly represent the given information in a Venn diagram.

In part (b) (i), the candidates formulated correctly the equation $(20 - x) + x + (30 - x) + 5 = 45$, or $45 = 55 - x$, where x represented the number of students who study both subjects by using the formula

$n(\xi) = n(P \cup C) + n(P \cap C)$ Finally, they got $x = 10$ which was the intended answer. The candidates showed their competence in interpreting information from Venn diagram correctly. In part (b) (ii), the candidates identified correctly the number of students studying Chemistry only as the number of events; and the number of universal set as the number of sample space. Then, they applied the correct formula

$$P(\text{Chemistry only}) = \frac{n(\text{Chemistry only})}{n(\text{Sample space})}$$

to calculate the probability that the student selected randomly studies Chemistry only. Extract 3.2 shows the response of a candidate who answered question 3 correctly.

3.	a) Solution: let: $U = \{\text{all students in a class}\}$ $C = \{\text{all students studying Chemistry}\}$ $P = \{\text{all students studying Physics}\}$ $x = \{\text{students studying both Physics and Chemistry}\}$
	<p>A Venn diagram with a rectangular universal set U. Inside, two overlapping circles represent sets P and C. The region of P that does not overlap with C is labeled $20-x$. The intersection of P and C is labeled x. The region of C that does not overlap with P is labeled $30-x$. The region outside both circles but inside the rectangle is labeled 5.</p>
3	b) Solution: i) From: $n(U) = n(C) + n(P) - n(C \cap P) + n(C \cup P)$ $45 = 30 + 20 - x + 5$ $45 = 50 + 5 - x$ $45 = 55 - x$ $45 - 55 = -x$ $-10 = -x$ $x = 10$ \therefore There are 10 students studying both subjects.
	ii) Chemistry only = 20 $30 - x$ $= 30 - 10$ $= 20$ students Probability = $\frac{n(\text{Only})}{n(S)}$ $= \frac{20}{45}$ $= \frac{4}{9}$

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

In Extract 3.2, the candidate prepared correctly the given information in a Venn diagram showing clearly the intersection, complement and all other regions representing those who study only one subject. In part (b), the candidate performed correct computations indicating the ability to interpret Venn diagram and skills to apply it when solving probability problems.

2.4 Question 4: Coordinate Geometry and Vectors

This question had two parts (a) and (b). In part (a), the candidates were given that, an engineer is in the process of constructing two straight roads R_1 and R_2 which will meet at the right angles. If R_1 will be represented by the equation $2x - 3y - 4 = 0$, and R_2 will pass through the point $(4, -2)$, they were required to find the equation representing R_2 in the form of $ax + by + c = 0$. In part (b), it was stated that, a boat crosses a river with a velocity of 30km/h southwards. Water in the river flows at 5km/h due east. By using knowledge of vectors, the candidates were required to calculate the resultant velocity of the boat, giving the answer correct to 2 decimal places.

The analysis shows that, this question was attempted by 485,565 (99.6%) candidates out of whom 67,042 (13.8%) passed. This shows that, the candidates' performance in this question was weak. Further analysis points out that, only 15,401 (3.2%) candidates scored full marks while a total of 399,208 (82.2%) scored zero. Figure 4 shows the summary of candidates' performance in question 4.

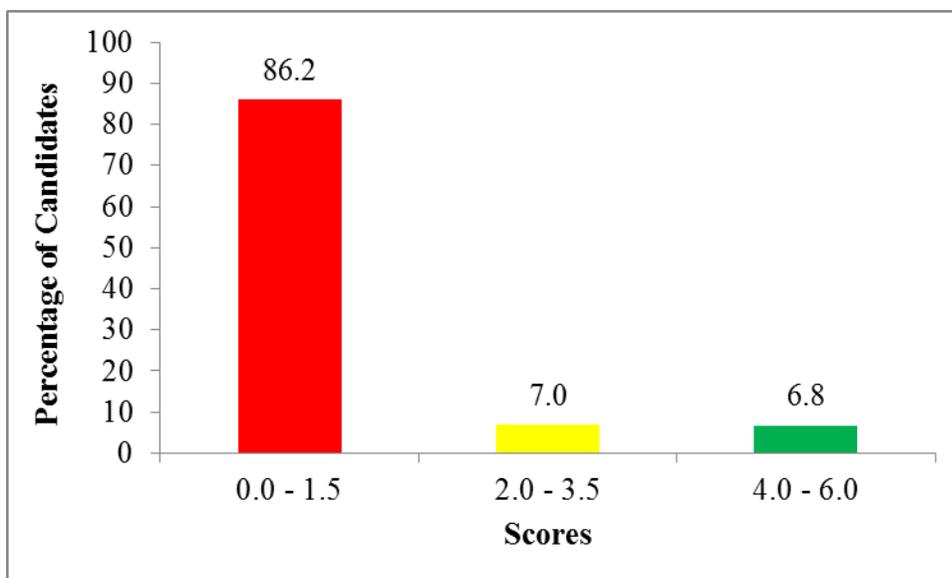


Figure 4: *Candidates' performance in question 4*

The analysis shows that, the candidates who scored zero faced various challenges when responding to the question. In Part (a), they failed to arrange the given equation in the form of $y = mx + c$, as a result, they were unable to obtain the correct gradient m . Moreover, the majority failed to recall condition for perpendicular lines given by the formula $m_1 m_2 = -1$. Others applied the formula for parallel lines given by $m_1 = m_2$ to find the slope of R_2 . In part (b), the candidates failed to interpret the given information due to lack of knowledge of vectors. Mostly, they applied incorrect formulae like $|v_r| = \sqrt{(v_b)^2 - (v_c)^2}$ instead of $|v_r| = \sqrt{(v_b)^2 + (v_c)^2}$ when finding the resultant velocity v_r . In general, the candidates seemed to lack the knowledge of parallel and perpendicular lines and magnitude of a vector in a given direction in solving problems. Extract 4.1 is a sample of an incorrect response in question 4.

4. @ Given.

$$R_1 = 2x - 3y - 4 = 0.$$

$$R_2 = (4, -2)$$

from

$$\text{Slope}(m) = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\text{Slope} = 2 \text{ from equation } R_1.$$

$$2 = \frac{y - (-2)}{x - 4}$$

$$2 = \frac{y + 2}{x - 4}$$

$$y + 2 = 2x - 8.$$

$$2x - y - 8 - 2.$$

$$2x - y - 10 = 0.$$

\therefore equation R_2 is form $ax + by + c = 0$.

$\therefore 2x - y - 10 = 0.$

~~9(b)~~ SOLUTION:

4(b)

$$a^2 + b^2 = c^2$$

$$30^2 + b^2 = 5^2$$

$$900 + b^2 = 25$$

$$b^2 = 900 - 25$$

$$\sqrt{b^2} = \sqrt{875}$$

$$b = 29.58$$

\therefore The resultant velocity of the boat = 29.58 km/h

Extract 4.1: A sample of an incorrect response in question 4

In Extract 4.1, the candidate applied incorrect gradient that led to incorrect equation of a line in part (a). In part (b), the candidate indicated incorrect

direction of water considering it North-East as shown in the diagram. Consequently, the candidate formulated incorrect equation $30^2 + b^2 = 5^2$.

In contrast, some candidates were able to answer this question correctly. In part (a), they were able to rearrange the equation $2x - 3y - 4 = 0$ in the form of $y = mx + c$ which was helpful to get the gradient of R_1 as $m_1 = \frac{2}{3}$. They correctly applied the formula for two

perpendicular lines which is $m_1 m_2 = -1$ to obtain $m_2 = -\frac{3}{2}$. As a result,

they were able to get the equation of the line R_2 by using the gradient of

R_2 and the point $(4, -2)$. In part (b), the candidates were able to represent

the given information by using a diagram showing the magnitude and direction of both the boat and water. They applied the correct formula for

the resultant of two vectors given by $|\underline{v}_r| = \sqrt{(\underline{v}_b)^2 + (\underline{v}_c)^2}$ and obtained the

required answer. This shows that, the candidates had adequate knowledge in

magnitude and direction of vectors and the skills to apply vectors to

solve simple problems in life. Extract 4.2 is the sample of a correct

response to question 4.

40 a1	Express Equation of R_1 in form of $y = mx + c$
	$2x - 3y - 4 = 0$
	$-3y = -2x + 4$
	$y = \frac{-2}{-3}x + \frac{4}{-3}$
	$y = \frac{2}{3}x - \frac{4}{3}$
	$m_1 = \frac{2}{3}$
	For perpendicular Lines
	$m_1 m_2 = -1$
	$\frac{2}{3} \times m_2 = -1$
	$m_2 = -\frac{3}{2}$
	Slope of R_2 is $-\frac{3}{2}$

R_2 taking point $(4, -2)$ and $(0, 4)$

$$m = \frac{\text{Change on } y}{\text{Change in } x} = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{4 + 2}{0 - 4}$$

$$m = \frac{4 + 2}{0 - 4}$$

$$\text{But } m = -\frac{3}{2}$$

$$-\frac{3}{2} = \frac{4 + 2}{0 - 4}$$

$$-3(x - 4) = 2(4 + 2)$$

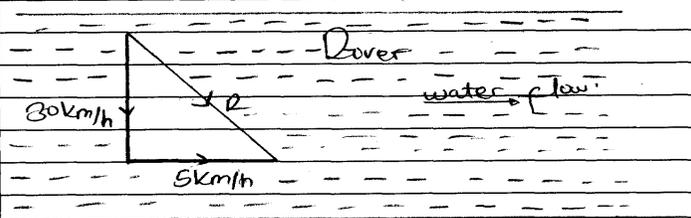
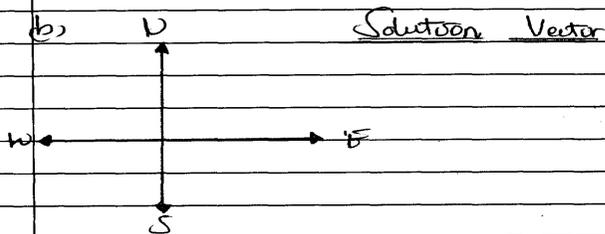
A_{ay}

$$-3x + 12 = 24 + 4$$

$$-3x - 24 + 12 - 4 = 0$$

$$-3x - 24 + 8 = 0$$

\therefore The Equation representing R_2 in form of $ax + by + c = 0$ is $-3x - 24 + 8 = 0$



Resultant velocity of the boat:

$$D = \sqrt{a^2 + b^2}$$

$$= \sqrt{30^2 + 5^2}$$

$$= \sqrt{900 + 25}$$

$$= \sqrt{925}$$

$$= 30.41 \text{ km/h}$$

\therefore The resultant velocity of the boat is 30.41 km/h.

Extract 4.2: A sample of a correct response in question 4

In Extract 4.2, the candidate obtained the gradient of R_2 by using the condition for perpendicular lines and got the intended equation. In part (b), the candidate correctly illustrated the information by using a diagram and calculated the resultant velocity as $\sqrt{30^2+5^2} = 30.41$ km/h.

2.5 Question 5: Geometry, Perimeters and Areas

This question consisted of parts (a) and (b). In part (a), it was given that, the length of two similar rectangles are 6cm and 8cm. The candidates were required to find the area of the larger rectangle provided that the area of the small rectangle is 73.8cm. In part (b), they were required to find the number of sides of a regular polygon whose exterior and interior angles are in the ratio 2:4 respectively.

The analysis shows that, this question was attempted by 485,601 (99.6%) candidates out of whom 54,540 (11.2%) passed. This indicates that, the candidates' performance in this question was weak. Further analysis reveals that, only 9,108 (1.9%) candidates scored full marks while a total of 399,551 (82.3%) scored zero. Figure 5 portrays the summary of candidates' performance in question 5.

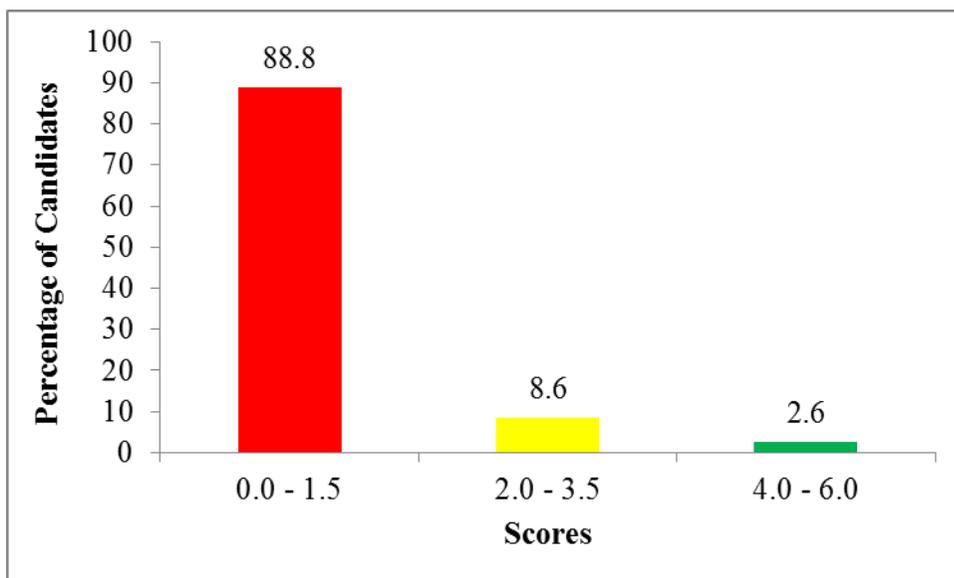


Figure 5: Candidates' performance in question 5

The response analysis shows that most of the candidates failed to answer the question correctly. In part (a), they were unable to calculate the ratio of the corresponding sides which was a necessary step in finding the area of the large rectangle. They wrote incorrect formulae like: $\frac{A_1}{A_2} = k^2$, where

A_1 and A_2 are the areas of small and large rectangles respectively; and $\frac{S_1}{S_2} = \frac{A_1}{A_2}$, where S_1 and S_2 are the lengths of small and large rectangles respectively. As a result, they performed incorrect calculations like $\frac{A_1}{73.8} = \left(\frac{3}{4}\right)^2$ instead of $\frac{A_1}{73.8} = \left(\frac{4}{3}\right)^2$ that could lead them to getting a correct answer. This reveals that, the candidates had inadequate knowledge and skills in solving the problems related to ratio of areas of similar polygons.

In part (b), some candidates were unable to find the number of sides of the polygon because they failed to relate the ratio given to the ratio of exterior angle (e) and interior angle (i). For example, most of them wrote incorrect equations like $\frac{e}{i} = \frac{4}{2}$ instead of $\frac{e}{i} = \frac{2}{4}$ or $i = 2e$. Others were not aware that the degree measure for a straight angle is 180° as they applied incorrect formulae like $e + i = 360^\circ$. Also, when finding the number of sides (n) of the given polygon the candidates applied incorrect formulae like $e = \frac{180^\circ}{n}$ and $i = \frac{360^\circ}{n-1}$. Instead, they were supposed to use the formula $e = \frac{360^\circ}{n}$ that could lead to the required value of n . Extract 5.1 shows a sample of an incorrect response to question 5.

5.	a)	Soln
		Area of rectangle
		= Length \times width
		= 6cm \times 8cm = 73.8cm ²
		= 40cm =
		also,
		= x \times 40cm = 73.8cm ²
		= 40cm \times x = 73.8cm ²
		= 40cm \times x = 73.8cm ²
		$\frac{40cm}{40cm} \quad \frac{40cm}{40cm}$
		$x = 1.845cm^2$
		\therefore Area of rectangle = 1.845cm ² .

5 b	Solutzon.	
		$\frac{360}{n} = e.$
		$2+4 = 6.$
		$\frac{360}{n} = \frac{e}{6}$
		$2n = 360 \times 6$
		$\frac{2n}{2} = \frac{2160}{2}$
		$n = 1,080.$

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

In Extract 5.1, the candidate failed to interpret the given problem as he/she calculated the area of a rectangle using the product of the sides from two rectangles indicating lack of knowledge of the areas of similar figures in part (a). In part (b), the candidate used the incorrect formula $e = \frac{360^\circ}{n}$ that led to an incorrect answer.

Despite the weak performance, some candidates performed well in this question. In part (a), they were able to recall the formula for the ratio of the corresponding sides which is $K = \frac{8}{6} = \frac{4}{3}$ and then applied it in the appropriate formula $\frac{A_1}{A_2} = K^2$ to obtain the required area. In part (b), the candidates were able to find the number of sides (n) for the given polygon by applying the correct formula. Extract 5.2 shows the response of a candidate who answered this question correctly.

s	a) Solution:
	From: $k = \frac{\text{length of small rectangle}}{\text{length of large rectangle}}$
	$k = \frac{6\text{cm}}{8\text{cm}}$
	$k = \frac{3}{4}$
	But $(k)^2 = \frac{\text{Area of small rectangle}}{\text{Area of large rectangle}}$
	$\frac{9}{16} = \frac{73.8\text{cm}^2}{\text{Area of large rectangle}}$
	$\frac{9}{16} = \frac{73.8\text{cm}^2}{\text{Area of large rectangle}}$
	$\text{Area of large rectangle} = \frac{16 \times 73.8\text{cm}^2}{9}$
	$= 131.2\text{cm}^2$
	<u>\therefore The area of the large rectangle is 131.2cm^2</u>
s	b) Solution:
	Given: ratio of exterior and interior angles is 2:4.
	From: Exterior angle + interior angle = 180°
	Also: Sum of the ratios = $2+4$

5	Then: Exterior angle = $\frac{2}{6} \times 180^\circ$
	= $2 \times 30^\circ$
	= 60°
	Interior angle = $\frac{4}{6} \times 180^\circ$
	= $4 \times 30^\circ$
	= 120°
	But, from: Exterior angle = $\frac{360}{n}$
	Where: Exterior angle = 60°
	n = number of sides of the polygon
	Then: $60^\circ = \frac{360^\circ}{n}$
	$60^\circ n = 360^\circ$
	$60^\circ \quad 60^\circ$
	$n = 6$
	\therefore The number of sides of the polygon is 6.

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

In Extract 5.2, the candidate in part (a) was able to compare the ratio for lengths and areas for the given rectangles something that was helpful to get the correct answer. In part (b), the candidate was able to use the concept of degree measure of the straight line to obtain the exterior angle that was used to obtain the number of sides of the polygon.

2.6 Question 6: Units, Rates and Variations

This question consisted of part (a) and (b). In part (a), the candidates were provided with the information that, a piece of length 7.42m is cut off from a string that is 13.5 m long. The candidates were required to determine the number of pieces of the remaining part of the string which is to be divided into equal pieces of length 32cm. In part (b), they were given that, the mass (M) which can be supported by a beam varies directly with the breadth (b) and inversely with the length (l). The candidates were required to find the mass that can be supported by a beam which is 3 m broad and 20 m long,

under the condition that the beam of breadth 2 m and length 15 m can support a mass of 200 kg.

The analysis shows that, this question was attempted by 485,212 (99.6%) candidates, where 98,211 (20.2%) candidates passed. This shows that, the candidates' performance was weak. Further analysis indicates that, only 24,200 (5.0%) candidates scored full marks while a total of 371,179 (76.5%) scored a zero mark. Figure 6 shows the summary of candidates' performance in question 6.

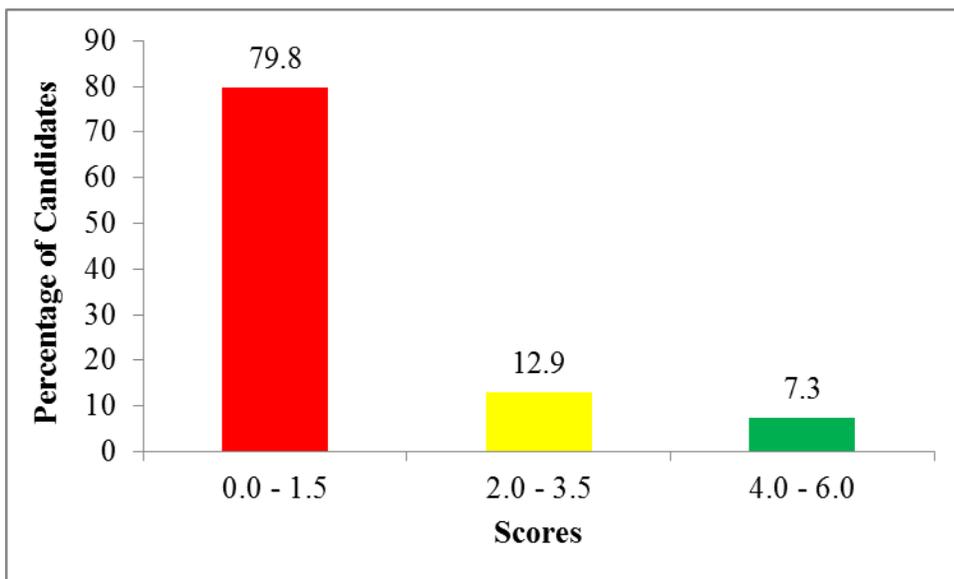


Figure 6: Candidates' performance in question 6

The analysis shows that, the majority of the candidates failed to answer the question correctly due to various reasons. In part (a), the candidates wrote $1\text{ cm} = 1000\text{ m}$ and $1\text{ m} = 10\text{ cm}$ which led them to get the incorrect number of pieces. The candidates seemed to have inadequate knowledge in units conversion. In part (b), they formulated incorrect proportional statements like $M \propto b$ and $M \propto \frac{l}{b}$ instead of $M \propto \frac{b}{l}$ then $k = \frac{Ml}{b}$, as a result they ended up getting incorrect values of constant k and mass M . Some candidates failed to get the correct values of k and M due to wrong substitution of the given values and incorrect computation. This indicates that, the candidates had inadequate knowledge of applying joint variation to

solve problems. Extract 6.1 is a sample of a candidate's incorrect response in question 6.

6	(a)	7.42 is cut from 17.5m
		= 6.08m remaining
		$1m \times 1000 \text{ cm}$
		7cm
		= 0.072m
		$6.08m \div 0.072m = 190m$
		= 190 pieces
	(b)	$M \propto \frac{1}{b} \propto L$
		b22
		L218
		M2200
		$200 \propto \frac{1}{2} \propto 2K18$
		$\frac{K2400}{18} = \frac{K18}{18}$
		= 26.6
		$M = \frac{26.6}{1m} = 266 \times 20$
		= 8186 = 592

Extract 6.1: A sample of an incorrect response question 6

In Extract 6.1, the candidate, in part (a), was unable to convert centimetre (cm) into metre (m) or vice versa, thus ending up with incorrect answer. In part (b), the candidate was unable to formulate the required equation of

variation using the given information something that led to getting incorrect constant (k) and the mass (M).

However, the candidates who managed to answer part (a) correctly were able to find the remaining part of the string by taking $13.5\text{ m} - 7.42\text{ m}$ and got 6.08 m . Then, they calculated the number of pieces of the string of equal lengths by writing $\frac{6.08\text{ m}}{0.32\text{ m}} = 19$. Others were able to convert 6.08 m to cm and got 608 cm , then divided by 32 cm and finally obtained 19 pieces of equal lengths. This indicates that, the candidates had adequate knowledge of unit conversion and arithmetic skills in performing calculations involving units.

In part (b), the candidates were able to formulate the correct equation from the given word problem. Then, they substituted correctly the given values of M , b and l to get $k = 15,00$ which was an important step to obtain the required mass (M) which was 225 kg . This implies that, the candidates had adequate knowledge and skills of applying joint variation to solve simple problems. Extract 6.2 shows the response of from a candidate who answered the question correctly.

$$6. \text{ a) length of string} = 13.5\text{m}$$
$$13.5\text{m} - 7.42\text{m} = 6.08\text{m}$$

$$\text{Remaining part} = 6.08\text{m}$$

but,

$$1\text{m} = 100\text{cm}$$

$$6.08\text{m} = ?$$

$$= \frac{6.08\text{m} \times 100\text{cm}}{1\text{m}}$$

$$1\text{m}$$

$$= 608\text{cm}$$

then,

$$1 \text{ piece} = 32\text{cm}$$

$$? \times 32 = 608\text{cm}$$

$$= \frac{1 \text{ piece} \times 608\text{cm}}{32\text{cm}}$$

$$32\text{cm}$$

$$= 19 \text{ pieces}$$

\therefore There are 19 pieces

6	(b) Let mass be M
	breadth be b
	length be L
	$M \propto b$ -- (i)
	$M \propto 1/L$ -- (ii)
	Combining (i) and (ii) -
	$M \propto b/L$
	$M = k \cdot (b/L)$
	$M = kb/L$
	$kb = ML$
	$k = \frac{ML}{b}$
	Then? $\frac{M_1 L_1}{b_1} = \frac{M_2 L_2}{b_2}$
	$\frac{200 \text{ kg} \times 15 \text{ m}}{2 \text{ m}} = \frac{M_2 \cdot 20 \text{ m}}{3 \text{ m}}$
	$M_2 = \frac{200 \text{ kg} \times 15 \times 3}{20 \times 2}$
	$= 150 \text{ kg} \quad 225 \text{ kg}$
	\therefore The mass which can be supported by the beam is 225 kg.

Extract 6.2: A sample of the correct response in question 6

In part (a) of Extract 6.2, the candidate calculated the number of pieces correctly by subtracting the given units in metre, then converted it into centimetre and lastly divided the result by 32 cm. In part (b), the candidates formulated the correct equation and solved for the mass (M) as required.

2.7 Question 7: Accounts, Ratios, Profit and Loss

The question had parts (a) and (b). In part (a), the candidates were asked to write the meaning of terms; trading account, profit and loss account, Balance sheet and cash account. Part (b) stated that, "a car which its buying price was shs 12,500,000 was sold at a loss of 20 percent". The candidates were required to find the loss made and selling price.

The analysis shows that, this question was attempted by 485,866 (99.7%) candidates where a total of 86,633 (17.8%) candidates passed. This shows that, the candidates' performance in this question was weak. Further analysis indicates that, 2,690 (0.6%) candidates scored full marks while 362,025 (74.5%) scored a zero mark. Figure 7 summarizes the candidates' performance in question 7.

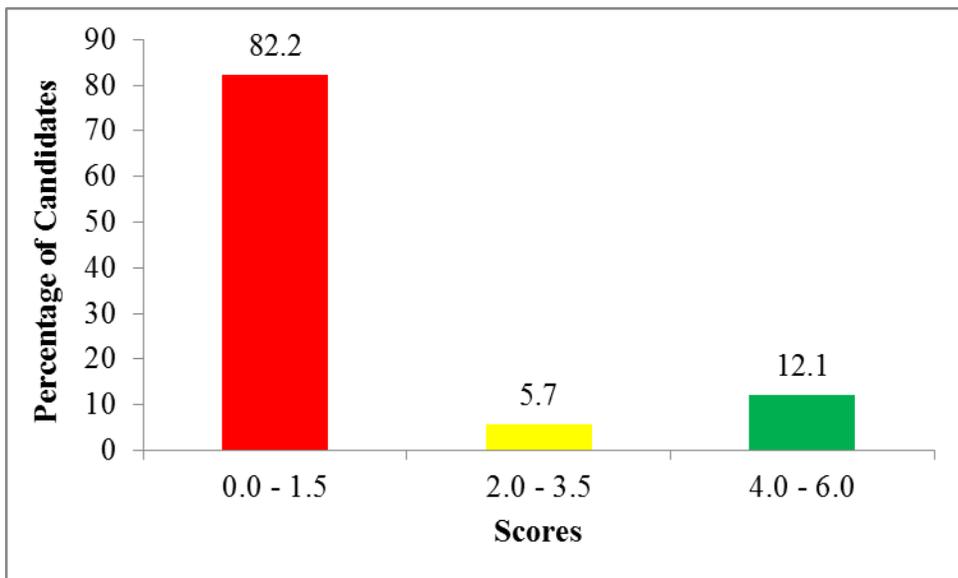


Figure 7: Candidates' performance in question 7

The analysis shows that, the majority of the candidates failed to respond to the question correctly. In part (a), the candidates were not able to define the given terms. For example, they defined *trading account* as the account which deals with trading issues, instead of the ledger which is used to find gross profit or gross loss; *profit and loss account* as the account removed from buying something, instead of the ledger which is used to find net profit or net loss. They also defined *balance sheet* as balance between debits and credits, instead of statement which shows the financial summary; and *cash account* as direct payment of money instead of the ledger where debit and credit entries of cash transactions are recorded. Also, others drew tables representing trading accounts, profit and loss account, balance sheet and cash account contrary to what the question needed. This indicates that, the candidates lacked understanding of terms used in accounts. In part (b), they failed to evaluate the loss made by using percentage loss and selling price. Most of them calculated incorrectly the loss made as

$\frac{12500,000}{20} \times 100\%$ instead of $\frac{12,500,000}{100} \times 20\%$. Others failed to get the correct selling price because they considered it as the sum of buying price and loss made. They were not aware that, the selling price is obtained by summing up the buying price and loss made. Furthermore, the candidates failed to differentiate the loss made from percentage loss as they regarded 20% as the loss made. Extract 7.1 shows the response of a candidate who answered this question incorrectly.

		Cash account						
	Drc	Amount	Selling	Foil	Amount	c/p	Selling	foil
7(a)	Open stock	1000,000	Purchase	1				
	Cash	1000	Purchase	2	200	Selling	3	
		2000000						
	Cross Trade							
		1000000						
	Profit and Loss ac	200	Selling	3	200	Cash	2	
		200			200			
	Balance sheet	200			200			
7(b)	$\% \text{ loss} = \frac{\text{Selling price} - \text{Buying price}}{\text{Buying price}} \times 100$ $= \frac{62,500,000 - 12,500,000}{12,500,000} \times 100$ $\% \text{ loss} = 50,000,000\%$							
	$\text{Selling price} = \text{Buying price} - \text{loss made}$ $= 12,500,000 - 50,000,000$ $= 2,500,000$							
	$\therefore \text{Selling price} = 2,500,000\%$							

Extract 7.1: A sample of incorrect response in question 7

In Extract 7.1, part (a), the candidate drew the table and filled in with the information which was not given; and not the requirement of the question.

In part (b), the candidate applied incorrect formula in calculating the percentage loss and selling price.

In contrast, the candidates who attempted this question correctly were able to portray the intended skills. In part (a), they correctly defined the given terms as applied in accounts. In Part (b), they were capable of calculating the selling price by using the correct formula for finding the percentage loss

which is given by $\frac{\text{loss made}}{\text{buying price}} \times 100\%$. Then, they substituted the given

values to get $20 = \frac{\text{loss made}}{12,500,000} \times 100$ and finally obtained shs 2,500,000 as

the required loss made; and shs 10,000,000 as the selling price. Extract 7.2 shows the response of one of the candidates who answered this question correctly.

7a)	Soln
i)	Trading account is an account formulated so as to obtained the business gross profit or loss normally by taking sales less cost of goods sold.
ii)	Profit and loss account is an account made so as to determine to the business either net profit or net loss is made normally by taking Gross profit less expenses.
iii)	Balance sheet is the account made so as to determine to financial position of a business especially after ascertaining Assets, Capital and liabilities.
iv)	Cash account is the account made when the transactions are made through cash basis only.

7. b)	where,
	Percentage loss = 20%
	Buying price = 12,500,000
	then,
	$20\% = \frac{\text{Loss made}}{12,500,000} \times 100\%$
	$20 \times 12,500,000 = 100 \times \text{loss made}$
	$\frac{20}{100} \times 12,500,000 = \frac{100}{100} \times \text{loss made}$
	Loss made = 2,500,000
	\therefore the loss made is 2,500,000.
	But Also,
	Loss made = Buying price - selling price
	2,500,000 = 12,500,000 - S.P
	S.P = 12,500,000 - 2,500,000
	= 10,000,000
	\therefore the selling price is 10,000,000.

Extract 7.2: A sample of the correct response in question 7

In Extract 7.2, part (a), the candidates defined correctly the given terminologies. In part (b), the candidates applied the correct formula and computed for the loss made and selling price as it was intended.

2.8 Question 8: Sequences and Series

This question had parts (a) and (b). In part (a), the candidates were given that; a farmer wants to plant 6 mango seedlings in a row at a fixed interval of 7 metres. Then, they were supposed to determine the length of the row. In part (b), they were required to find the common ratio and the first term of the Geometric Progression (GP) if the fifth and the sixth terms are 162 and 486 respectively.

According to data analysis, this question was attempted by a total 485,257 (99.6%) candidates out of whom 52,347 (10.8%) candidates passed indicating a weak performance. It was also identified that, only 2,593

(0.5%) candidates scored full marks whereas 413,641 (85.2%) scored a zero mark. Figure 8 presents a summary of the candidates' performance in question 8.

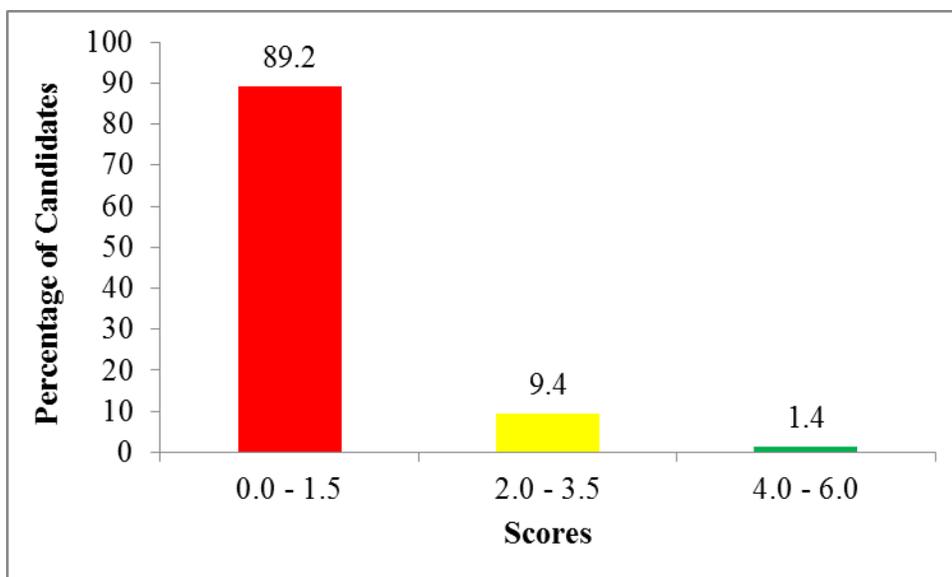


Figure 8: *Candidates' performance in question 8*

According to analysis, most of the candidates failed to answer the question correctly. In part (a), the candidates multiplied the length of one interval of 7 m by 6 mango seedling which was incorrect. Instead, they were supposed to multiply 7 by 5 fixed intervals to get the required length of the row, that is $7\text{ m} \times 5 = 35\text{ m}$. Others added the given numbers, that is $6\text{ plants} + 7\text{ metres} = 13$. This indicates that candidates lacked knowledge of applying the general term of an Arithmetic Progression (AP) in solving real life problems. Others applied inappropriate formulae such as $S_n = \frac{1}{2}[2A_1 + (n-1)d]$ and $s_n = A_1 + A_n$ which did not help them to get the required answer.

In part (b), the candidates failed to recall the correct formula for the n^{th} term of the GP, as a result, they got incorrect common ratio and first term of the GP. The candidates also applied incorrect formulae like: $A_2 = A_1 + (n+1)d$, $G_5 = 1r^{n-4}$ and $G_6 = 1r^{n-5}$ that led them to incorrect answer while others determined the common ratio by subtracting, that is

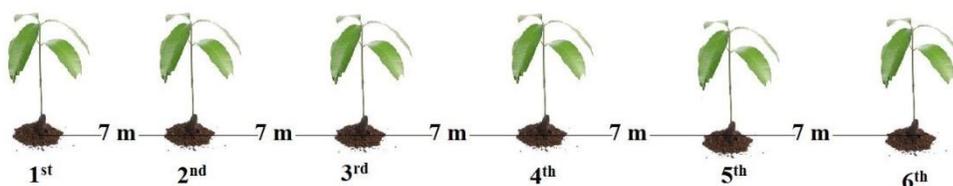
$G_6 - G_5 = 486 - 162 = 324$. This shows that the candidates lacked knowledge of applying the general term of a geometric progression to find the common ratio and the first term of a progression. Extract 8.1 shows the response of one of the candidates who answered this question incorrectly.

8 a)	solution
	Given that;
	The row fixed interval = 7 metres
	Number of mango seedlings planted = 6
	Then;
	The length of the row = Fixed interval length \times Number of seedlings
	$= 7\text{m} \times 6$
	$= 42\text{metres}$
	\therefore The length of the row is 42 metres.
8 b)	Solution
	$G_5 = 162$
	$G_6 = 486$.
	$G_5 = G_1 r^{n-1}$
	$162 = G_1 + r^{5-1}$
	$162 = G_1 + r^4$ ——— (i)
	$G_6 = G_1 + r^{6-1}$
	$486 = G_1 + r^5$ ——— (ii)
	$\begin{cases} G_1 + r^4 = 162 & \text{--- (i)} \\ G_1 + r^5 = 486 & \text{--- (ii)} \end{cases}$
	$\sqrt{r^2} = \sqrt{324}$
	$r = 18$.
	Substitute r in eqn (i)
	$G_5 = G_1 r^4$
	$\frac{162}{18} = \frac{18^4}{18} G_1$
	$G_1 = 9$.
	\therefore first term is 9 and Common ratio is 18.

Extract 8.1: A sample of incorrect response in question 8

In Extract 8.1, part (a), the candidate multiplied the number of seedlings with the fixed length, hence got incorrect length of the row. In part (b), the candidate wrote incorrect formula of G_5 and G_6 which resulted into getting wrong value of common ratio and the first term.

In spite of weak performance, some candidates managed to answer the question correctly. In part (a), the candidates were able to sketch the 6 seedlings in a row with 5 fixed intervals of 7 metres each. Other candidates were able to determine the length of the row by finding the sum of all seedling intervals while others determined it by multiplying the 5 fixed intervals by 7 m to get 35 m which was the required length of the row. The intervals of 7 m between consecutive seedlings were shown in a row as indicated in the following sketch.



Meanwhile, others interpreted correctly the question into an arithmetic progression. They identified that the length of the row of seedling is the distance from the first to the last seedling. They also identified the first term, that is, $A_1 = 0$, the common difference, $d = 7\text{ m}$, number of terms, $n = 6$, and the last term A_n which was the length of the row. The candidates applied the formula for the general term of an arithmetic progression (AP), $A_n = A_1 + (n - 1)d$, to get the required length of the row of seedlings as 35 metres. This indicates that, the candidates had adequate knowledge and skills in applying n^{th} term formula to solve real life problems.

In part (b), the candidates applied the formula for the n^{th} term of GP, which is $G_n = G_1 r^{n-1}$ where $n=5$ and $n=6$ to give $G_5 = G_1 r^4$ and $G_6 = G_1 r^5$ respectively. They were also able to find the common ratio which is the ratio of the preceding term to the previous term. Then, they solved

$$\frac{G_1 r^5}{G_1 r^4} = \frac{486}{162}, \text{ to obtain the common ratio } r = 3 \text{ and hence the first term of the}$$

GP as $G_1 = 2$. This indicates that the candidates had adequate knowledge of using the general term of GP to find the common ratio and the first term of

the sequences. Extract 8.2 shows a sample of correct response from one of the candidates in this question.

8a.	$A_1 = 0, n = 6, d = 7m$ <p>from</p> $A_n = A_1 + (n-1)d$ $A_n = 0 + (6-1) \times 7m$ $A_n = 35m$ <p>∴ The length of the row is 35m</p>
8	<p>b) Solution:</p> <p>From; $G_n = G_1 r^{n-1}$</p> $G_5 = G_1 r^{5-1}$ $162 = G_1 r^4 \quad \text{---(i)}$ $G_6 = G_1 r^{6-1}$ $486 = G_1 r^5 \quad \text{---(ii)}$
8	<p>b)</p> $\frac{G_6}{G_5} = \frac{486}{162}$ $\frac{G_1 r^5}{G_1 r^4} = \frac{486}{162}$ $r^{5-4} = 3$ $r^1 = 3$ $r = 3$ <p>∴ The common ratio is 3</p> <p>from; eqn (i)</p> $162 = G_1 r^4$ $162 = G_1 \times 3^4$ $162 = G_1 \times 81$ $\frac{162}{81} = \frac{G_1}{81}$ $G_1 = 2$ <p>∴ The first term of the G.P is 2</p>

Extract 8.2: A sample of a correct response in question 8

In Extract 8.2, the candidate performed the required calculations to get the correct answer in part (a). In part (b), the candidate applied the formula and

defined all terms in the formula correctly to obtain the required first term of GP.

2.9 Question 9: Trigonometry and Pythagoras Theorem

This question consisted of parts (a) and (b). In part (a), the candidates were required to show that $\cos(90^\circ + \theta) = -\sin \theta$. Part (b) stated that; in a triangle UVW , $\overline{UV} = 3\text{cm}$ and $\overline{UW} = 5\text{cm}$. The angle formed between the two sides is 60° . The candidates were required to find \overline{VW} correct to two decimal places.

The analysis reveals that, this question was attempted by a total of 484,965 (99.5%) candidates and among them, 19,344 (4.0%) candidates passed, indicating a weak performance. It was also identified that, only 3,067 (0.6%) candidates scored all marks while 460,186 (94.9%) candidates scored 0 mark. Figure 9 shows the summary of candidates' performance in question 9.

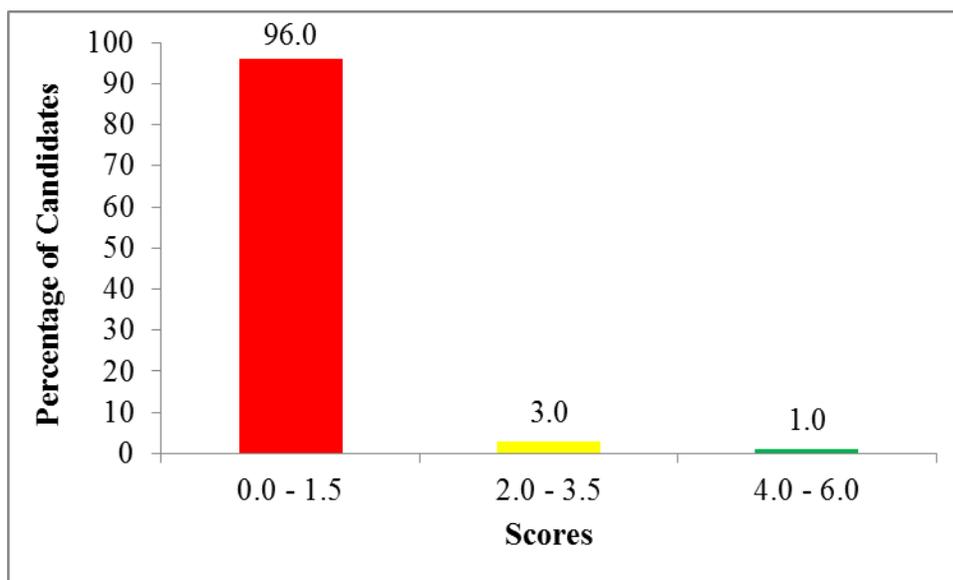


Figure 9: Candidates' performance in question 9

The analysis reveals that, most of the candidates performed poorly in this question. In part (a), they failed to recall the compound angle formula for cosine as they formulated incorrect expansions for $\cos(90^\circ + \theta)$ like $\cos 90^\circ \cos \theta + \sin 90^\circ \sin \theta$ and $\cos 90^\circ \sin \theta \pm \sin 90^\circ \cos \theta$. Instead, they

were supposed to write $\cos 90^\circ \cos \theta - \sin 90^\circ \sin \theta$ which could produce the correct results. Other candidates failed to remember that $\cos 90^\circ = 0$ and $\sin 90^\circ = 1$, instead they used $\cos 90^\circ = 1$ and $\sin 90^\circ = 0$ which are incorrect. This reveals that candidates had inadequate knowledge of trigonometric ratios for the special angles and compound angles.

In part (b), most of the candidates applied sine rule which was not applicable in determining the length of the given triangle. Others calculated the area of the triangle as they applied the formula $\frac{1}{2} \times \overline{UV} \times \overline{UW} \times \sin 60^\circ$ which is contrary to the requirement of the question. They did not realize that, in order to get the length of \overline{VW} they were supposed to use the formula $\overline{VW}^2 = \overline{UV}^2 + \overline{UW}^2 - 2(\overline{UV})(\overline{UW})\cos 60^\circ$. However, there were candidates who applied Pythagoras theorem to obtain the length of \overline{VW} , that is $\overline{VW}^2 = \overline{UV}^2 + \overline{UW}^2$. Those candidates were not aware that the Pythagoras theorem is used for finding the length of any side of a right angled triangle when two sides are known. Extract 9.1 is the sample from one of the candidate's incorrect response in question 9.

9	a)	Solution
		$\cos(90^\circ + \theta) = -\sin \theta$
		$\cos 90^\circ + \cos \theta = -\sin \theta$
		$\sin \theta + \cos 90^\circ + \cos \theta = 0$
		$\sin \theta + 0 = \cos \theta$
		$\sin \theta = \cos \theta - 0$
		$\sin \theta = \cos \theta - 0$ hence proved.

9	Solution.
$c^2 = a^2 + b^2 + 2ab \sin \hat{C}$	
$c^2 = 7^2 + 3^2 + 2 \times 3 \times 7 \times \sin 60^\circ$	
$c^2 = 27 + 9 + 30 \times 0.8660.$	
$c^2 = 34 + 25.98.$	
$\sqrt{c^2} = \sqrt{59.98}$	
$c = 7.7416 \text{ cm.}$	
$\text{Ans} \approx 7.74 \text{ (Correct to two decimal places)}$	
$\therefore \text{Ans} = 7.74 \text{ cm}$	

Extract 9.1: A sample of incorrect response in question 9

In Extract 9.1, the candidate expressed $\cos(90^\circ + \theta)$ into $\cos 90 + \cos \theta$ indicating lack of knowledge of compound angle formulae in part (a). In part (b), the candidate applied incorrect formula $c^2 = a^2 + b^2 + 2ab \cos \hat{C}$ instead of $c^2 = a^2 + b^2 - 2ab \cos \hat{C}$.

Although the performance was weak, some candidates performed well in the question. In part (a), the candidates were able to recall and apply the compound angle formula $\cos(A + B) = \cos A \cos B - \sin A \sin B$ to show that $\cos(90^\circ + \theta) = -\sin \theta$. In part (b), the candidates were able to illustrate the given information in a diagram and applied the cosine rule correctly to get the required length. This shows that, the candidates had adequate knowledge and skills to apply compound angle formula for cosine to solve trigonometric problems. Extract 9.2 is the sample from one of the candidates' correct responses in question 9.

9.	a) Soln	
	Required: to show that	
	$\cos(90^\circ + \theta) = -\sin \theta$	
	Consider L.H.S of eqn	
	From, $\cos(A+B) = \cos A \cos B - \sin A \sin B$	
	$= \cos 90^\circ \cos \theta - \sin 90^\circ \sin \theta$ (But $\cos 90^\circ = 0$ and $\sin 90^\circ = 1$)	
	$= 0 \times \cos \theta - 1 \sin \theta$	
	$= 0 - \sin \theta$	
	$= -\sin \theta$	
	then $\cos(90^\circ + \theta) = -\sin \theta$ hence shown	
09	(b)	
	from $c^2 = a^2 + b^2 - 2ab \cos \theta$	
	$(VW)^2 = 3^2 + 5^2 - 2 \times 3 \times 5 \cos 60^\circ$	
	$(VW)^2 = 34 - 15$	
	$\sqrt{(VW)^2} = \sqrt{19}$	
	$VW = 4.36 \text{ cm}$	
	\therefore The length VW is 4.36 cm	

Extract 9.2: A sample of correct response in question 9

In Extract 9.2, the candidate expressed $\cos(90^\circ + \theta)$ in terms of $\cos 90^\circ \cos \theta - \sin 90^\circ \sin \theta$ that simply turned into $-\sin \theta$ as required. In part (b), the candidate was able to find the length \overline{VW} as 4.36 cm by applying the cosine rule.

2.10 Question 10: Algebra and Quadratic Equations

This question consisted of parts (a) and (b). In part (a), the candidates were given that a trapezium has the area of $2x^2 - 8x + 6$ square units. If the parallel sides are $(2x + 3)$ units and $(2x - y)$ units long, then the candidates were required to find the height of the trapezium. In part (b), the candidates were given that the difference between two positive numbers is 7. The candidates were required to find the numbers if their product is 30.

According to the analysis, this question was attempted by 485,150 (99.5%) candidates and out of them, 48,511 (10.0%) candidates passed. This shows that, the candidates' performance in this question was weak. Additionally, the analysis indicates that, 6,407 (1.3%) candidates scored all marks while a total of 406,240 (83.7%) scored zero. Figure 10 summarizes the candidates' performance in question 10.

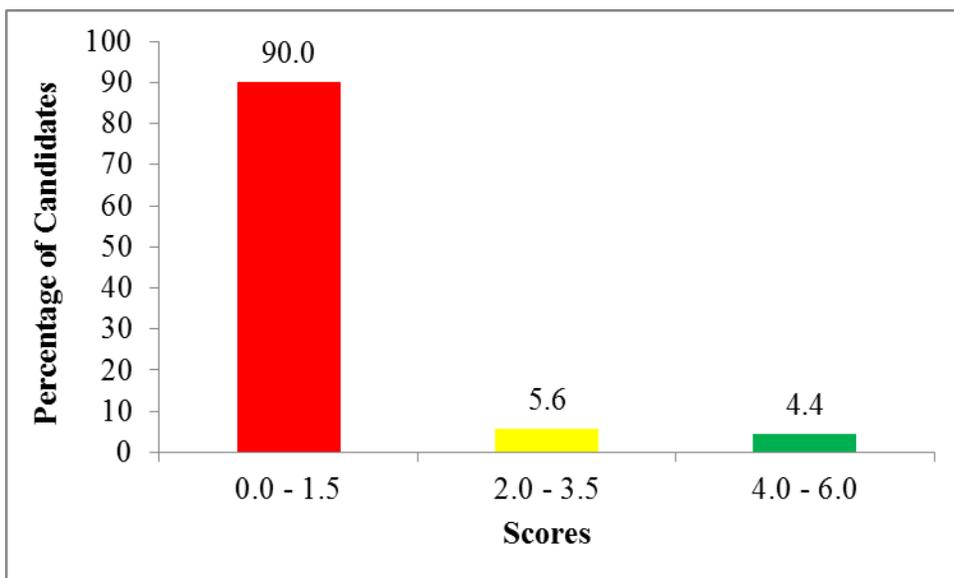


Figure 10: *Candidates' performance in question 10*

The response analysis shows that, most of the candidates failed to answer the question correctly due to various reasons: In part (a), the candidates failed to recall the formula for finding the area of a trapezium. They wrote incorrect formulae like $A = \frac{1}{2}a + bh$. Moreover, the candidates were unable to substitute correctly the given values in the formula for the area of the trapezium. Others were incapable of solving the equation to get the value of the required height. Additionally, there were candidates who multiplied the given sides as $A = \frac{1}{2}(2x+3)(2x-7)h$ instead of $A = \frac{1}{2}((2x+3) + (2x-7))h$ which could produce the correct answer.

In part (b), some candidates were not able to transform the given information into equation. Some failed to solve the equations they formulated as they could not remember the correct methods. They applied

incorrect quadratic formulae like: $x = -b \pm \frac{\sqrt{b^2 - 4ac}}{2a}$ and $x = \frac{b \pm \sqrt{b^2 - 4ac}}{2a}$

instead of $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$. This reveals that, the candidates had inadequate

knowledge of solving problems related to quadratic equations. Extract 10.1 is a sample the candidate's incorrect response in question 10.

10.	a) Consider Area = $\frac{1}{2} h (b+a)$
	$A = 2x^2 - 8x + 6$
	$a = 2x + 3$
	$b = 2x - 7$
	Then;
	$2x^2 - 8x + 6 = \frac{1}{2} h (2x + 3 + 2x - 7)$
	$2x^2 - 8x + 6 = \frac{1}{2} h (4x - 4)$
	Consider $2x^2 - 8x + 6$ factorise.
	From;
	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
	$x = \frac{-(-8) \pm \sqrt{-8^2 - 4 \times 2 \times 6}}{2 \times 2}$
	$x = \frac{8 \pm \sqrt{64 - 48}}{4}$
	$x = \frac{8 \pm \sqrt{16}}{4}$
	$x = \frac{8+4}{4}$ or $\frac{8-4}{4}$
	$x = 3$ or 1
10	b) posit positive number 7 product 30 solution 30×7 $= 210$ positive number = 210

Extract 10.1: A sample of incorrect response in question 10

In Extract 10.1, the candidate failed to apply the formula correctly in part (a). In part (b), the candidate formulated incorrect quadratic expression and hence ended up with incorrect answer.

Regardless of the weak performance, there were few candidates who answered the question correctly. In part (a), they applied correctly the formula for finding the area of a trapezium to obtain the required height of a trapezium. In part (b), the candidates formulated the equation $x(x+7)=30$ which they solved to get the required numbers 3 and 10. Extract 10.2 is the sample of a correct response from one of the candidates in question 10.

10.	a) Data given,
	Area of trapezium, $A = 2x^2 - 8x + 6$
	Parallel sides, P_1 and $P_2 = (2x + 3)$ and $(2x - 7)$
	Required: to find the height of trapezium
	from the formula,
	$A = \frac{1}{2}(P_1 + P_2)h$ (substitute the given values)
	$2x(2x^2 - 8x + 6) = \frac{(2x + 3) + (2x - 7)}{2} h \times 2$
	$4x^2 - 16x + 12 = (4x - 4)h$
	$4x - 4 \quad 4x - 4$
10.	a) $4(x^2 - 2x + 3) = h$
	$4(x - 1)$
	$x^2 - 2x + 3 = h$
	$x - 1$
	$(x - 3)(x - 1) = h$
	$(x - 1)$
	$h = (x - 3) \text{ cm}$
	\therefore The height of trapezium is $(x - 3) \text{ cm}$

	b) let first number be x
	second number be y
	then, $x - y = 7$
	$xy = 30$
	From equation (i)
	$x - y = 7$
	$x = 7 + y$
	Substitute eqn. (ii) into eqn. (i)
	$(7 + y)y = 30$
	$y^2 + 7y - 30 = 0$, $a = 1$, $b = 7$ and $c = -30$
	By using quadratic formula,
	$y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
	$= \frac{-7 \pm \sqrt{(7)^2 - 4(1)(-30)}}{2(1)}$
	$= \frac{-7 \pm \sqrt{49 + 120}}{2}$
	$= \frac{-7 \pm \sqrt{169}}{2}$
	$y = \frac{-7 \pm 13}{2}$
	\therefore Either, $y = \frac{-7 + 13}{2}$ or $y = \frac{-7 - 13}{2}$
10.	b) then, $y = 3$ or -10
	Since the numbers are positive, then $y = 3$
	Substitute $y = 3$ into eqn. (ii)
	$x = 7 + y$
	$= 7 + 3$
	$x = 10$
	\therefore The numbers are 10 and 3

Extract 10.2: A sample of correct response in question 10

In Extract 10.2, the candidate was able to identify the parallel sides of the trapezium and apply the correct formula to obtain its height using the given

area. In part (b), the candidate formulated correct equations and managed to solve them simultaneously to get the required numbers.

2.11 Question 11: Statistics

This question had parts (a), (b) and (c). The candidates were given the following marks obtained by 40 students in one of Basic Mathematics Examination:

48	47	57	56	71	62	46	45	50	76
58	66	48	32	89	60	42	47	54	67
64	49	37	64	67	44	45	45	42	34
47	44	73	44	58	43	54	35	54	52

In part (a), the candidates were required to prepare a frequency distribution table using the information with the number of classes = 8, class size = 8 and the lower limit of the first class interval = 32. In part (b), they were instructed to use the frequency distribution obtained in part (a) to find the actual mean, when the assumed mean is 83.5. In part (c), they were required to calculate the difference between the actual mean and the median of this distribution and hence comment on the difference obtained.

The analysis shows that, out of 485,895 (99.7%) candidates who attempted this question, only 39,852 (8.2%) candidates passed showing that, the candidates' performance was weak. It was further identified that, only 576 (0.1%) candidates scored full marks whereas 348,972 (71.8%) scored zero. Figure 11 summarizes the candidates' performance in question 11.

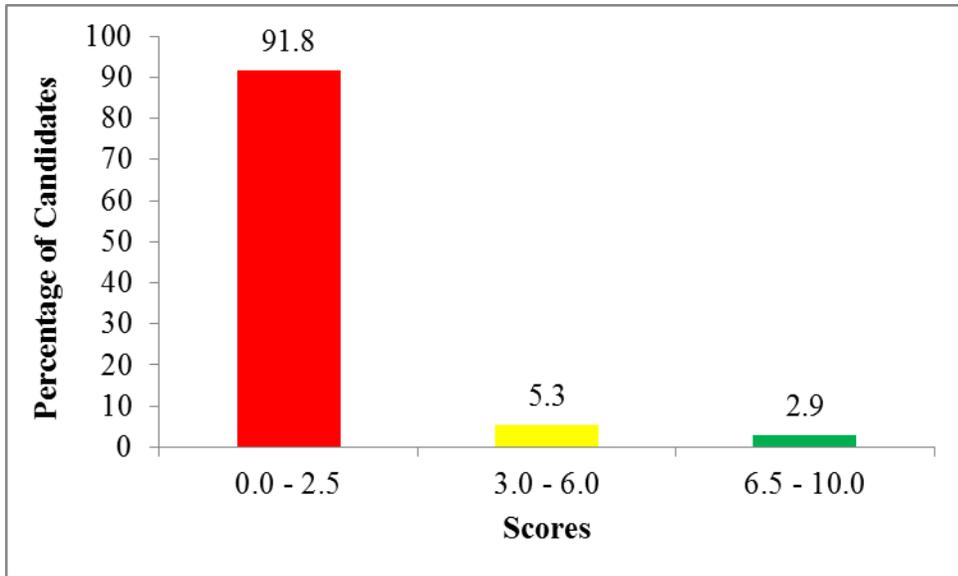


Figure 11: *Candidates' performance in question 11*

The analysis points out that, most of the candidates failed to answer this question correctly. In part (a), they were unable to prepare a frequency distribution table because they failed to obtain the correct frequency of the given values in each class interval. Those candidates lacked skills to represent the given information by using a frequency distribution table. In part (b), the candidates were not able to find the actual mean as they used incorrect frequency distribution table obtained in part (a). Also, others used inappropriate formulae for finding the actual mean like: $\bar{X} = \frac{\sum fx}{\sum f}$,

$\bar{X} = \frac{\sum fd}{N}$ and $\bar{X} = A + \frac{\sum fx}{\sum f}$ instead of $\bar{X} = A + \frac{\sum fd}{\sum f}$. Others obtained

incorrect deviations as they used $d = A - X$ instead of $d = X - A$. This led to obtaining incorrect mean. In part (c), most candidates failed to calculate the difference between the actual mean and median of the distribution because they applied incorrect formulae for finding median like:

$L + \left(\frac{\frac{N}{2} + n_b}{n_w} \right) i$, $\left(\frac{\frac{N}{2} - n_w}{2} \right) i$ and $L + \left(\frac{\frac{N}{2} + n_b}{n_w} \right)$ instead of,

$L + \left(\frac{\frac{N}{2} - n_b}{n_w} \right) i$ which could have resulted to correct result. However, most

of them substituted incorrect values in the formula and consequently ended up with incorrect difference between the actual mean and median. Consequently, they incorrectly commented on the final results because they failed to interpret the results of the given problems. This shows that the candidates had inadequate knowledge on measures of central tendency, including lack of skills to apply statistics in real life situation. Extract 11.1 represents a sample of incorrect response to question 11.

40 Frequency distribution table					
11					
a	class interval	frequency	class mark (x)	Σfx	Deviation (d) ($x - \bar{x}$)
	32 - 40	4	36	144	11897
	40 - 48	15	44	660	11281
	48 - 56	7	52	364	11677
	56 - 64	7	60	420	11621
	64 - 72	4	68	272	11769
	72 - 80	2	76	144	11897
	80 - 88	0	84	0	12,041
	88 - 96	1	92	92	11949
$= 96328 \div 8 = 12,041$					
b	Find actual mean				
	$(\bar{x}) = A + d$				
	$83.5 + 94231$				
	$(\bar{x}) = 54315.5$				
	Mean = 54315.5				
c	Median				
	$L + \left(\frac{\frac{N}{2} - nb}{fw} \right) c$				
	$39.5 + \left(\frac{40 - 4}{15} \right) 8$				
	$39.5 + \left(\frac{20 - 4}{15} \right) 8$				
	$39.5 + \left(\frac{16}{15} \right) 8$				
	$39.5 + 8.5 = 48$				
	$\therefore \text{Median} = 48$				

11	
C	Different between actual mean and median
	$(\bar{X}) = 54315.5 - (\text{Median}) = 48$
	$= 54315.5 - 48$
	54267.5
	\therefore The difference = 54315 54267.5
	\therefore The actual mean is greater than median

Extract 11.1: A sample of incorrect response in question 11

In extract 11.1, the candidate, prepared an incorrect frequency distribution with class size 9 instead of 8 class size in part (a). In part (b), the candidate applied the formula $\bar{X} = A + d$ to calculate the actual mean resulting to incorrect value of the mean. In part (c), the candidate was not able to comment on the result of the difference between the mean and median.

Although the performance was weak, the analysis shows that, few candidates performed well in this question. Those candidates managed to prepare the correct frequency distribution table for the given ungrouped data in part (a). In part (b), the candidates applied the correct formula for finding the actual mean which is $\bar{X} = A + \frac{\sum fd}{\sum f}$, where \bar{X} is the actual

mean, A is the given assumed mean, d is deviations, $\sum f$ the sum of all the frequencies, and $\sum fd$ the sum of all the products of the frequencies and the corresponding deviations. As a result, they managed to calculate the actual mean as $\bar{X} = 83.5 + \frac{(-1216)}{40} = 53.1$. In part (c), the candidates were

able to get the correct median, that is $47.5 + \left(\frac{20-17}{8}\right)8 = 50.5$ and hence

obtained the difference between the actual mean and median which is $53.1 - 50.5 = 2.6$. This shows that, the candidates were knowledgeable on measures of central tendency. Extract 11.1 is the sample response from one of the candidates who responded to question 11 correctly.

Sl. No.	Class I	Tally	f	x	d = x - A	fd	cumf.
	32-39		4	43.5 35.5	-48	-192	4
	40-47		13	43.5	-40	-520	17
	48-55		8	51.5	-32	-256	25
	56-63		6	59.5	-24	-144	31
	64-71		6	67.5	-16	-96	37
	72-79		2	75.5	-8	-16	39
	80-87		0	83.5	0	0	39
	88-95		1	91.5	8	8	40
			$\Sigma f = 40$			$\Sigma fd = 1216$	

u. b. Mean = $A + \frac{\Sigma fd}{\Sigma f}$

$$= 83.5 + \frac{-1216}{40}$$

$$= 83.5 + -30.4$$

$$= 53.1$$

\therefore Actual mean = 53.1

c. Median = $L + \left(\frac{N/2 - F_b}{F_w} \right) i$

Median class = 48-55

$L = 47.5$ $F_b = 17$ $F_w = 8$ $i = 8$ $N/2 = 20$

$$\text{Median} = 47.5 + \left(\frac{20 - 17}{8} \right) 8$$

$$= 47.5 + \frac{3}{8} \times 8$$

$$= 47.5 + 3$$

$$= 50.5$$

Median = 50.5

$$\text{Difference} = 53.1 - 50.5 = 2.6$$

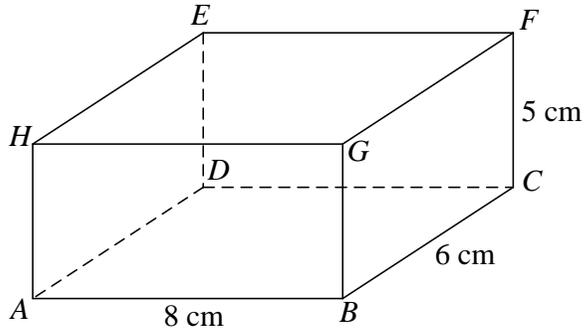
If 2.6 is the difference then the average of their marks doesn't differ greatly.

Extract 11.2: A sample of correct response in question 11

In Extract 11.2, the candidate prepared the correct frequency table and used it to calculate the actual mean, and median by using the correct approach. Lastly, the candidate compared the obtained difference and concluded that they did not differ greatly.

2.12 Question 12: The Earth as a Sphere and Three Dimensional Figures

The question had parts (a), (b) and (c). The candidates were given the following rectangular block which is 8 cm long, 6 cm wide and 5 cm high:



In part (a), they were required to name the angles that the line segment \overline{AG} forms with the planes ABCD and BCFG. In part (b), the candidates were required to calculate (i) the length of \overline{AC} , (ii) the length of \overline{AF} and (iii) the size of angle CAF. In part (c), they were given the information stating that, “A ship sails from point $A(10^{\circ}S, 30^{\circ}W)$ to point $B(11^{\circ}N, 30^{\circ}W)$ at a speed of 900 km/h. Then, they were required to find the time at which the ship will arrive at B if it leaves point A at 10:00 am. They were instructed to use $R = 6400$ km as the Radius of the Earth.

This question was attempted by 485,684 (99.7%) candidates, among them, only 92,233 (19.0%) candidates passed. This indicates a weak performance. The analysis shows that, only 1,931 (0.4%) candidates scored full marks while a total of 345,854 (71.2%) scored a zero mark. Figure 12 shows the summary of candidates’ performance in question 12.

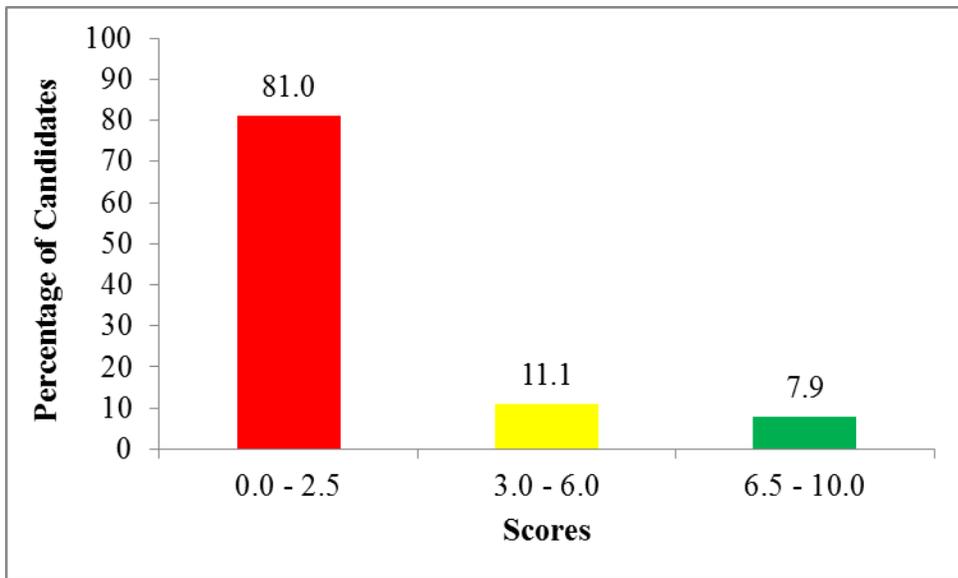


Figure 12: *Candidates' performance in question 12*

According to the analysis, most of the candidates failed to answer the question correctly due to various reasons. In part (a), the candidates failed to recognize the planes $ABCD$ and $BCFG$, hence they were not able to name the angles formed between line \overline{AG} and the stated planes. In part (b) (i), the candidates failed to find the length of \overline{AC} . They treated \overline{AC} as the sum of \overline{AB} and \overline{BC} instead of applying Pythagoras theorem based on the relation $\overline{AC}^2 = \overline{AB}^2 + \overline{BC}^2$. This indicates that, the candidates had no knowledge of three dimensional figures. Also, some candidates considered the length of \overline{AC} as the product of \overline{AB} and \overline{BC} which was incorrect. Other candidates incorrectly wrote that $\overline{AF} = \overline{AB} + \overline{CF}$ instead of considering the right angled triangle ACF which could lead to $\overline{AF}^2 = \overline{AC}^2 + \overline{CF}^2$. As a result, they ended up getting incorrect value of \overline{AF} . It was further identified that, some candidates calculated the size of angle CAF as the summation of sides, that is $\overline{AB} + \overline{BC} + \overline{CF}$ which was incorrect. This shows that, the candidates were not conversant with the concepts of sides and angles in three dimensional figures. In part (b) (ii), the candidates failed to calculate the length of \overline{AF} since they incorrectly wrote the length of \overline{AF} as the product of the lengths of \overline{AB} , \overline{BC} and \overline{CF} that is $\overline{AF} = \overline{AB} \times \overline{BC} \times \overline{CF}$. In part (c), the candidates applied incorrect

formulae for finding the length of arc \overline{AB} . For example, they applied formulae like $L = \left(\frac{\alpha + \beta}{360}\right) \times 2\pi R \cos \theta$ and $L = (\alpha - \beta) \times 60 \text{ nm}$. Instead, they were supposed to use the formula $L = \frac{\theta}{360^\circ} \times 2\pi R$ or $L = (\alpha + \beta) \times 60 \text{ nm}$ to solve the given problem. As a result, they failed to get the correct time that was taken by the ship to arrive at point B. This is an indication that the candidates lacked the knowledge of finding the length of an arc along the great and small circles. Extract 12.1 shows a sample of incorrect response from one of the candidates in this question.

12	(a) Solution:
	(a) The angle formed between line AG and the plane ABCD is \hat{GAC}
	The angle formed between line AG and the plane BCFG is \hat{AGC}
12	(b) (i) Length of AC.
	Data given:
	$AB = 8 \text{ cm}$
	$BC = 6 \text{ cm}$
	$AC = ?$
	Soln.
	length = AB + BC = AC.
	length = $8 \text{ cm} + 6 \text{ cm}$
	length = 14 cm .
	Length of AC = 14 cm .

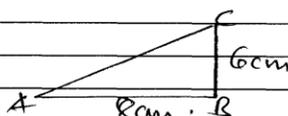
12.	(B)(ii) the length of AF. Data given: AB = 2cm BC = 6cm CF = 5cm AF = ? Soln: Length = AB + BC + CF = AF. Length = 2cm + 6cm + 5cm Length = 19cm. Length of AF = 19cm.
12	(B) (ii) size of angle CAF. the size of angle CAF is 180° because CAF is straight line
12c)	Soln Distance along small circle = $\frac{2\pi R \cos \theta}{180^\circ}$ $D = \frac{21 \times 3.14 \times 6400 \times \cos 30^\circ}{180^\circ}$ $D = 2030.425 \text{ km}$ Speed = $\frac{\text{Distance}}{\text{Time taken}}$ $\frac{900 \text{ km/h}}{1} \times \frac{t}{t} = \frac{2030.425 \text{ km}}{900 \text{ km/h}}$ $t = 2.256 \text{ hrs.}$ $10:00 \text{ am} + 2.256 \text{ hrs} = 12:25 \text{ noon}$ ∴ The ship will arrive B at 12:25 noon.

Extract 12.1: A sample of incorrect response in question 12

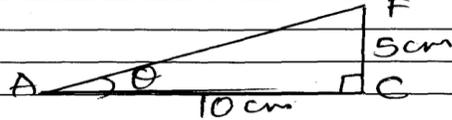
In Extract 12.1, part (a), the candidate wrote incorrect name of angle formed between line \overline{AG} with planes ABCD and BCFG. In part (b) (i), the candidate applied incorrect step for finding length \overline{AC} by taking $\overline{AB} + \overline{BC}$. Also, in part (b) (ii), the candidate applied the incorrect method for finding

length of \overline{AF} by writing $\overline{AB} + \overline{BC} + \overline{CF} = \overline{AF}$. In part (b) (iii), the candidate had no idea on how to find the size of angle CAF. In part (c), the candidate applied incorrect formula when finding the distance along the same longitude.

On the other hand, the candidates who scored full marks in this question demonstrated the required competences. In part (a), they made a simple sketch of the triangle BAG by using the properties of three dimensional figures and hence managed to name the required angles. In part (b) (i), the candidates were able to extract and sketch triangle ABC from the given rectangular block, then applied the Pythagoras theorem to determine the length of \overline{AC} . Also, in part (b) (ii), they identified correctly the projection of the line \overline{AF} with the plane ABCD which was \overline{AC} and then sketched the right angled triangle ACF to determine the length of \overline{AF} . In part (b) (iii), they were able to get angle CAF by using the knowledge of trigonometric ratios. This shows that the candidates had enough knowledge for finding the angle between a line and a plane. In part (c), they were able to describe the great circles since the two coordinates lied on the same longitude. However, the candidates determined the central angle and applied the correct formula to get distance \overline{AB} as 2347 km. Finally, they applied the formula for time taken from point A to B to obtain the arrival time at point B which was 12:36 pm. This implies that the candidates were competent enough in calculating the distance along a small circle. Extract 12.2 shows a sample of correct response from one of the candidates in this question.

12	<p>i) The angle between line AG and plane ABCD is angle GAB</p> <p>ii) The angle between line AG and plane BCFG is angle AGB</p> <p>(b) i) solution.</p>  <p>From, $a^2 + b^2 = c^2$ $8^2 + 6^2 = c^2$ $64 + 36 = c^2$ $\sqrt{100} = \sqrt{c^2}$ $c = 10\text{cm}$</p> <p>\therefore The length AC is 10cm.</p>
----	--

12 b. ii) Consider $\triangle AFC$



$$\begin{aligned} AF^2 &= AC^2 + FC^2 \quad [\text{Pythagoras Theorem}] \\ AF^2 &= 10^2 + 5^2 \\ AF^2 &= 100 + 25 \\ \sqrt{AF^2} &= \sqrt{125} \\ AF &= 11.18 \end{aligned}$$

\therefore The length of $AF = 11.18 \text{ cm}$.

12 b. iii) $\hat{CAF} = \theta$

Where as

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

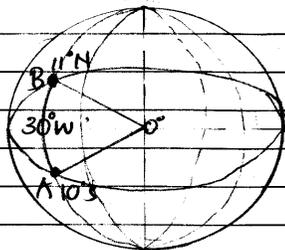
$$\theta = \tan^{-1} \left(\frac{\text{opp}}{\text{adj}} \right)$$

$$\theta = \tan^{-1} \left(\frac{5}{10} \right)$$

$$\theta = 26.6^\circ$$

\therefore the size of angle $CAF = 26.6^\circ$.

12 c.



A ($10^\circ \text{S}, 30^\circ \text{W}$)
and
B ($11^\circ \text{N}, 30^\circ \text{W}$)

Let α be difference in latitudes

$$\alpha = 10^\circ + 11^\circ$$

$$\alpha = 21^\circ$$

then

$$D = \frac{\alpha}{180^\circ} \text{TR} \quad (\text{great circle})$$

	$D = \frac{21^\circ \times 3.14 \times 6400}{180^\circ}$
	$D = 2344.5 \text{ Km.}$
	From
	$\text{Time} = \frac{\text{Distance (Km)}}{\text{Speed (Km/hr)}}$
	$= \frac{2344.5 \text{ Km}}{900 \text{ Km/h}}$
	$= 2.6 \text{ hrs or } 2 \text{ hrs and } 36 \text{ mins}$
	So,
	$= 1000 \text{ hrs} + 2 \text{ hr } 36 \text{ min}$
	$= 1236 \text{ hrs}$
	$\therefore \text{It will arrive at B at } 12:36 \text{ pm}$

Extract 12.2: A sample of the correct response in question 12

In Extract 12.2, part (a), the candidate named the angles that the line \overline{AG} forms with the planes ABCD and BCFG as \hat{GAB} and \hat{AGB} respectively. In part (b), the candidate applied the required skills to get the intended lengths and angle. In part (b) (ii), the candidate used triangle ACF to get the length of AF as 11.18 cm. In part (c), the candidate applied the correct formula to determine the required distance and time.

2.13 Question 13: Matrices and Transformations

This question consisted of parts (a), (b) and (c). In part (a), the candidates were instructed to solve the equations $2x - y = 5$ and $3x + 2y = 4$ simultaneously by using the matrix method. In part (b), they were given a triangle ABC with the vertices A(1, 1), B(2, 4) and C(5, 3) and were instructed to find the vertices of its image under the transformation matrix

$T = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix}$. In part (c), the candidates were required to find the image of point A(4, 2) after a rotation about the origin through 120° anticlockwise.

The analysis shows that, this question was attempted by 486,003 (99.7%) candidates out of whom 89,825 (18.5%) passed. This shows that, the candidates' performance in this question was weak. Further analysis points out that, only 7,646 (1.6%) candidates scored full marks while a total of 353,428 (72.7%) scored zero. Figure 13 shows the summary of candidates' performance in question 13.

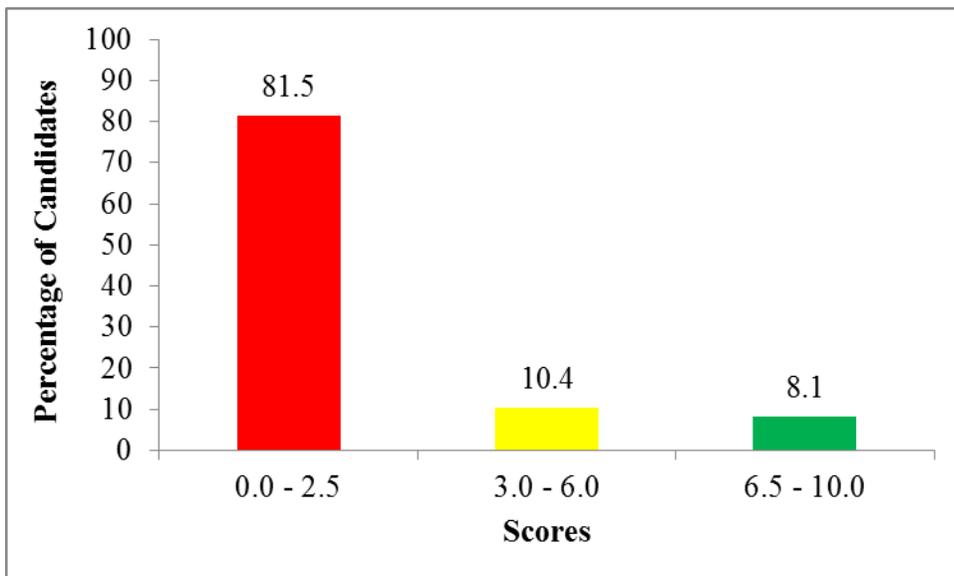


Figure 13: *Candidates' performance in question 13*

The analysis shows that, most of the candidates were not able to answer this question correctly. In part (a), they failed to express the equations in matrix form as the first step of the process. The candidates were unable to find the determinant of the coefficient matrix as they incorrectly subtracted the main diagonal from leading diagonal, that is

$$\begin{vmatrix} 2 & -1 \\ 3 & 2 \end{vmatrix} = (-1 \times 3) - (2 \times 2) = -7.$$

Instead, they were supposed to subtract the leading diagonal from the main

diagonal to get $\begin{vmatrix} 2 & -1 \\ 3 & 2 \end{vmatrix} = (2 \times 2) - (-1 \times 3) = 7$. In some cases, others failed

to apply the correct procedure or formula for the inverse of a matrix. Those candidates failed to assign the elements in the leading diagonal with a

negative sign. For example some of them wrote $\begin{pmatrix} 2 & -1 \\ 3 & 2 \end{pmatrix}^{-1} = \frac{1}{7} \begin{pmatrix} 2 & -1 \\ 3 & 2 \end{pmatrix}$

instead of $\begin{pmatrix} 2 & -1 \\ 3 & 2 \end{pmatrix}^{-1} = \frac{1}{7} \begin{pmatrix} 2 & -(-1) \\ -(-3) & 2 \end{pmatrix} = \frac{1}{7} \begin{pmatrix} 2 & 1 \\ -3 & 2 \end{pmatrix}$. All these incorrect steps led to incorrect inverse of a given matrix. Moreover, most of them failed to get correct value because they had inadequate knowledge in multiplication of matrices. They were unable to follow the required procedures of multiplying of different orders as they wrote

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 5 \\ 4 \end{pmatrix} \begin{pmatrix} \frac{2}{7} & \frac{1}{7} \\ -\frac{3}{7} & \frac{2}{7} \end{pmatrix} \text{ instead of } \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} \frac{2}{7} & \frac{1}{7} \\ -\frac{3}{7} & \frac{2}{7} \end{pmatrix} \begin{pmatrix} 5 \\ 4 \end{pmatrix} \text{ that could produce the}$$

correct result. This shows that candidates lacked knowledge of the properties of matrices under multiplication. As a result, they failed to get the correct solution of the given equations.

In part (b), most of the candidates failed to find the vertices of the image of the given triangle due to various factors. This includes lack of adequate knowledge of pre-multiplying the column matrix $\begin{pmatrix} x \\ y \end{pmatrix}$ by a transformation

matrix $T = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$. For example, for point A (1, 1), they incorrectly wrote

$$\text{the image as } A' = \begin{pmatrix} 1 \\ 1 \end{pmatrix} \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} \text{ instead of } A' = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} 1 \\ 1 \end{pmatrix}.$$

In this case, they failed to realize that, matrix multiplication is not commutative; hence they came up with incorrect image of the given triangle. In part (c), the candidates failed to recall the general form of a rotation matrix as most of

them wrote incorrect forms like $R_\theta = \begin{pmatrix} \sin 2\theta & \cos 2\theta \\ -\sin 2\theta & \cos 2\theta \end{pmatrix}$ and

$$R_\theta = \begin{pmatrix} \sin \theta & \cos \theta \\ -\sin \theta & \sin \theta \end{pmatrix} \text{ instead of applying } R_\theta = \begin{pmatrix} \sin \theta & -\cos \theta \\ \cos \theta & \sin \theta \end{pmatrix} \text{ which is}$$

correct. Some of them failed to write the correct values of *sine* and *cosine* of 120° in the matrix rotation. In addition to that, some candidates were not aware that, when point (x, y) is rotated anticlockwise the angle is positive and not negative. For example, they wrote

$$R_\theta = \begin{pmatrix} \cos(-120^\circ) & -\sin(-120^\circ) \\ \sin(-120^\circ) & \cos(-120^\circ) \end{pmatrix} \text{ instead of } R_\theta = \begin{pmatrix} \cos 120^\circ & -\sin 120^\circ \\ \sin 120^\circ & \cos 120^\circ \end{pmatrix}.$$

Extract 13.1 is a sample of incorrect response from one of the candidates who attempted this question.

B	a) Simultaneous Equations
	$\begin{aligned} 3\sqrt{2}x - y &= 5 \\ 2\sqrt{3}x + 2y &= 4 \end{aligned}$
	$\begin{aligned} \sqrt{6}x - 3y &= 15 \\ \sqrt{3}x + 4y &= 8 \end{aligned}$
	$\begin{aligned} -3y &= 15 \\ 4y &= 8 \end{aligned}$
	$\begin{aligned} -\frac{3}{4}y &= \frac{15}{4} \\ \frac{3}{4}y &= -\frac{15}{4} \\ y &= -1 \end{aligned}$
	$\begin{aligned} 3x + 2y &= 4 \\ 3x + 2(-1) &= 4 \\ 3x - 2 &= 4 \\ 3x &= 4 + 2 \\ 3x &= 6 \\ x &= 2 \end{aligned}$
	$\therefore \text{The value of } x = 2 \text{ and } y = -1$

$$13 \quad (b) \quad \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \end{pmatrix} + \begin{pmatrix} x \\ y \end{pmatrix}.$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} + \begin{pmatrix} 1 \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 3 \\ 3 \end{pmatrix} \quad \text{--- (i)}$$

$$\begin{pmatrix} 2 \\ 4 \end{pmatrix} + \begin{pmatrix} 1 \\ 1 \end{pmatrix} = \begin{pmatrix} x' \\ y' \end{pmatrix}$$

$$\begin{pmatrix} 2 \\ 2 \end{pmatrix} + \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} = \begin{pmatrix} x' \\ y' \end{pmatrix}$$

$$\begin{pmatrix} 4 \\ 5 \end{pmatrix} = \begin{pmatrix} x'' \\ y'' \end{pmatrix} \quad \text{--- (ii)}$$

$$\therefore \begin{pmatrix} x''' \\ y''' \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \end{pmatrix} + \begin{pmatrix} x'' \\ y'' \end{pmatrix}$$

$$= \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} + \begin{pmatrix} 4 \\ 5 \end{pmatrix}$$

$$\begin{pmatrix} x'''' \\ y'''' \end{pmatrix} = \begin{pmatrix} 7 \\ 4 \end{pmatrix}.$$

13	(c) From the Rotation
	Point $(x, y) = 4, 2$
	Angle $= 120^\circ (180^\circ - 120^\circ) = 60^\circ$
	From Rotation
	$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos \phi & -\sin \phi \\ \sin \phi & \cos \phi \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$
	$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos 60^\circ & -\sin 60^\circ \\ \sin 60^\circ & \cos 60^\circ \end{pmatrix} \begin{pmatrix} 4 \\ 2 \end{pmatrix}$
	$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{pmatrix} \begin{pmatrix} 4 \\ 2 \end{pmatrix}$
	$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 2 + \sqrt{3} \\ 2\sqrt{3} + 1 \end{pmatrix}$
	$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 \\ 3 \end{pmatrix} \text{ Answer.}$

Extract 13.1: A sample of incorrect response in question 13

In extract 13.1, the candidate solved the equation by elimination method, however it was incorrect. In part (b), the candidate performed addition to matrix of different orders which was an incorrect approach. In part (c), the candidate applied incorrect rotational angle, and yet the calculations were incorrect.

On the other hand, some candidate attempted this question correctly. In part (a), they were able to change the equations into matrix form $\begin{pmatrix} 2 & -1 \\ 3 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 5 \\ 4 \end{pmatrix}$. Secondly, they managed to calculate the determinant of the coefficient matrix which is $2 \times 2 - 3 \times (-1) = 7$. Then, they were able to get the inverse of the coefficient matrix and get the required values, $x=2$ and $y=-1$. This shows that those candidates had adequate knowledge and skills of applying the method of matrix inverse to solve simultaneous equations involving two unknowns. In part (b), the candidates were able to find the vertices of the image of the given triangle by using the

transformation matrix $T = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix}$. They correctly performed calculations

as follows: $A = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} 1 \\ 1 \end{pmatrix} = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$, $C = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} 5 \\ 3 \end{pmatrix} = \begin{pmatrix} 13 \\ 14 \end{pmatrix}$ and

$B = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} 2 \\ 4 \end{pmatrix} = \begin{pmatrix} 8 \\ 14 \end{pmatrix}$. In part (c), they applied correctly rotated the point

$A(4, 2)$ about the origin through 120° in anticlockwise direction and obtained the image $A'(-2 - \sqrt{3}, 2\sqrt{3} - 1)$. Other candidates used graph and protractor to show the object and image on the same axes after rotating the given point through 120° about the origin in anticlockwise direction. Extract 13 is a sample of correct response from a candidate who attempted question 13.

13	a) Solution
	$\begin{cases} 2x - y = 5 \\ 3x + 2y = 4 \end{cases}$
	Rewrite in matrix form
	$\begin{pmatrix} 2 & -1 \\ 3 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 5 \\ 4 \end{pmatrix}$
	Let $\begin{pmatrix} 2 & -1 \\ 3 & 2 \end{pmatrix}$ be A
	Find A^{-1}
	Then, determinant $ A = (2 \times 2) - (-1 \times 3)$
	$= 4 - (-3)$
	$= 4 + 3$
	$= 7$
	So $A^{-1} = \frac{1}{7} \begin{pmatrix} 2 & 1 \\ -3 & 2 \end{pmatrix}$
	$= \begin{pmatrix} \frac{2}{7} & \frac{1}{7} \\ -\frac{3}{7} & \frac{2}{7} \end{pmatrix}$
	Pre-multiply the inverse to both sides of the matrix equation
	$\begin{pmatrix} \frac{2}{7} & \frac{1}{7} \\ -\frac{3}{7} & \frac{2}{7} \end{pmatrix} \begin{pmatrix} 2 & -1 \\ 3 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} \frac{2}{7} & \frac{1}{7} \\ -\frac{3}{7} & \frac{2}{7} \end{pmatrix} \begin{pmatrix} 5 \\ 4 \end{pmatrix}$
	$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} \frac{10}{7} + \frac{4}{7} \\ -\frac{15}{7} + \frac{8}{7} \end{pmatrix}$
	$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} \frac{14}{7} \\ -\frac{7}{7} \end{pmatrix}$

13. a) $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 2 \\ -1 \end{pmatrix}$

$$x = 2$$

$$y = -1$$

∴ The value of $x = 2$ and $y = -1$

b) Solution

Let $T[x, y] = (x', y')$

For point A: (1, 1)

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} 1 \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 2+1 \\ 1+3 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$$

Point A' = (3, 4)

For point B (2, 4)

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} 2 \\ 4 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 4+4 \\ 2+12 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 8 \\ 14 \end{pmatrix}$$

Point B' = (8, 14)

For point C (5, 3)

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 2 & 1 \\ 1 & 3 \end{pmatrix} \begin{pmatrix} 5 \\ 3 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 10+3 \\ 5+9 \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 13 \\ 14 \end{pmatrix}$$

13	b) Point $c' = (13, 14)$
	∴ The vertices of its image are $A'(3, 4)$, $B'(8, 14)$ and $c'(13, 14)$
	c) solution
	For a rotation of 120° anticlockwise about the origin, $\theta = 120^\circ$
	From
	$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$
	$= \begin{pmatrix} \cos 120^\circ & -\sin 120^\circ \\ \sin 120^\circ & \cos 120^\circ \end{pmatrix} \begin{pmatrix} 4 \\ 2 \end{pmatrix}$
	$= \begin{pmatrix} -\frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & -\frac{1}{2} \end{pmatrix} \begin{pmatrix} 4 \\ 2 \end{pmatrix}$
	$= \begin{pmatrix} -2 - \sqrt{3} \\ 2\sqrt{3} - 1 \end{pmatrix}$
	$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} -2 - \sqrt{3} \\ 2\sqrt{3} - 1 \end{pmatrix}$
	$x' = -2 - \sqrt{3}$
	$y' = 2\sqrt{3} - 1$
	∴ The image of point A (4, 2) is $(-2 - \sqrt{3}, 2\sqrt{3} - 1)$

Extract 13.2: A sample of a correct response in question 13

In extract 13.2, the candidate determined the inverse matrix and used to solve the given equations in part (a). In part (b), the candidate performed the correct matrix multiplication that was a step to get the required image. In part (c), the candidate applied the correct formula and procedures to get the required image.

2.14 Question 14: Linear Programming

This question comprised parts (a) and (b). In part (a), the question states that, “Jennifer makes two types of garments, Batiki and Kitenge. Batiki requires 2.5 metres of material while Kitenge requires 2 metres of material. The business uses up to 400 metres of material daily for the production of both garments but produces at most 80 Batiki and at least 60 Kitenge daily”. Taking x to represent the number of Batiki produced daily and y the number of Kitenge produced daily, the candidates were required to: (i) write down the inequalities satisfying the given information and (ii) find the number of each garment the business can produce in order to get the maximum income if the income is given by $f(x, y) = 300x + 200y$. In part (b), they were instructed to give two points on the importance of studying linear programming.

The analysis shows that, out of 485,078 (99.5%) candidates who attempted this question, only 19,774 (4.1%) candidates passed. This shows that, the candidates’ performance in this question was weak. Figure 14 shows the summary of candidates’ performance in question 14.

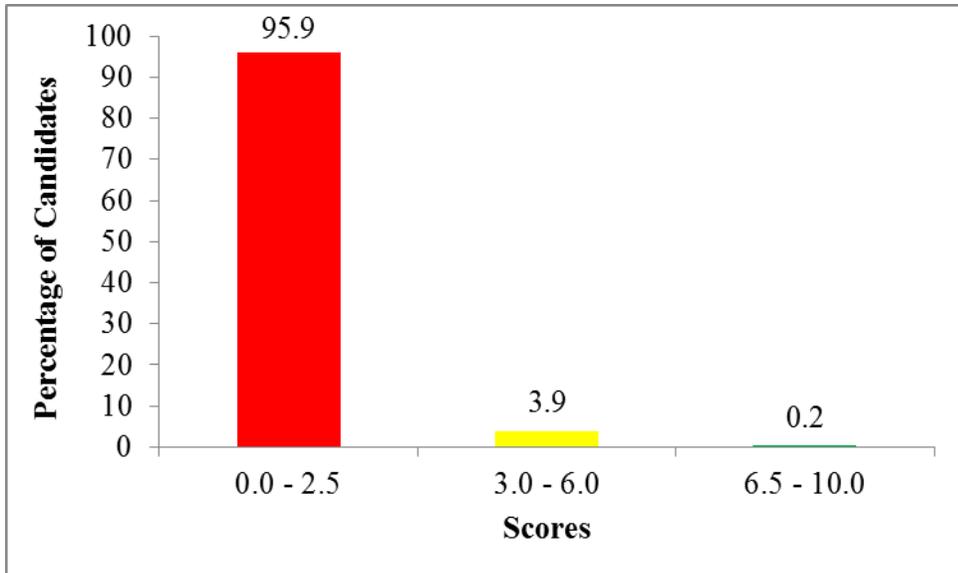
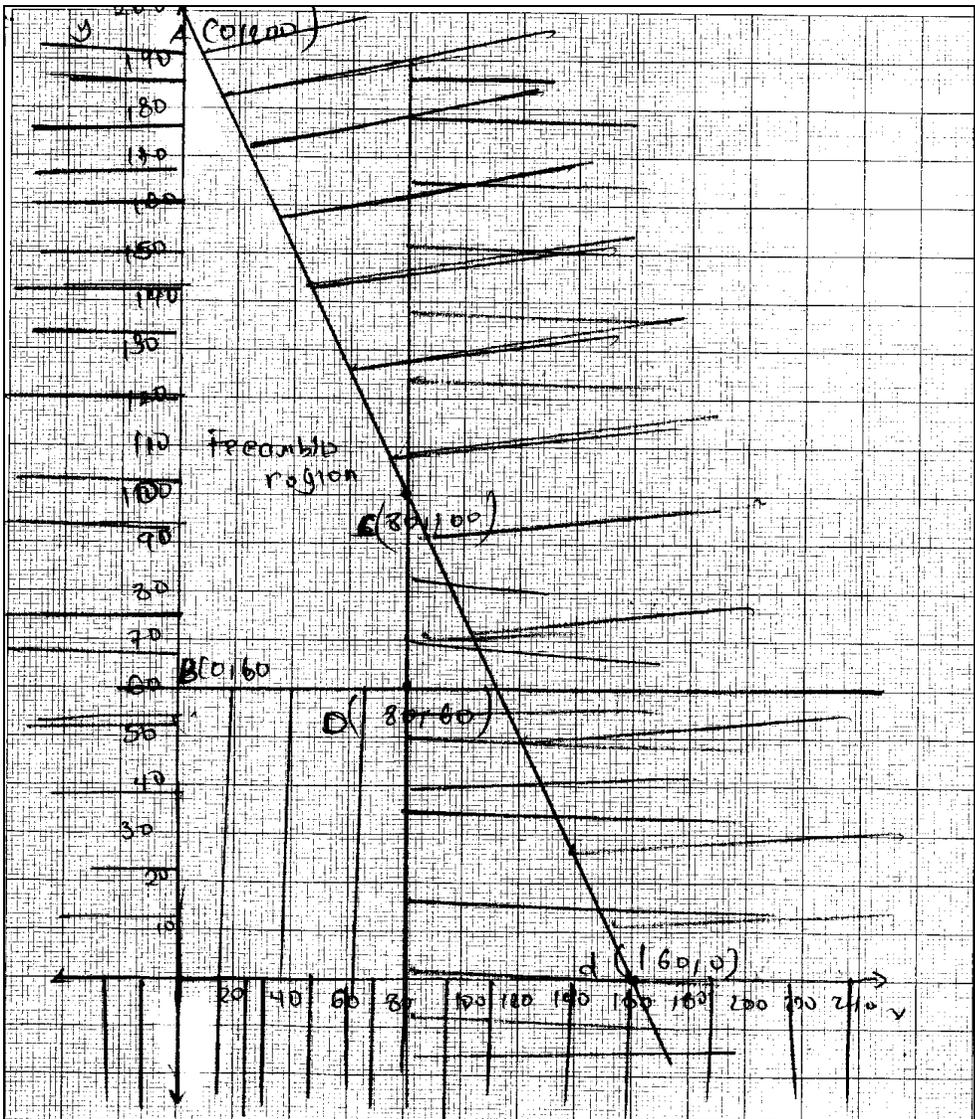


Figure 14: *Candidates’ performance in question 14*

The analysis of candidates’ responses reveal that, the majority of the candidates failed to get correct answer in this question due to the following reasons: in part (a) (i), the candidates formulated incorrect linear

inequalities like $2.5x+2y \geq 400$ instead of $2.5x+2y \leq 400$; $2.5x \geq 80$, instead of $2.5x \leq 80$; and $2y \leq 60$ instead of $2y \geq 60$. This shows that, the candidates had inadequate knowledge of formulating the linear inequalities from a word problem. In part (a) (ii), the candidates were unable to find correctly the intercepts of x and y . As a result, they drew incorrect graph that led to incorrect feasible region and corner points. For that reason, they failed to obtain the coordinates of a point that would give the maximum income. In part (b), they failed to give the correct points on the importance of studying linear programming. This indicates that, the candidates had inadequate knowledge of applying linear programming in solving real life problems. Extract 14.1 shows a sample of incorrect response from one of the candidates in this question.

14	a	Solution	
		Constraint:	
		$2.5x + 2y \leq 400$	
		$x \leq 80$	
		$y \geq 60$	
		$y \geq 0$	
		$x \geq 0$	
		Objective function: Maximizing $f(x,y) = 300x + 200y$	
		Graphing	
		$2.5x + 2y = 400$	
		x	0 160
		y	200 0
		(i) $x = 80$	
		(iii) $y = 60$	
		(iv) $y \geq 0$	
		(v) $x \geq 0$	
		Corner point: $A(0, 200)$ $B(0, 60)$, $C(80, 100)$ $D(80, 60)$.	
		Corner point:	$f(x,y) = 300x + 200y$ Total
		$A(0, 200)$	$0 + 200(200)$ 40,000
		$B(0, 60)$	$0 + 200(60)$ 12,000
		$C(80, 100)$	$300(80) + 200(100)$ 44,000
		$D(80, 60)$	$300(80) + 200(60)$ 36,000



14 (b) ~~7~~ IMPORTANCE OF LINEAR PROGRAMING

i) It help to get The number from at most and numb or of at least.

ii) It shown The variation of positive and negative (minimum and maximum value).

Extract 14.1: A sample of incorrect response in question 14

In Extract 14.1, the candidate formulated incorrect linear inequalities in part (a) (i). As a result, the candidate got incorrect graph and wrong values of the objective function in part (a) (ii). In part (b), the candidate wrote incorrect points on the importance of studying linear programming.

Even though the performance was weak, few candidates performed well and scored full marks. In part (a) (i), the candidates were able to use the given decision variables to formulate the correct inequalities. In part (a) (ii), the candidates managed to draw the graph of the obtained inequalities and identified the corner points of the feasible region from the graph. Lastly, they substituted the corner points to the objective or income function and got the point (32, 160) as the optimal point that gave the required number of Batiki and Kitenge to be produced in order to get the maximum income. In part (b), they were able to list the importance of studying linear programming. Extract 14.1 shows a sample of correct response from one of the candidates who responded correctly to this question.

14	axis	solution
		The inequalities are:
		$2.5x + 2y \leq 400$
		$2.5x \leq 80$
		$2y \geq 60$
		$x \geq 0$
		$y \geq 0$
	(b)	Let x represent no. of Batiki
		y represent no. of Kitenge
		Constraints,
		$2.5x + 2y \leq 400$
		$2.5x \leq 80$
		$2y \geq 60$
		$x \geq 0$
		$y \geq 0$

Objective function: Maximize
 $f(x,y) = 300x + 200y$

Graph

$$2.5x + 2y = 400$$

x	0	160
y	200	0

object corner points

A (0, 200)

B (0, 30)

C (32, 30)

D (32, 160)

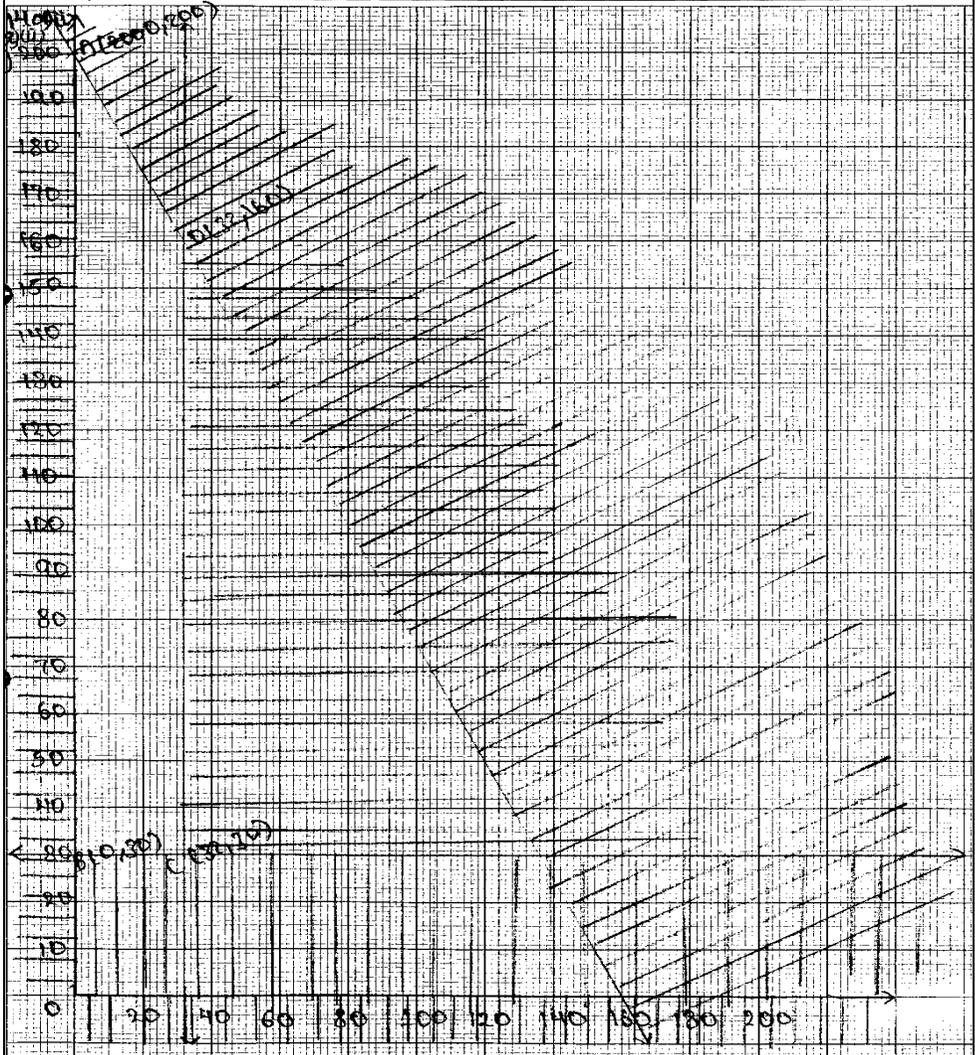
objective function

$$300(0) + 200(200) = 40,000$$

$$300(0) + 200(30) = 6,000$$

$$300(32) + 200(30) = 15,600$$

$$300(32) + 200(160) = 41,600$$



(a)	\therefore 32 garments of Batiki and 160 garments of
(ii)	Kitenge can be produced for maximum
	income
b)(i)	It helps us to determine maximum profit
	to be attained in a certain product.
	(ii) It helps us to determine amount of tools ^{required} used
	in the industry for maximum production of
	products in respect to the area which is
	available for production.

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

In Extract 14.1, the candidate formulated the correct inequalities representing the given information as required in part (a) (i). In part (a) (ii), the candidate managed to solve the obtained inequalities graphically to get the number of Batiki and Kitenge that yield maximum income. In part (b), the candidate listed two points on the importance of studying linear programming as required.

3.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH TOPIC

The analysis shows that, out of 24 topics which were examined in Basic Mathematics in CSEE 2021, only 2 topics of *Numbers* and *Approximations* had an average performance of 44.9 per cent. The rest of the topics had weak performance ranging from 20.2 to 4.0 per cent of the candidates who passed. Those topics include: *Units, Rates and Variations, The Earth as a Sphere, Three Dimensional Figures, Matrices and Transformations, Sets, Probability, Accounts, Ratios, Profit and Loss, Coordinate Geometry, Vectors, Geometry, Perimeters and Areas, Sequences and Series, Algebra, Quadratic Equations, Statistics, Exponents and Radicals, Logarithms, Linear Programming, Trigonometry* and *Pythagoras Theorem*. The summary of candidates' performance in each topic is shown in the Appendix.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The data analysis reveals that, out of fourteen (14) questions which were examined in Basic Mathematics in CSEE 2021, only one (01) question had an average performance of 44.9 per cent. The question was set from the topics of *Numbers* and *Approximations*. Further analysis shows that, the remaining thirteen (13) questions were performed below the average. Those questions were set from the following topics: *Units, Rates and Variations* (20.2%), *The Earth as a Sphere and Three Dimensional Figures* (19.0%), *Matrices and Transformations* (18.5%), *Sets and Probability* (18.1%), *Accounts, Ratios, Profit and Loss* (17.8%), *Coordinate Geometry and Vectors* (13.8%), *Geometry, Perimeters and Areas* (11.2%), *Sequences and Series* (10.8%), *Algebra and Quadratic Equations* (10.0%), *Statistics* (8.2%), *Exponents, Radicals and Logarithms* (5.1%), *Linear Programming* (4.1%), *Trigonometry and Pythagoras Theorem* (4.0%).

The response analysis shows that, the key factors that contributed to weak performance were the candidates' inability to: recall and apply the correct formulae, rules, theorems, properties and procedures; formulate mathematical equations, expressions and inequalities and from word problems and figures; apply appropriate procedures when performing calculations; sketch correct diagrams or graphs as well as failure to interpret the information from diagrams or graphs.

4.2 Recommendations

In order to improve the candidates' performance in Basic Mathematics examinations in future, teachers are recommended to:

- (a) guide students in pairs to distinguish between multiples and factors of a number using factor tree and number chart in the topic of *Numbers* and assess them through group work.
- (b) use letters to demonstrate on how to simplify expressions by using the BODMAS rule, formulate and solve equations with one to two unknowns and linear inequalities with one unknown especially from real life related word problems.
- (c) demonstrate to students in small groups and apply the proper methods and formulae in solving quadratic equations step by step as

well as discussing the properties of quadratic equations and techniques used in solving related word problems.

- (d) use teaching and learning tools such as identical objects in leading students' classroom discussions on applying the rules, formulae and diagrams; solving real life problems and evaluating students' competence in each concept.
- (e) use flat shapes and hall shapes in teaching 3 dimensional figures and simple techniques for finding angles, side lengths and diagonals, angles formed between two planes, angles between line segment and plane and procedures for finding areas and volume of hall shapes including prisms, cylinders, pyramids, cone and building models.
- (f) use a variety of tools such as globe, orange, water melon, atlas and graphs to guide students to discuss on how to use latitude and longitude in finding the distances (in kilometers and nautical miles) between two places on the Earth.
- (g) supervise students to discuss how to find the distance between two towns located on the same latitude and two different latitudes; and the distance between two cities located on the same longitude and two different longitudes and on how to apply the acquired knowledge and skills to solve problems related to navigation.
- (h) guide students in their groups to discuss on how to use the concepts of numbers, decimals and percentages in simplifying mathematical expressions, forming and solving real life related problems involving different operations.
- (i) demonstrate to students on how to apply the rules of exponents to verify the rules of logarithm, simplify terms, calculate equations and rationalize the denominators of the expressions involving radicals and assess students' skills in all concepts of logarithms, exponents and radicals.
- (j) use participatory methods to guide students' discussion on the characteristics of relations and functions by using the locally available teaching and learning resources, how to draw graphs step by step and solve simultaneous equations by graphical method.

- (k) use the teaching and learning resources available in their surroundings to explain all the necessary procedures to lead students' discussion on formulating the inequalities/equations and objective functions, drawing graphs and calculating maximum values and minimum values using real examples pertaining to linear programming.
- (l) lead students' discussions in small groups on how to formulate linear equations by using gradient and intercepts as well as two points; and steps to consider in drawing graphs of linear equations using a table of values and intercepts in the xy-plane.
- (m) use various techniques when teaching all concepts in Vectors, including assessing students' competence through real life related problems pertaining to velocities, displacements and forces of various objects.
- (n) use real flat-shaped objects in demonstrating how to calculate the perimeters and areas and solve real life related problems associated with these concepts.
- (o) use creative and participatory techniques in teaching students on how to multiply matrices and demonstrating all necessary steps in determining the inverse of matrices as well as solving simultaneous equations by using the matrix methods.
- (p) use teaching and learning resources such as square cuttings, flat objects that are in a shape of a right angled triangle, square root tables and square tables in guiding students on how to apply the Pythagoras theorem in solving related miscellaneous problems.
- (q) demonstrate on how to use sine, cosine and tangent in solving problems about angle of elevation and angle of depression; and calculate the heights and angles of real structures by employing the knowledge of trigonometry and Pythagoras theorem.

APPENDIX

ANALYSIS OF CANDIDATES' PERFORMANCE PER TOPIC IN BASIC MATHEMATICS – CSEE 2021

S/N	Topics	Question Number	Percentage of Candidates who Passed	Remarks
1	Numbers and Approximations	1	44.9	Average
2	Units, Rates and Variations	6	20.2	Weak
3	The Earth as a Sphere; and Three Dimensional Figures	12	19.0	Weak
4	Matrices and Transformations	13	18.5	Weak
5	Sets and Probability	3	18.1	Weak
6	Accounts; and Ratios, Profit and Loss	7	17.8	Weak
7	Coordinate Geometry; and Vectors	4	13.8	Weak
8	Geometry; and Perimeters and Areas	5	11.2	Weak
9	Sequences and Series	8	10.8	Weak
10	Algebra; and Quadratic Equations	10	10.0	Weak
11	Statistics	11	8.2	Weak
12	Exponents and Radicals; and Logarithms	2	5.1	Weak
13	Linear Programming	14	4.1	Weak
14	Trigonometry; and Pythagoras Theorem	9	4.0	Weak

