THE NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CANDIDATES' ITEMS RESPONSE ANALYSIS REPORT FOR THE CERTIFICATE OF SECONDARY EDUCATION EXAMINATION (CSEE) 2017

041 BASIC MATHEMATICS

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041 BASIC MATHEMATICS

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FOREWORD

The National Examinations Council of Tanzania has prepared this report on the analysis of the candidates' responses for Basic Mathematics items for the Certificate of Secondary Education Examination (CSEE) 2017 in order to provide feedback to students, teachers and other education stakeholders on how the candidates responded to the questions.

The analysis shows that, the candidates performed well in the question that was set from the topic of *Accounts*; averagely in the question that was set from the topic of *Statistics* and had weak performance in the questions that were set from the topics of *Matrices and Transformations, Approximations, Radicals, Decimals, Rates and Variation, Algebra, Sets, Probability, Functions, Exponents, Logarithms, Vectors, Coordinate Geometry, Circles, Quadratic Equations, Linear Programming, Percentages, Trigonometry, Sequences and Series*, *Geometry* and *Similarity.*

The candidates' weak performance was due to the following reasons: inability to identify the requirements of the questions; inability to correctly perform mathematical operations; failure to formulate equations/inequalities from given information, inability to correctly represent given information in diagrams; lack of skills to draw graphs; failure to follow given instructions; inadequate knowledge and skills in using the laws, formulae, theorems and other mathematical concepts in answering the questions and substituting incorrect data in these formulae.

It is the expectation of the Council that this report will be useful in improving the candidates' performance in future Basic Mathematics examinations.

The Council would like to thank the examiners, examination officers and all others who participated in preparing this report. The Council will also be grateful to receive constructive comments from the education stakeholders for improving future reports.

Dr. Charles Msonde
EXECUTIVE SECRETARY

1.0 INTRODUCTION

This report has analysed the items responses for the candidates who sat for the 041 Basic Mathematics examination in CSEE 2017. The analysis mainly focuses on the areas on which the candidates faced challenges and those which they performed well.

The 041 Basic Mathematics examination paper consisted of two sections, A and B, with a total of 16 questions. Section A had 10 questions each carrying 6 marks, whereas section B had 6 questions each carrying 10 marks. The candidates were required to answer all the questions in section A and 4 questions from section B.

In 2017, a total of 317,444 candidates sat for the 041 Basic Mathematics examination out of which 60,621 (19.19%) candidates passed. In 2016, a total of 349,202 candidates sat for the 041 Basic Mathematics examination out of which 62,990 (18.12%) candidates passed. This indicates that the performance in 2017 has increased by 1.07 percent.

The analysis of the candidates' performance in each question is presented in section 2 of this report. The analysis briefly includes descriptions of the requirements of the items, summary on how the candidates answered the questions, extracts showing the samples of candidates' best and worst solutions and the reasons for good, average or weak performance in each question.

The candidates' performance was categorized using the percentage of candidates who scored at least 30 percent of the marks that were allocated to a particular question. The performance was categorized in the following three groups: 65 – 100 for a good performance, 30 – 65 for an average performance and 0 – 29 for a weak performance; represented by green, yelow and red colours respectively in the figures and tables used in this report.

2.0 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION

2.1 Question 1: Approximation, Radicals and Decimals

This question had three parts, namely (a), (b) and (c). In part (a), the candidates were required to round off: (i) 9.67 to ones, (ii) 0.205 to one decimal place and (iii) 0.0197 to two decimal places; and hence use the results to estimate the value of $\frac{9.67 \times 0.205}{0.0197}$. In part (b), the candidates were required to simplify the expressions: (i) $(3+\sqrt{2})(4-2\sqrt{2})$ and (ii) $\sqrt{40} \times \sqrt{45}$, while in part (c), they were required to express $0.3636\ldots$ in the form $\frac{a}{b}$, where a and b are integers and such that $b \neq 0$.

The performance of the candidates in this question is summarized and represented graphically in Figure 1. It shows that only 23.16 percent of the candidates scored from 2 to 6 marks, therefore the question had a weak performance.

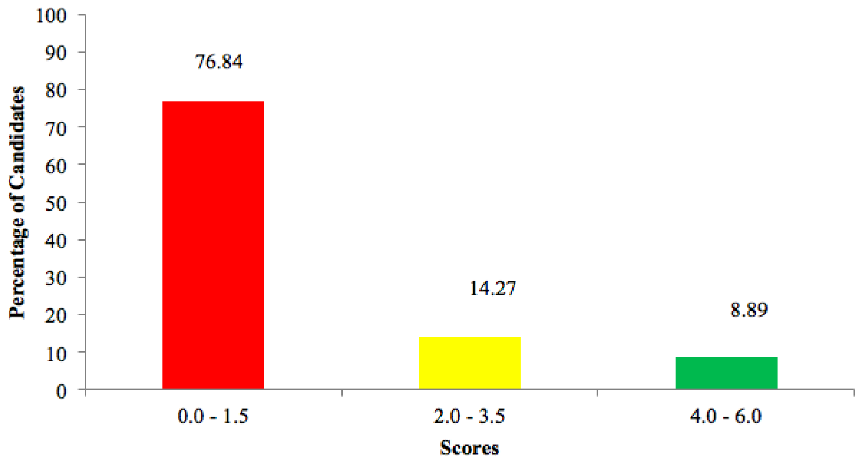


***Figure 1**: Candidates' Performance in Question 1.*

In part (a), the majority of candidates failed to round off to the required number of decimal places. An analysis of the responses shows that the candidates did not understand well the procedures for rounding off decimals.

For instance, in part (a) (i), they were unable to round off 9.67 to ones as 10. Several candidates rounded 9.67 to one decimal place, that is, 9.7 while others rounded it to 9, 900, 100, etc. In part (a) (ii), the candidates were unable to round off 0.205 to one decimal place, that is, 0.2 with some of the incorrect answers including 0.21, 0.25, 2.05 and 20.5.

Further analysis shows that other candidates confused between rounding off and identifying place values of a number as well as expressing numbers in standard notation.

The failure of the candidates to obtain correct answers in parts (a) (i) to (iii) also led them to fail to estimate the value of $\frac{9.67 \times 0.205}{0.0197}$. It was also noted that although a number of candidates rounded off the decimals as required, they could not correctly calculate the value of the resulting numerical expression $\frac{10 \times 0.2}{0.02}$ to get the required answer 100. Others did not use the answers they obtained in parts (a) (i) to (iii) as instructed as they calculated the actual value of the given expression, i.e. 100.6269 either by using mathematical tables or by performing long multiplication and division operations.

In part (b) (i), many candidates lacked the knowledge to simplify the given expression by expanding the brackets and handling expressions involving radicals. For example, some omitted the brackets and as a result wrote $(3+\sqrt{2})(4-2\sqrt{2}) = 3+\sqrt{2}\times 4 - 2\sqrt{2}$, while several candidates incorrectly multiplied the terms in the brackets. It was also observed that a number of candidates managed to correctly expand the brackets but then failed to get the correct answer when performing the addition and subtraction operations.

In part (b) (ii), some candidates ignored the radical sign when multiplying the numbers, and as a result got $\sqrt{40}\times\sqrt{45} = 40 \times 45 = 1800$. Others multiplied the numbers correctly and got $\sqrt{1800}$ but failed to simplify the expression by expressing the radical as the product of prime factors, that is, $\sqrt{2 \times 3^2 \times 10^2}$ to obtain the required answer $30\sqrt{2}$. Some of the candidates also confused between simplifying and rationalizing the expression, while others used mathematical tables to find the values of $\sqrt{40}$, $\sqrt{45}$ and $\sqrt{1800}$ instead of simplifying the expression as required.

In part (c), most of the candidates failed to express the repeating decimal as a fraction. It was noted that some of them considered it as a terminating decimal, that is, $0.3636... = \frac{3636}{10000}$ instead of expressing it as a repeating decimal, that is, $0.3636... = 0.\dot{3}\dot{6}$. However, few correctly expressed it as $x = 0.\dot{3}\dot{6}$ but failed to perform the calculations to arrive at the required answer $\frac{4}{11}$. It was also observed that several candidates performed calculations that were not related to the demands of the question, such as dividing 0.3636 by 2 or finding its square root, indicating that they lacked the knowledge and skills to convert repeating decimals into fractions. Extract 1.1 is a sample solution of a candidate who failed to answer this question.

Extract 1.1

1 (a) (i) Round off

9·67 to ones

9·67

= 900

= 900

(ii) 0·205 one decimal place

0·205

= 20·5

= 20·5

(iii) 0·0197 to two decimal place

= 1·97

1. (b) (i)

$(3 + \sqrt{2})(4 - 2\sqrt{2})$

$3 + \sqrt{2} \times 4 - 2\sqrt{2}$

$3 + \sqrt{2} \times 2\sqrt{2}$

$(3 \times 2) \cdot \sqrt{2} \times \sqrt{2}$

$6 \times \sqrt{2}$

$= 6 + \sqrt{2}$

(ii) $\sqrt{40} \times \sqrt{45}$

40×45

1800

$= 1800$

1 (c) $0 \cdot 3636$ in form $\frac{a}{b}$

$\frac{0 \cdot 3636}{10000}$

$= \frac{3636}{10000}$

$= \frac{909}{2500}$

$= \frac{909}{2500}$

$\therefore = \frac{909}{2500}$

Extract 1.1 shows that a candidate lacked the knowledge of rounding off to the required number of decimal places, simplifying expressions and converting a repeating decimal into a fraction.

On the other hand, 3,105 (0.98%) candidates managed to answer this question correctly and scored full marks. Extract 1.2 is a sample solution of one of such candidates.

Extract 1.2

1\. a) Solution

i) $9.67 \approx 10$ (To ones)

ii) $0.205 \approx 0.2$ (To one decimal place)

iii) $0.0197 \approx 0.02$ (To two decimal place)

Then,

$$\frac{9.67 \times 0.205}{0.0197} = \frac{10 \times 0.2}{0.02}$$

$$= 100$$

$\therefore$ Estimated value for $\frac{9.67 \times 0.205}{0.0197} = 100$

b) i) $(3+\sqrt{21})(4-2\sqrt{21}) = 12 - 6\sqrt{21} + 4\sqrt{21} - 2\sqrt{441}$

$= 12 - 2\sqrt{21} - 2 \times 21$

$= 12 - 42 - 2\sqrt{21}$

$= -30 - 2\sqrt{21}$

$\therefore (3+\sqrt{21})(4-2\sqrt{21}) = -30 - 2\sqrt{21}$

ii) $\sqrt{40} \times \sqrt{45} = \sqrt{40 \times 45}$

$= \sqrt{(2\times2\times2\times5)\times3\times3\times5}$

$= \sqrt{2\times2\times2\times3\times3\times5\times5}$

$= \sqrt{2^3 \cdot 3^2 \cdot 5^2}$

$= 2\times3\times5\sqrt{2}$

$= 30\sqrt{2}$

$\therefore \sqrt{40} \times \sqrt{45} = 30\sqrt{2}$

1 c) $0.3636\ldots = 0.\dot{3}\dot{6}$

Let, $0.\dot{3}\dot{6}$ is equal to x

Then, $x = 0.3636\ldots$

Thus, $100x = 36.3636\ldots$

$- \quad x = 0.3636\ldots$

$99x = 36$

$x = \frac{36}{99} = \frac{4}{11}$

$\therefore 0.3636\ldots$ in form of a/b is $4/11$

Extract 1.2 shows how a candidate worked out correctly the answers for Question 1.

2.2 Question 2: Exponents and Logarithms

The question had parts (a) and (b). In part (a), the candidates were required to simplify: (i) $27^{1/4} \times 3^{1/4} \times \left(\sqrt{3}\right)^{-2}$ and (ii) $\log_3 10 + \log_3 8.1$. In part (b), they were required to find the value of n if $n\log_5 125 = \log_2 64$.

Most of the candidates were unable to correctly apply the laws of exponents and logarithms in answering this question. Whereas 79.68 percent of the candidates scored 0 marks, only 15.27 percent of the candidates who attempted it scored from 2 to 6 marks showing that the performance in this question was weak. Figure 2 presents the performance of candidates in this question.

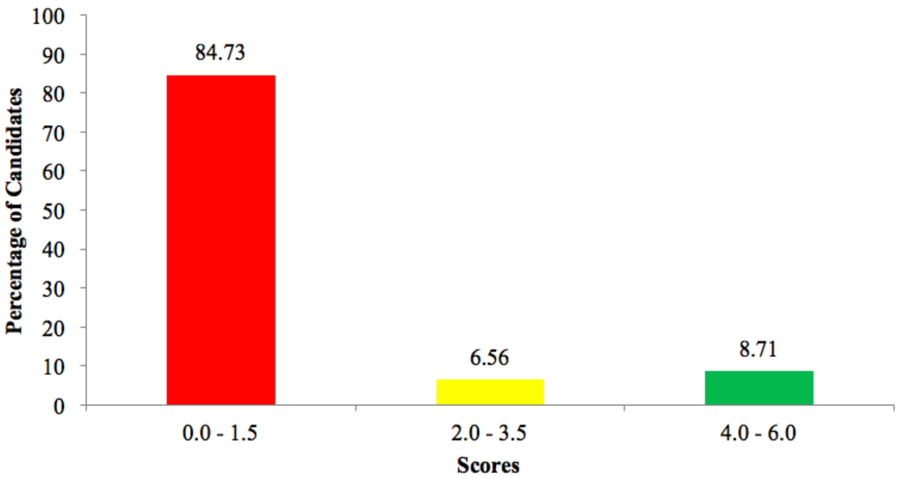


***Figure 2**: Candidates' Performance in Question 2.*

In part (a) (i), many candidates faced problems in expressing the terms in the given expression with a base of 3, an important step in working out the solution. For example, some candidates multiplied the bases and the exponents, while others considered $27^{1/4}$ and $3^{1/4}$ as the mixed fractions $27\frac{1}{4}$ and $3\frac{1}{4}$ respectively.

Some candidates managed to express the given expression correctly as $\left(3^3\right)^{1/4} \times 3^{1/4} \times \left((3)^{1/2}\right)^{-2}$ but then failed to apply the exponent rule: $a^x \times a^y = a^{x+y}$ to get $3^0 = 1$ as the required answer. Some candidates ignored the negative sign while adding up the exponents, while others ignored the base and worked out the answer as $\frac{3}{4}+\frac{1}{4}-1=0$, indicating that they did not have adequate knowledge and skills on the laws of exponents.

In part (a) (ii), many candidates could not apply the product rule $\log_a x+\log_a y=\log_a(xy)$ to simplify the expression. For example, some of them incorrectly wrote $\log_3 10+\log_3 8.1$ is equal to $\log_3 10\times\log_3 8.1$ instead of $\log_3(10\times 8.1)$. It was disappointing to see other candidates cancelling out "$\log_3$" in the expression and then either adding or multiplying the numbers left, that is, $10+8.1=18.1$ or $10\times 8.1=81$.

It was also noted that a few candidates managed to correctly apply the product rule to get $\log_3 81$ but did not remember to simplify it further using the power rule ($\log_a M^b = b\log_a M$) to get $4\log_3 3=4$ as required.

In part (b), most of the candidates failed to apply the knowledge and skills from the concepts of exponents and logarithms to get the correct value of n in the given logarithmic equation. First, they could not express the terms in the given equation in exponential form as $n\log_5 5^3=\log_2 2^6$ and then apply the power rule to get the equation $3n\log_5 5=6\log_2 2$, which was to be simplified further to $3n=6$ and eventually n = 2. Extract 2.1 is a sample solution of a candidate who failed to answer this question.

Extract 2.1

2(a)(i) $27^{1/4}\times 3^{1/4}\times(\sqrt{3})^{-2}$

$=\frac{109}{4}\times\frac{13}{4}\times\sqrt{-9}$

$=\frac{122}{4}+-3$

$=\frac{-125}{4}$

$=-31.25$

2(a)(ii) $\log_3 10 + \log_3 8.1$

$= \log_3 10+8.1$

$= \log_3 18.1$

$\therefore = \log_3 18.1$

(b) If $n\log_5 125 = \log_2 64$ find the value of n.

Soln.

$n\log_5 125 = \log_2 64$.

$\log_{\cancel{5}} \cancel{125}^{n} = \log_{\cancel{2}} \cancel{64}$.

$\log 25^n = \log 32$.

$\log 5^{5n} = \log 2^5$

$5\log 5 = 5\log 2$

$5n \log 5 = 5\log 2$

$5\log = (5n = 2)$

$\frac{5n}{5} = \frac{2}{2}$

$n = 2/5$

$\therefore n\log_5 125 = \log_2 64 \quad n = 2/5$

Extract 2.1 shows a response of a candidate who demonstrates a complete lack of understanding of the laws of exponents and logarithms in answering the question.

However, there were 10,042 (3.16%) candidates who correctly answered this question. A sample answer from one of these candidates is shown in Extract 2.2.

Extract 2.2

2 a) i) $27^{1/4} \times 3^{1/4} \times (\sqrt{3^1})^{-2} = 3^{3\times 1/4} \times 3^{1/4} \times 3^{1/2\times -2}$

$= 3^{3/4} \times 3^{1/4} \times 3^{-1}$

$= 3^{3/4 + 1/4 - 1}$

$= 3^{1-1}$

$= 3^{0}$

$= 1$

$\therefore 27^{1/4} \times 3^{1/4} \times (\sqrt{3^1})^{-2} = \underline{1}$

ii) $\log_3 10 + \log_3 8.1$

From, $\log_b a + \log_b c = \log_b ac$

Then

$\log_3 10 + \log_3 8.1 = \log_3 (10 \times 8.1)$

$= \log_3 81 = \log_3 3^4 = 4\log_3 3 = 4$

$\therefore \log_3 10 + \log_3 8.1 = 4.$

2 b) $n\log_5 125 = \log_2 64$

$n\log_5 5^3 = \log_2 2^6$

$3n\log_5 5 = 6\log_2 2$

$3n = 6$

$n = 2$

$\therefore n = 2.$

Extract 2.2 shows how a candidate correctly applied the laws of exponents and logarithms.

2.3 Question 3: Algebra and Sets

The question consisted of parts (a) and (b). In part (a), the candidates were required to factorize the expressions: (i) $16y^2 + xy - 15x^2$ and (ii) $4 - (3x-1)^2$. In part (b), it was given that at Moiva's graduation ceremony 45 people drank pepsicola, 80 drank coca-cola and 35 drank both pepsicola and coca-cola. The candidates were required to find the number of people who were at the ceremony if each person drank pepsicola or coca-cola.

In general, this question had a weak performance, since only 19.03 percent of the candidates scored from 2 to 6 marks. The candidates' scores are shown in Figure 3.

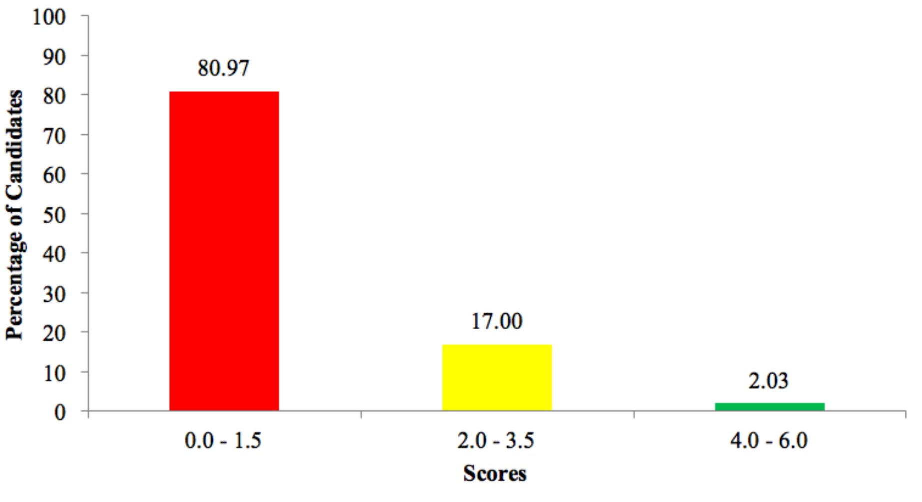


Figure 3: *Performance of Candidates in Question 3.*

In part (a) (i), the majority of candidates were not able to split the middle term involving variables x and y in order to obtain the quadratic expression $16y^2+16xy-15xy-15x^2$ that was to be factorized as $(16y-15x)(y+x)$.

In part (a) (ii), the candidates also failed to factorize the quadratic expression $4-(3x-1)^2$. Some of them could not correctly expand the term $(3x-1)^2$ and as a result failed to obtain the expression $3-9x^2+6x$ that they would factorize by spliting the middle to obtain $3[(-3x-1)(x-1)]$ as required. Some of them managed to correctly expand it but failed to introduce the negative sign while combining the results, that is, they obtained $4-(3x-1)^2=4-9x^2-6x+1$ instead of $4-9x^2+6x-1$. Further analysis shows that only a few candidates applied correctly the formula for the difference of two squares to express the given expression as $(2+3x-1)(2-(3x-1))$ and eventually simplified it as required. Some candidates wrote the formula wrongly, while others made addition and subtraction errors while applying it. In addition, it was noted that some candidates confused between "factorizing" and "solving" as they equated the given expressions to 0 and then find the values of x and y that satisfied the equations. This shows that the candidates lacked knowledge and skills in factorizing quadratic expressions.

In part (b), most of the candidates were unable to represent correctly the given information in a Venn diagram and therefore could not find the number of people who were at the ceremony. Most of them were unable to find the number of people who drank pepsicola only and coca-cola only. Extract 3.1 illustrates this case. Those candidates did not understand that the number of people who drank pepsicola only was equal to 45 – 35 = 10 and the number of people who drank coca-cola only was equal to 80 – 35 = 45. Further analysis shows that some candidates used the formula $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ instead of using a Venn diagram as instructed. Those candidates lost the marks that were allocated for the Venn diagram. Moreover, there were some candidates who copied the question and did not write the solution, while others used the numbers in the question to perform calculations that were not related to the requirements of the question.

Extract 3.1

3. (a) i. $16y^2 + xy - 15x^2$

$= 16y^2 + xy - 15x^2$

$\sqrt{16y} + \sqrt{xy} - \sqrt{15x}$

$\cancel{16y}\ 4y + xy - \sqrt{15x}$

$y + 4xy - \sqrt{60x}$

$y + 4xy - \sqrt{60x}$

$y + 4xy - 60x$

(a) ii/ Solution

$4 - (3x-1)^2$

$4 - (3x-1)(3x-1)$

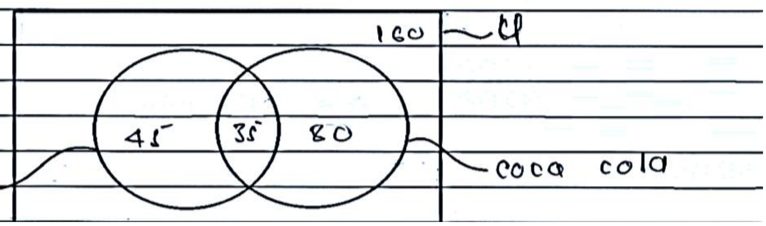
$4 - (9x^2 - 3x - 3x + 1$

$4 - 9x^2 - 6x + 1$

$-9x^2 - 6x + 4 + 1$

$\underline{-9x^2 - 6x + 5}$

b.



Extract 3.1 shows a response of a candidate who could not correctly factorize the given quadratic expressions and represent the given information in the Venn diagram.

On the other hand, there were few candidates (0.41%) who correctly answered this question as they were able to factorize the quadratic expressions and solve the set problem as shown in Extract 3.2.

Extract 3.2

03. a) i, Given; $16y^2 + xy - 15x^2$

$= (16y^2 + 16xy)(-15xy - 15x^2)$

$= 16y(y + x) - 15x(y + x)$

$= (16y - 15x)(y + x)$

$\therefore$ $16y^2 + xy - 15x^2 = (16y - 15x)(y + x)$

03 a) ii, Given; $4 - (3x - 1)^2$

$= 2^2 - (3x - 1)^2$ from $a^2 - b^2 = (a+b)(a-b)$

$= [2 + (3x - 1)][2 - (3x - 1)]$

$= (2 - 1 + 3x)(2 + 1 - 3x)$

$= (3x + 1)(3 - 3x)$

$=$

$\therefore$ $4 - (3x-1)^2 = (1 + 3x)(3 - 3x)$

b) Let:

P = {all people who drank Pepsi-Cola}

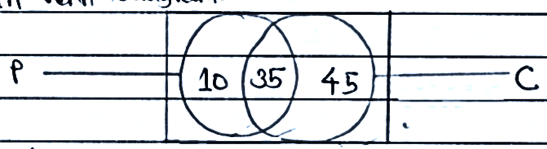
C = {all people who drank Coca-Cola}

Then; $n(P) = 45$

$n(C)$ 80

$n(P \cap C) = 35$

In Venn diagram.



$\therefore n(P \cup C) = 10 + 35 + 45$

$= 90$

$\therefore$ There were 90 people at the ceremony.

Extract 3.2 shows how a candidate correctly factorized the given expressions as well as solved the question on sets.

2.4 Question 4: Vectors and Coordinate Geometry

This question had parts (a), (b) and (c). In part (a), the candidates were given three vectors $\underset{\sim}{a} = 4\mathbf{i} + 6\mathbf{j}$, $\underset{\sim}{b} = 4\mathbf{i} + 10\mathbf{j}$ and $\underset{\sim}{c} = 2\mathbf{i} + 4\mathbf{j}$ and were required to determine the magnitude of their resultant. In part (b), it was given that, Camilla walks 5 km northeast, then 3 km due east and afterwards 2 km due south. The candidates were required to represent these displacements together with the resultant displacement graphically using the scale 1 unit = 1 km. In part (c), the candidates were required to show that triangle ABC was right-angled, where $A = (-2, -1)$, $B = (2, 1)$ and $C = (1, 3)$.

The performance of the candidates in this question is shown in Figure 4.

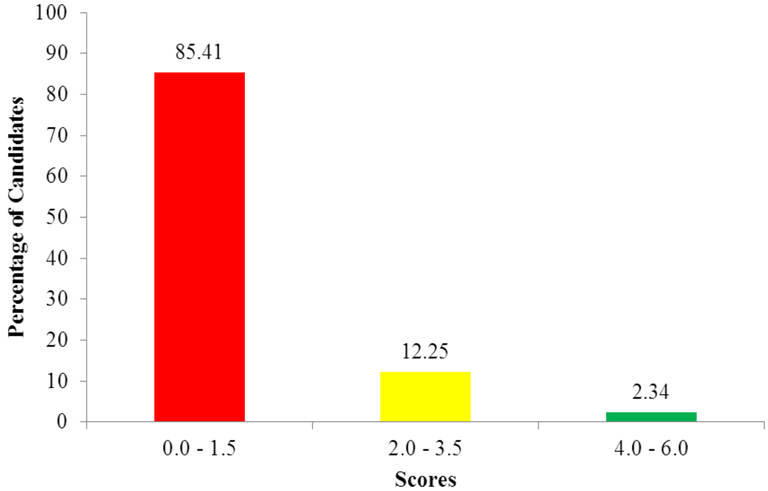


***Figure 4**: Performance of Candidates in Question 4.*

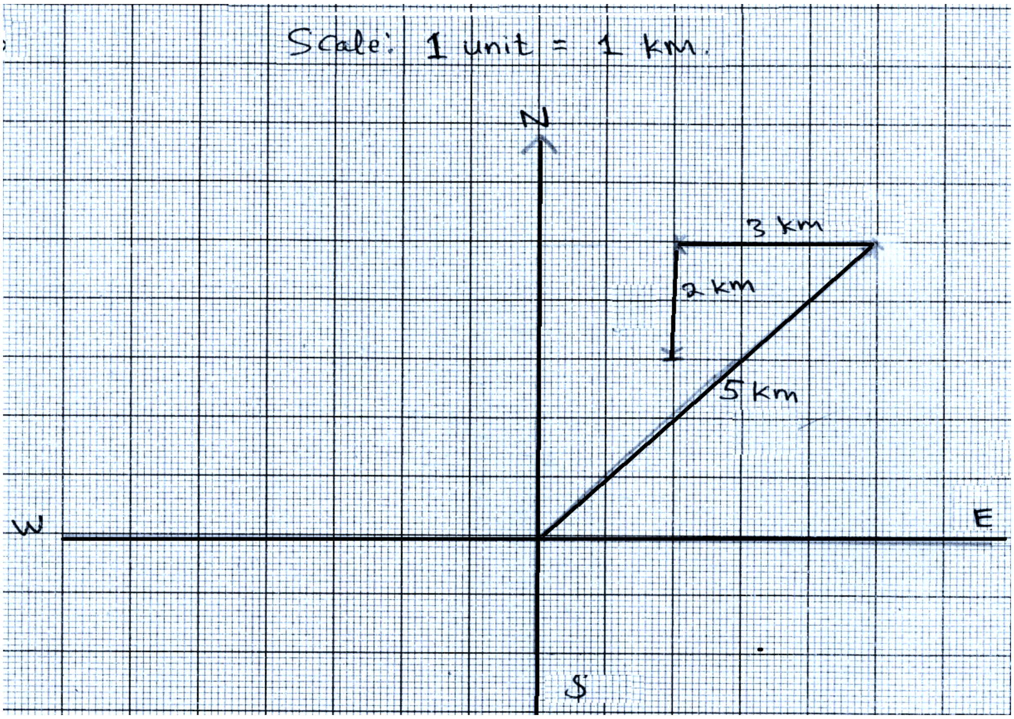
Figure 4 shows that many candidates scored low marks from 0 to 1.5. It also shows that the percentage of candidates who scored from 2 to 6 is 14.59; therefore the question had a weak performance.

In part (a), most of the candidates failed to determine the magnitude of the resultant of the given vectors. Some of them seemed not to understand the meaning of 'resultant.' Instead of adding the three vectors together, these candidates performed calculations unrelated to the question demand. For example, they determined things, such as the product of the vectors and unit vectors. Although some candidates had an idea of finding $\underset{\sim}{a} + \underset{\sim}{b} + \underset{\sim}{c}$, they could not correctly add the vectors, while others added them correctly but failed to apply the correct formula for finding the magnitude of a vector. For example, they used formulae such as $\left|x\underset{\sim}{\mathrm{i}} + y\underset{\sim}{\mathrm{j}}\right| = \sqrt{x^2 - y^2}$ and $\left|x\underset{\sim}{\mathrm{i}} + y\underset{\sim}{\mathrm{j}}\right| = \sqrt{x + y}$ instead of $\left|x\underset{\sim}{\mathrm{i}} + y\underset{\sim}{\mathrm{j}}\right| = \sqrt{x^2 + y^2}$. It was noted that some candidates computed the magnitude of each vector, that is, $|\underset{\sim}{a}|$, $|\underset{\sim}{b}|$, $|\underset{\sim}{c}|$ instead of the magnitude of the resultant vector, that is, $|\underset{\sim}{a} + \underset{\sim}{b} + \underset{\sim}{c}|$.

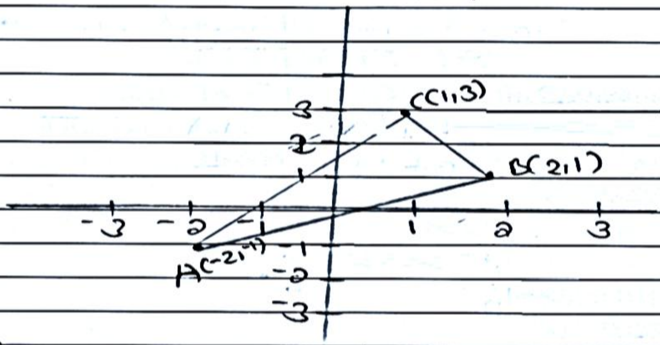
In part (b), most of the candidates were unable to use the given scale to represent the displacements graphically. Some of the displacements were not drawn in accordance with the given scale, the vectors were not drawn according to their directions and in most cases the directions of the vectors were not indicated.

In part (c), many candidates were unable to use either the slope formula, distance formula or graphical method to show that triangle ABC was a right-angled. For example, some candidates correctly calculated the slopes of the sides of the triangle but failed to relate such slopes with the condition that the "*product of the slopes of two perpendicular lines is equal to* -1". Also, some candidates managed to find the distance of lines AB, BC and AC but could not correctly use the Pythagoras theorem in establishing the results. Likewise, several candidates represented triangle ABC on the xy-plane but failed to measure the angles in order to conclude that the triangle is right angled. Extract 4.1 is a sample answer showing how the candidates failed to answer parts (b) and (c) of this question.

Extract 4.1



4 (c) Sln



Triangle ABC is a right angle
AB = BC ____ of side
CB = Base of the triangle
hence shown by side side side rule as (S S S)

Extract 4.1 shows a response of a candidate who could not represent the given displacements graphically and show that triangle ABC was right-angled.

However, 770 (0.24%) candidates managed to answer this question correctly. Extract 4.2 represents a sample answer from one of the candidates.

Extract 4.2

4 (a) $\underline{a} = 4\underline{i}+6\underline{j}$, $\underline{b} = 4\underline{i}+10\underline{j}$, $\underline{c} = 2\underline{i}+4\underline{j}$

$\underline{a}+\underline{b}+\underline{c} = 4\underline{i}+6\underline{j} + 4\underline{i}+10\underline{j} + 2\underline{i}+4\underline{j} = 4\underline{i}+4\underline{i}+2\underline{i}+6\underline{j}+10\underline{j}+4\underline{j}$

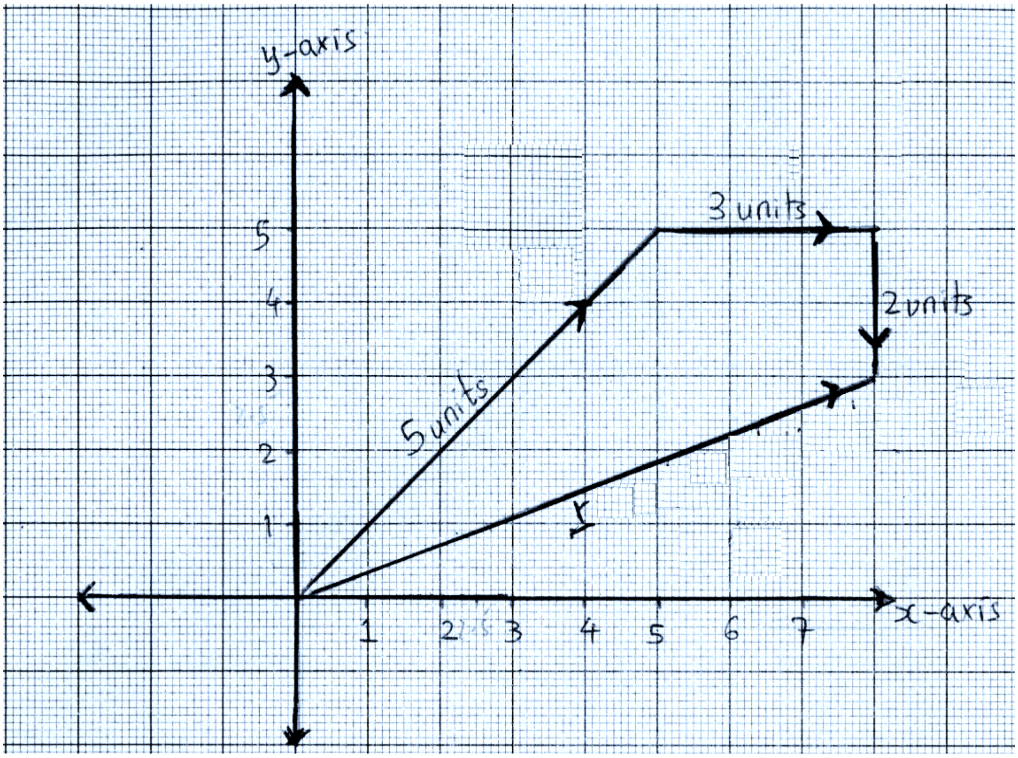
$\underline{a}+\underline{b}+\underline{c} = 10\underline{i}+20\underline{j}$

$|\underline{a}+\underline{b}+\underline{c}| = (\sqrt{10^2+20^2})$ units $= (\sqrt{100+400})$ units

$= \sqrt{500}$ units

$= 10\sqrt{5}$ units Ans

(b) IN THE GRAPH PAPER



(c) distance between $A(-2,-1)$ and $B(2,1)$

$d = \sqrt{(-2-2)^2+(-1-1)^2} = \sqrt{16+4} = \sqrt{20} = \underline{2\sqrt{5}\text{ units}}$

distance between $A(-2,-1)$ and $C(1,3)$

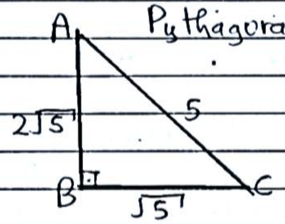
$d = \sqrt{(-2-1)^2+(-1-3)^2} = \sqrt{9+16} = \sqrt{25} = \underline{5\text{ units}}$

4 (c) distance between $B(2,1)$ and $C(1,3)$

$d = \sqrt{(2-1)^2+(1-3)^2} = \sqrt{1+4} = \underline{\sqrt{5}\text{ units}}$

Hence for a right angled triangled

Pythagoras theorem: $a^2+b^2=c^2$



$(2\sqrt{5})^2+(\sqrt{5})^2 = 5^2$

$(4\times5)+5 = 25$

$20+5 = 25$

$25 = 25$

Hence LHS = RHS, hence a rightangled triangle

Extract 4.2 shows a response of a candidate who correctly determined the magnitude of the resultant vector, represented the given displacements together with the resultant displacement graphically and showed that triangle ABC was right-angled.

2.5 Question 5: Similarity and Geometry

The question had parts (a) and (b). In part (a), the candidates were required to: (i) show whether triangles AXB and CXD were similar or not, (ii) find the length CD and (iii) find the ratio of the areas of the triangles AXB and CXD using the given figure ABCD, where $AB = 10\text{ cm}$, $AX = 6\text{ cm}$, $CX = 8\text{ cm}$ and AB was parallel to DC. In part (b), the candidates were required to construct an angle of 90° using a ruler and a compass.

The performance of the candidates in this question is shown in Figure 5.

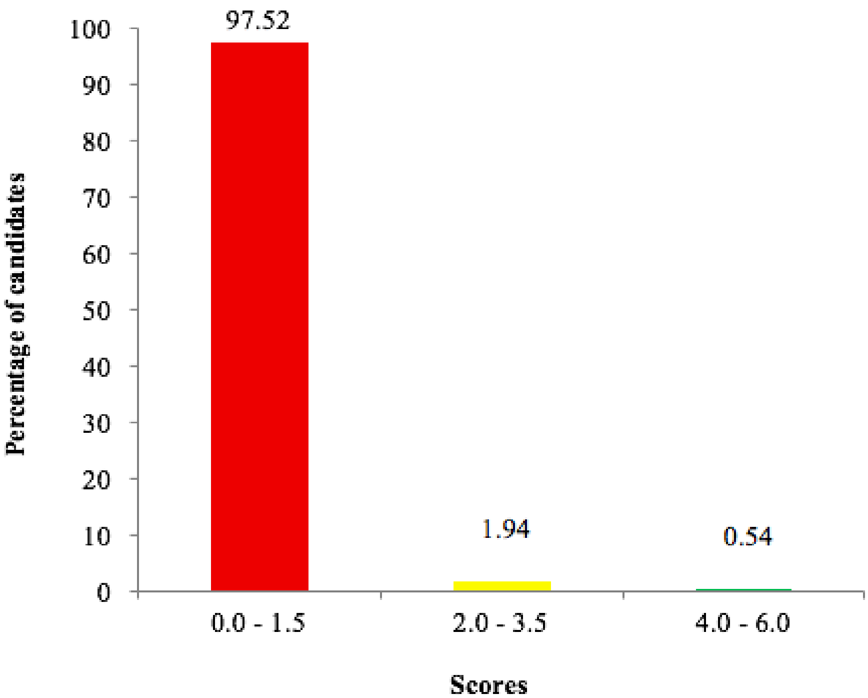


Figure 5: *Candidates' Performance in Question 5.*

Figure 5 shows that only 2.48 percent of the candidates scored from 2 to 6 marks, therefore the question had a weak performance. The majority of candidates (97.52%) scored low marks (0 to 1.5) and among them 88.42 percent scored 0. In part (a)(i), most of candidates failed to show that triangles AXB and CXD were similar. They were unable to identify two angles in triangle AXB which were congruent to two angles in triangle CXD. These candidates lacked knowledge and skills to apply the AA triangle similarity test. The candidates were also unable to use the fact that 'when two triangles are similar the ratio of lengths of their corresponding sides are equal' in answering parts (a)(ii) and (iii). Further analysis shows that the candidates were unable to use the properties of the parallel lines AB, DC and the transversal lines AC and BD in identifying the congruent angles. Morever, the candidates seemed to lack knowledge on the relationship between the area of two similar triangles and the lengths of their corresponding sides. For example, there were candidates who applied the formula $\frac{A_1}{A_2} = \frac{h_1}{h_2}$ instead of $\frac{A_1}{A_2} = \left(\frac{l_1}{l_2}\right)^2$ in answering part (a)(iii). Extract

5.1 shows a sample solution of one of the candidates who failed to answer this question.

In part (b), many candidates could not construct an angle of 90° using a ruler and a compass. Most of them drew perpendicular lines using a ruler whereas some left this part un-answered. The candidates were unable to realize that the construction of an angle of 90° is done by constructing a perpendicular bisector of a line segment as follows:
Let AB be the line segment. With A and B as centres and radius greater than a half AB, draw arcs which intersect at L and M. Join L and M to obtain the perpendicular bisector of a line segment $\overline{AB}$ that meets at N and an angle $L\hat{N}B = 90^\circ$ as required.

Extract 5.1

5. (a) i) To show whether triangles AXB and CXD are similar

= AB = DC - parallel lines

= AXB = CXD - Isosceles triangles

ii) Length CD

= $\frac{1}{2}bh = \frac{1}{2}b \times 8 = 4$ cm

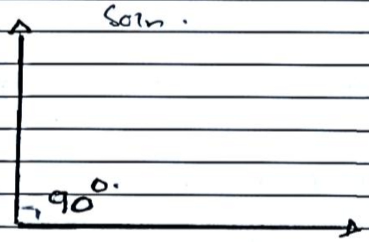
CD = 14 cm

iii) Ratio of areas of AXB and CXD

$A_1 = \frac{1}{2}bh = \frac{1}{2} \times 60 = 30$, $A_2 = \frac{1}{2}bh = \frac{1}{2} \times 32 = 16$

= 30 + 16 = 46

(b) Soln.



Extract 5.1 shows a solution from a candidate who was unable to solve problems using similarity theorems and construct an angle of 90° using a ruler and a compass.

Despite the weak performance in this question, there were 224 (0.07%) candidates who provided correct responses. Those candidates managed to correctly show that triangles AXB and CXD were similar by using the properties of similarity. They were able to find the length CD and the ratio of the areas of triangles AXB and CXD using the lengths of corresponding sides of triangles AXB and CXD. They also managed to correctly construct an angle of 90° using a ruler and a compass as it is shown in Extract 5.2.

Extract 5.2

5(a) Soln.

(i) In the triangles AXB and CXD:

$\angle DXC = \angle AXB$ (vertically opposite angles).

$\angle BAX = \angle DCX$ (alternate interior angles.)

$\angle XDC = \angle XBA$ (alternate interior angles).

$\therefore \Delta AXB \sim \Delta CXD$ (AAA).

(ii) $\frac{CX}{XA} = \frac{DC}{AB} = \frac{DX}{XB}$

$\frac{8cm}{6cm} = \frac{DC}{10cm}$

$CD = \frac{8cm \times 10cm}{6cm}$

$CD = \frac{40cm}{3}$

$CD \approx 13.3cm$ Answer.

(iii) Soln.

$(\text{Ratio of sides})^2 = \text{Ratio of areas}$

$\left(\frac{8}{6}\right)^2 = \frac{A_2}{A_1}$

$\frac{A_2}{A_1} \Rightarrow \frac{64}{36} \Rightarrow \frac{16}{9}$

$\therefore$ Ratio of areas is 16 : 9.

(b) CONSTRUCTION OF 90° BY USING RULER AND COMPASS.

steps:

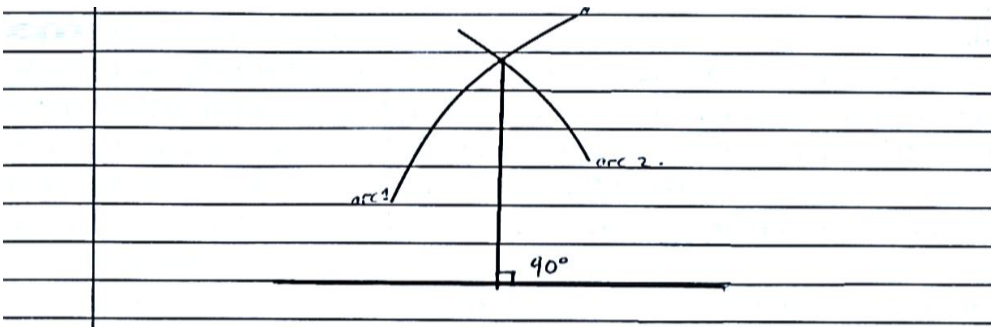
(i) Draw a straight horizontal line of any length and mark its centre

(ii) start from one end put a compass and draw an arc

(iii) Repeat to draw an arc on the other side

(iv) Joint the point of intersection of arcs drawn to the centre

(v) The angles between vertical and horizontal line are 90°.



Extract 5.2 shows a solution from a candidate who demonstrated good understanding on the tested concepts of similarity. He/She had adequate skills in constructing an angle of 90° using a ruler and a compass.

2.6 Question 6: Rates and Variations

In part (a) of this question it was given that; In the preparation of fanta orange drink, a bottle filling machine can fill 1,500 bottles in 45 minutes. The candidates were required to find the number of bottles it will fill in $4\frac{1}{2}$ hours.

In part (b), the candidates were required to find the values of a and b in the table below if *X* varies directly as *Y* and inversely as *W*.

X	8	6	*b*
Y	4	*a*	2
W	2	3	4

The performance of candidates in this question is presented in Figure 6.

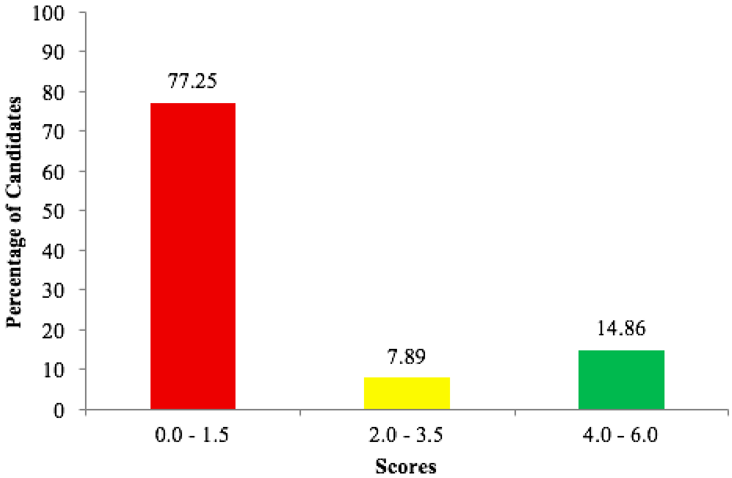


***Figure 6**: Candidates' Performance in Question 6.*

Figure 6 shows that 22.75 percent of the candidates scored from 2 to 6 marks, therefore this question had a weak performance. The majority of candidates scored low marks and notably 70.87 percent scored 0. In part (a), many candidates failed to properly convert 45 minutes into hours or $4\frac{1}{2}$ hours into minutes before finding the required number of bottles. For example, several candidates wrote that the number of bottles equals $\dfrac{1500\text{ bottles}\times 4\frac{1}{2}\text{ hours}}{45\text{minutes}}$ instead of $\dfrac{1500\text{ bottles}\times 4\frac{1}{2}\times 60\text{minutes}}{45\text{minutes}}$ or $\dfrac{1500\text{ bottles}\times 4\frac{1}{2}\text{ hours}}{\left(\frac{45}{60}\right)\text{hours}}$.

These candidates lacked knowledge of converting units of time.

In part (b), most candidates also failed to formulate the correct variation equation, that is, $X \propto \dfrac{Y}{W}$ from the statement "*X* varies directly as *Y* and inversely as *W*". Some of the incorrect equations that the candidates wrote include $X \propto \dfrac{W}{Y}$ and $X \propto WY$. Further analysis shows that some candidates managed to correctly formulate the equation $X = k\dfrac{Y}{W}$, where k is a proportionality constant but could not correctly use the data given in the table to find the values of a and b. Furthermore, a number of candidates performed calculations that were not related to the requirements of the question and others writing the values of a and b without formulating the variation equation, indicating lack of knowledge on joint variation. Extract 6.1 represents the work of a candidate who failed to correctly answer this question.

Extract 6.1

6 (a) Solution

Data

Bottles - 1500

Time - 45 mn

Bottles - ?

Time → 270 mn

let Bottles = B

Time = T

$B_1T_1 = B_2T_2$

$1500 \times 45 = B_2 270$

$\frac{1500 \times 45}{270}$

$= 250$

∴ 250 bottles will be produced

6 (b) Soln

$x_1 = 8 \quad x_2 = 6 \quad x_3 = b$

~~$y_1 = 4 \quad y_2 = a \quad y_3 = 2$~~

$w_1 = 2 \quad w_2 = 3 \quad w_3 = 4$

$\frac{x_1 y_1}{w_1} = \frac{x_2 y_2}{w_2}$

$= \frac{8 \times \cancel{4}}{\cancel{2}} = \frac{6 \times a}{3}$

$= \frac{16}{1} = \frac{6a}{3}$

$= 6a = 16 \times 3$

$= a = \frac{8}{\cancel{16}} \times \frac{\cancel{3}}{\cancel{6}_{2\ 1}}$

∴ $= a = 8$

$\frac{x_2^8 y_2}{\cancel{w_2}} = \frac{x_3 y_3}{\cancel{w_3}}$

$\frac{6 \times 8}{3} = \frac{b \times 2}{4}$

$\frac{48}{3} = \frac{2b}{4}$

$= \frac{6b}{6} = \frac{\cancel{48}^{8} \times 4}{\cancel{6}_1}$

∴ $b = 32$

Extract 6.1 shows a response of a candidate who formulated incorrect variations equations in both parts (a) and (b).

On the other hand, 6.93 percent of the candidates who attempted the question managed to provide correct answers. A sample answer from one of those candidates is shown in Extract 6.2.

Extract 6.2

06. Solution.

(a) Given; 1,500 bottles are filled in 45 minutes.

$4\frac{1}{2}$ hours $= 4\times60 + \frac{1}{2}\times60$ minutes,

$= 270$ minutes,

Then; 1,500 bottles $\longrightarrow$ 45 minutes

so; x $\longrightarrow$ 270 minutes

[x is the unknown number of bottles].

$\Rightarrow x = \frac{270\times1,500}{45} = 9,000$ bottles.

$\therefore$ 9,000 bottles can be filled.

06. (b) Given; $x \propto \frac{y}{w}$.

$x_1 = 8,\ y_1 = 4,\ w_1 = 2$

$\Rightarrow x = \frac{ky}{w}$ --- (i)

$\Rightarrow k = \frac{x_1w_1}{y_1} = \frac{8\times2}{4} = 4.$

Now; $a = y_2$.

But $y = \frac{xw}{k}$ (From (i) above).

$\Rightarrow y_2, a = \frac{x_2w_2}{k} = \frac{6\times3}{4}$

$\therefore a = 4.5$

Again; $b = x_2$.

But $x_2 = \frac{ky_2}{w_2}$

$\Rightarrow x_2, b = \frac{4\times2}{4} = 2.$

$\therefore b = 2.$

$\therefore$ $\underline{a = 4.5 \text{ and } b = 2.}$

Extract 6.2 shows that a candidate applied the concepts of direct and joint variations correctly in answering this question.

2.7 Question 7: Percentages

In this question it was given that, a computer was advertised in a shop as having a list price of sh. 2,500,000/= plus value added tax (VAT) of 20% and the sales manager offered a discount of 25% before adding VAT. The candidates were required to calculate: (a) the list price including VAT, (b) the amount of discount before VAT was added and (c) the reduced final price of the computer.

Most of the candidates who attempted this question got low scores from 0 to 1.5 out of 6 marks (see Figure 7).

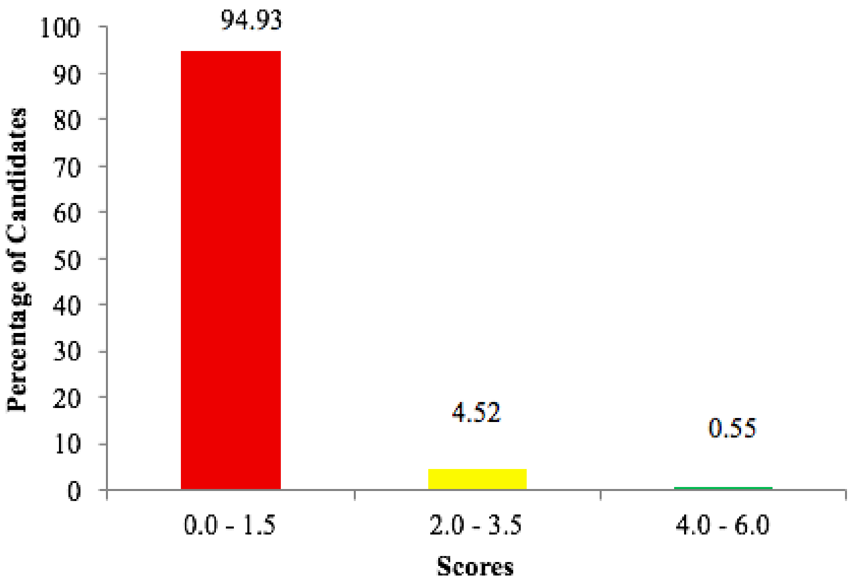


Figure 7: *Candidates' Performance in Question 7.*

Figure 7 shows only 5.07 percent of the candidates scored from 2 to 6 marks. Therefore the question had a weak performance, despite been straightforward. This weak performance was due to candidates' inability to interpret the question's requirements and failing to apply knowledge of percentages to solve it. The following examples demonstrate why the candidates failed to correctly answer this question.

In part (a), some of the candidates calculated the VAT ($\frac{20}{100}\times 2{,}500{,}000 = 500{,}000/=$) and wrongly considered it as the list price including VAT; instead of adding it to the given list price, that is, 2,500,000 + 500,000 = 3,000,000/= to get the required answer. Other candidates calculated the VAT correctly but then subtracted it from the given list price, that is, $2{,}500{,}000 - 500{,}000 = 2{,}000{,}000$.

In part (b), several candidates calculated the amount of discount after VAT was added, that is, $\frac{25}{100}\times 3{,}000{,}000 = 750{,}000/=$ instead of finding the amount of discount before VAT was added, that is $\frac{25}{100}\times 2{,}500{,}000 = 625{,}000/=$.

In part (c), the candidates used incorrect methods, such as:
$Reduced\ Final\ Price = Price\ before\ VAT + Discount$

$Reduced\ \ Final\ Price = Price\ after\ VAT + Discount$

$Reduced\ Final\ Price = List\ Price\text{-}\ \frac{25}{100}\times Discount$

The candidates were supposed to calculate it as follows: $Reduced\ Final\ Price = Price\ after\ Discount + VAT\ after\ Discount$.

Additionally, there were few candidates who applied unrelated formulae, such as: $I = \frac{PRT}{100}$ for simple interest and $A = P\left(1+\frac{RT}{100}\right)^n$ for compound interest, indicating that they did not understand the requirements of the question. Extract 7.1 illustrates this case.

Extract 7.1

7 (a) Solution

$I = \frac{PRT}{100}$

$P = \frac{20}{1\cancel{00}} \times 2,500,\cancel{000}$

$= 500,000$

The list price including VAT was 500,000

(b) $\frac{25}{1\cancel{00}} \times 500,\cancel{000}$

$= 125000$

(c) 500 000 − 125 000 = 375000

The final price of the computer = 375000.

Extract 7.1 shows a response of a candidate who performed calculations that were not related to the question demand.

Despite the weak performance, 357 (0.11%) candidates managed to correctly answer this question. These candidates were able to calculate the list price including VAT, the amount of discount before VAT was added and the reduced final price of the computer as required. Extract 7.2 is a sample solution from one of the candidates.

Extract 7.2

7a List price = 2 500 000

VAT = 20% List price

$= \frac{20}{1\cancel{00}} \times 2\ 500\ \cancel{000}$

$= 500\ 000$

List price + vat = 2 500 000 + 500 000

= 3000000/=

∴ The price will be 3 000 000/=

b Discount = 25%

$= \frac{25}{1\cancel{00}} \times 2500\ \cancel{000}$

$= 625000$

∴ The discount amount is 625000/=

e Final price

$= 2\,500\,000 - 625\,000 \cancel{+500\,000}$

$= 1\,875\,000$

VAT = 20%

$= \frac{20}{100} \times 1\,875\,000$

$= 375\,000$

∴ Final price $= 1\,875\,000 + 375\,000$

$= 2\,250\,000/=$

∴ The final price is 2 250 000/=

e Final price

$= 2\,500\,000 - 625\,000 \cancel{+500\,000}$

$= 1\,875\,000$

VAT = 20%

$= \frac{20}{100} \times 1\,875\,000$

$= 375\,000$

∴ Final price $= 1\,875\,000 + 375\,000$

$= 2\,250\,000/=$

∴ The final price is 2 250 000/=

Extract 7.2 shows how a candidate worked out the solution correctly.

2.8 Question 8: Sequences and Series

This question had parts (a) and (b). In part (a), the candidates were required to find the number of terms if the sum of *n* terms of a geometric progression with first term 1 and common ratio $\frac{1}{2}$ was $\frac{31}{16}$. In part (b), they were required to find the number of integers between 14 and 1000 which were divisible by 17.

Figure 8 shows the marks they got out of 6 marks and the corresponding percentage of candidates.

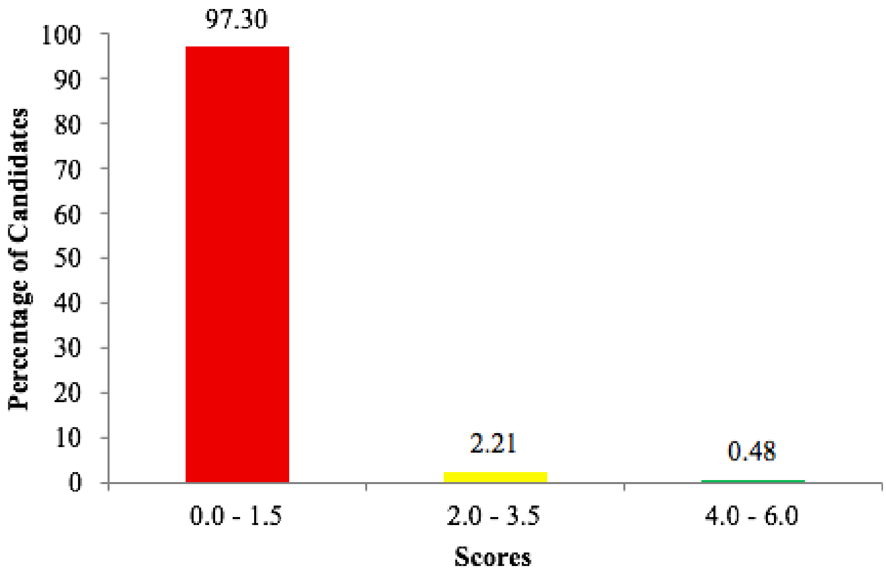


***Figure 8**: Candidates' Performance in Question 8.*

The data presented in Figure 8, shows that this question had a weak performance because only 2.68 percent of the candidates scored from 2 to 6 marks. Among the 97.30 percent of candidates who scored low marks, 92.43 percent scored 0. In part (a), these candidates were unable to correctly apply the formula $S_n = \frac{G_1(1-r^n)}{1-r}$ to find the number of terms as required. The candidates were instead applying incorrect formulae, such as $S_n = \frac{G_1(r^{n-1})}{r-1}$, $S_n = \frac{G_1(1-r^n)}{r-1}$ and $S_n = G_1 r^{n-1}$ and hence ended up with wrong answers (see Extract 8.1). Some of the candidates were able to recall the formula but then substituted incorrect data, whereas others substituted the correct data to get $\frac{31}{16} = \frac{1-\left(\frac{1}{2}\right)^n}{\frac{1}{2}}$ but could not find the value of *n*, because they lacked knowledge and skills of solving equations requiring application of the laws of exponents.

In part (b), most of the candidates failed to find the number of integers between 14 and 1000 which are divisible by 17. The majority did not recognize that the given integers form an arithmetic progression with the first term $A_1 = 17$, common difference $d = 17$ and the last term $A_n = 986$, and therefore they were required to find the value of n in the equation $986 = 17 + 17 \times (n-1)$. Further analysis shows that some of the candidates did not answer this part and others used incorrect data, for example $A_1 = 14$ and $A_n = 1000$. Some of the candidates applied incorrect formulae, for example $A_n = A_1(n-1)d$ and inappropriate concepts for example determining the Lowest Common Multiple (LCM) and Greatest Common Factor (GCF) of 14, 17 and 1000. Generally, these candidates lacked knowledge and skills on the application of arithmetic progression.

Extract 8.1

(8.) (a.) Soln

$G_1 = 1$

$r = 1/2$

$G_n = 31/16$

$G_n = G_1 r^{n-1}$

$31/16 = 1 \times 1/2^{n-1}$

$\frac{31}{16} = \frac{1}{2}^{n-1}$

$31/16 = 2^{-1(n-1)}$

$31/16 \times \frac{2^{-1n+1}}{1}$

$16 \times 2^{-n+1} = 31$

$2^4 \times 2^{-n+1} = 31$

$4 + -n + 1 = 0$

$4 + 1 = n$

$n = 5.$

(8.) (b)

14 and 1000

$A_n = A_1 + (n-1)d$

$1000 = 14 + (n-1)17$

$1000 = 14 + 17n - 17$

$\cancel{17n =}$

$1000 = 14 - 17 + 17n$

$= -3 + 17n$

$1000 - 3 = 17n$

$\frac{997}{17} = \frac{\cancel{17}n}{\cancel{17}}$

$n = 52$ terms

Extract 8.1 shows how a candidate failed to correctly use the concepts of arithmetic and geometric progressions in answering the question.

There were few candidates (0.2%) who correctly answered this question. Those candidates were able to apply the correct formulae for geometric and arithmetic progressions as shown in Extract 8.2.

Extract 8.2

8. a) $S_n = 31/16$ $\quad S_n = G_1 . \frac{1-r^n}{1-r}$

$G_1 = 1$ $\quad \frac{31}{16} = 1 \times \frac{1-(1/2)^n}{1-1/2} = 1 \times \frac{1-2^{-n}}{1/2}$

$r = 1/2$

$\frac{31}{16} = \frac{1-2^{-n}}{1/2}$

$\frac{31 \times 1/2}{16} = 1 - 2^{-n}$

$\frac{31}{32} = 1 - 2^{-n}$

$2^{-n} = 1 - \frac{31}{32} = \frac{32}{32} - \frac{31}{32} = 1/32$

$2^{-n} = 1/2^5 = 2^{-5}$

$2^{-n} = 2^{-5}$

$-n = -5$

$n = 5$

$\therefore$ number of terms is $\underline{5}$

b.) It will be an arthimetic progresion.

$A_1 = 17$ $\quad d = 17$ $\quad 17\sqrt{1000} = 58$ rem 14

$A_2 = 34$

$58 \times 17 = 986$ $\quad$ So, $A_n = 986.$

$59 \times 17 = 1003$

$$A_n = A_1 + (n-1)d$$

$$986 = 17 + 17(n-1) = 17 + 17n - 17$$

$$\frac{986}{17} = \frac{17n}{17}$$

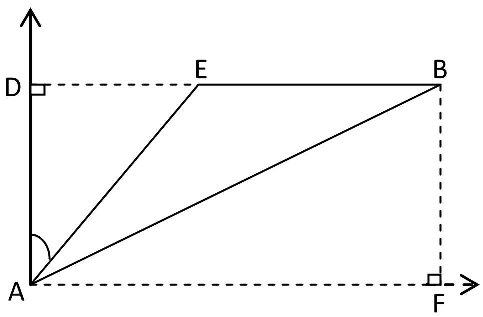
$$58 = n.$$

$\therefore$ There are 58 intergers.

Extract 8.2 shows a response of a candidate who demonstrated good understanding on the application of the concepts of arithmetic and geometric progressions in solving the question.

2.9 Question 9: Trigonometry

The question was as follows: Using the following figure, where AE = 20m, EB = $20\sqrt{2}$m and $D\hat{A}E = 45^\circ$, find: (a) the lengths DE, AD and AB; and (b) the area of triangle ABE, leaving the answer in surd form.



The analysis of data shows that the majority of candidates who attempted this question got low scores ranging from 0 to 1.5 out of 6 (see Figure 9).

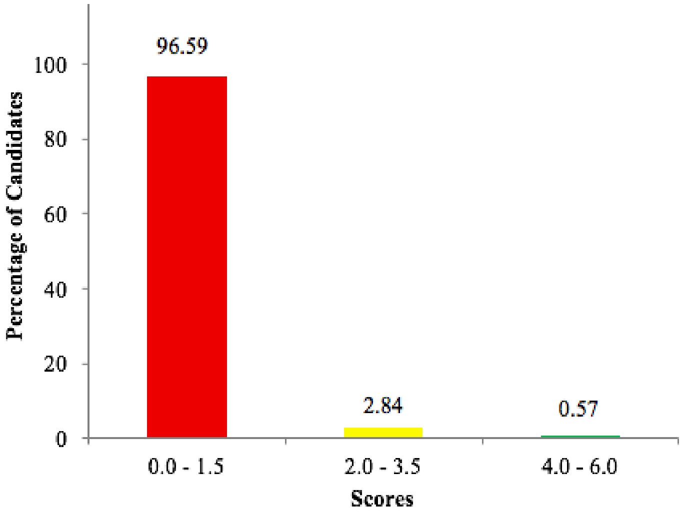


Figure 9: *Candidates' Performance in Question 9.*

In Figure 9, only 3.41 percent of the candidates scored from 2 to 6 marks. Generally, the performance in this question was weak.

In part (a), many candidates were able to use the concept of trigonometric ratios of *sine* and *cosine* to obtain the equations, such as $\sin 45^\circ = \frac{AD}{20}$ and $\cos 45^\circ = \frac{DE}{20}$ that were needed in answering this part. It was noted that some of them could not get the required lengths DE and AD from these equations because they used incorrect values for $\sin 45^\circ$ and $\cos 45^\circ$ whereas others used correct values but performed incorrect calculations.

The part on finding the length AB was not answered correctly by most candidates. Some of them used incorrect trigonometric ratios, for example $\sin 45^\circ = \frac{14.142}{\text{AB}}$, $\sin 135^\circ = \frac{\text{AB}}{20}$. Others used incorrect concepts and formulae, for example $AB^2 = AE^2 + EB^2$. These candidates wrongly considered triangle AEB as a right-angled triangle. The candidates were supposed to consider triangles ADB or AFB and applied either the Pythagoras theorem $AB^2 = AD^2 + (DE + EB)^2$ or the cosine rule, that is, $AB^2 = AE^2 + EB^2 - 2(AE)(EB)\cos(\text{A}\hat{\text{E}}\text{B})$.

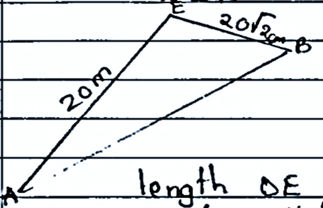
In part (b), many candidates also failed to find the area of triangle ABE as they were not able to correctly recall and apply one of the following formula:

$$Area\ of\ triangle\ ABE = \frac{1}{2} \times AE \times EB \times \sin(A\hat{E}B)$$

$Area\ of\ triangle\ ABE = \frac{1}{2} \times base(b) \times height(h)$. The candidates were substituting incorrect data in these formulae, for example some considered the height of triangle AEB as $20\,\text{m}$ instead of $10\sqrt{2}\,\text{m}$. Extract 9.1 is a sample answer showing how the candidates failed to answer this question.

Extract 9.1

9 a) solution



length DE, AD and AB

by pathagoras theorm

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

$20^2 + 10^2 = 45$

$\sqrt{400} + \sqrt{100}$

$\sqrt{c^2} = \sqrt{500}$

$c = 25$ cm.

b) Area of triangle ABE

solⁿ

$\frac{1}{\cancel{2}} \times \cancel{20}^{10}\text{m} \times 20\sqrt{2}\,\text{m}$

$10\text{m} \times 10\text{m}$

$\therefore = 100\,\text{m}^2$

$\therefore$ Area of triangle ABE $= 100$m.

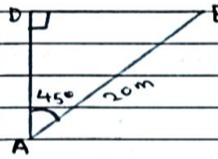
Extract 9.1 shows that a candidate could not apply the Pythagoras theorem and used incorrect data in finding the area.

On the other hand, 419 (0.13%) candidates managed to correctly answer this question. A sample solution from one of the candidates is shown in Extract 9.2.

Extract 9.2

9 (a) Data given:

$AE = 20m$, $EB = 20\sqrt{2}$ m, $D\hat{A}E = 45°$



$\sin 45° = \frac{DE}{20m}$

$DE = 20m \times \sin 45°$

$DE = 20m \times 0.7071$ or $20m \times \sqrt{2}/2$

$DE = 14.142m$ or $10\sqrt{2}m$

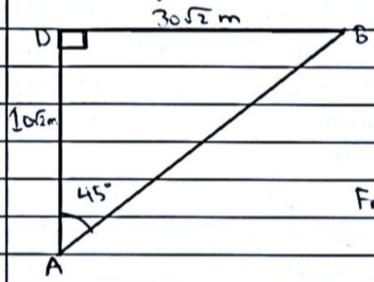
$\therefore$ The length DE is $14.142m$ or $10\sqrt{2}m$.

$\cos 45° = \frac{AD}{20m}$

$AD = 20m \times 0.7071$ or $20m \times \sqrt{2}/2$

$AD = 14.142m$ or $10\sqrt{2}$ m

$\therefore$ The length AD is $10\sqrt{2}$ m or $14.142m$.



$DB = DE + EB$

$DB = 10\sqrt{2}m + 20\sqrt{2}m$

$DB = 30\sqrt{2}$ m

From Pythagoras theorem:

$\overline{AB}^2 = \overline{AD}^2 + \overline{DB}^2$

$\overline{AB}^2 = (10\sqrt{2}\ m)^2 + (30\sqrt{2}\ m)^2$

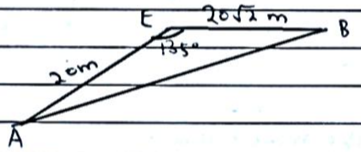
$\overline{AB}^2 = 200m^2 + 1800m^2$

$\overline{AB}^2 = 2000m^2$

$\overline{AB} = 20\sqrt{5}$ m or 44.72 m

$\therefore$ The length $\overline{AB}$ is 44.72 m or $20\sqrt{5}$ m.

(b)



From:

$Area = \frac{1}{2} ab \sin \hat{C}$

$Area = \frac{1}{2} \times 20m \times 20\sqrt{2}\ m \times \sin 135°$

$Area = 200\sqrt{2}\ m^2 \times \sqrt{2} \sin 45°$

$Area = 200\sqrt{2}\ m^2 \times \frac{\sqrt{2}}{2}$

$Area = (100 \times 2)\ m^2$

$Area = 200m^2 = (10\sqrt{2} \times 10\sqrt{2})m^2$

$= (10\sqrt{2}m)^2$

$\therefore$ The area of triangle ABE is $(10\sqrt{2}\ m)^2$

Extract 9.2 shows a response of a candidate who correctly applied the Pythagoras theorem and the concepts of trigonometric ratios in finding the required lengths. The candidate also applied the formula for finding the area correctly.

2.10 Question 10: Quadratic Equations

The question had parts, (a) and (b). In part (a), the candidates were required to solve the equation $4x^2 - 32x + 12 = 0$ by using the quadratic formula. In part (b), they were asked to find how old was Anna and Jerry, given that Anna was 6 years younger than her brother Jerry and the product of their ages was 135.

The percentage of candidates who scored from 0 to 1.5, 2 to 3.5 and 4 to 6 is shown in Figure 10.

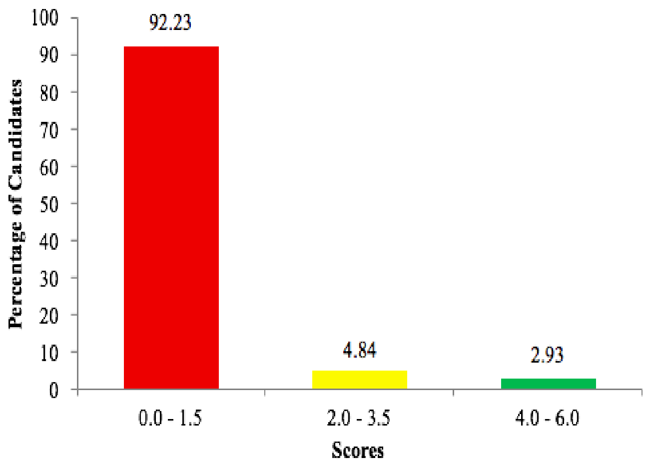


Figure 10: *Candidates' Performance in Question 10.*

The data in Figure 10 shows that 7.77 percent of the candidates scored from 2 to 6 marks; therefore this question had a weak performance. The weak performance in part (a) was mainly due to candidates' inability to correctly recall and apply the quadratic formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2}$ in solving the equation $4x^2 - 32x + 12 = 0$. For example, some of the candidates wrote it as $x = -b \pm \frac{\sqrt{b^2 - 4ac}}{2a}$, $x = \frac{-b\sqrt{b^2 - 4ac}}{2a}$ and as a result ended up with incorrect solutions. However, several candidates were able to recall and write the formula correctly but substituted incorrect values for either *a*, *b* or *c*. For example, some of them ignored the negative sign on $b = -32$ when substituting it in the formula. Additionally, other candidates solved the given equation by factorization and completing the square methods, which were contrary to the given instructions.

In part (b), most candidates were unable to correctly formulate the equation [$x(x+6)=135$] that represented the word problem; where x was Ann's age and (x + 6) was Jerry's age. Some of the incorrect equations they formulated include: $x+(x-6)=135$, $6x\times y=135$, $x\times 7x=135$ and $6x+x=135$. Other candidates performed meaningless calculations using the numbers that were given in the question. Those candidates lacked knowledge and skills of solving word problems. Extract 10.1 represents a sample answer from one of the candidates.

Extract 10.1

10 (a)

From $\frac{b \pm \sqrt{b^2 + 4ac}}{2a}$

$\frac{32 \pm \sqrt{(-32)^2 + 4ac}}{2a}$

$\frac{b \pm \sqrt{1024 + 4\times 4\times 12}}{2\times 4}$

$\frac{b \pm \sqrt{1024 + 192}}{8}$

$\frac{b \pm \sqrt{1216}}{8}$

$\frac{32 + \sqrt{1216}}{8}$ or $\frac{32 - \sqrt{1216}}{8}$

b) Soln

6 year younger than her brother

135 sum of their ages

135 -/6

1/2h

135 ÷ 2 = 67.

135 − 67 = 68

~~67 − 6~~

The brotter has 70 year and Anne is 65.

Extract 10.1 shows a response of a candidate who wrote the quadratic formula wrongly and could not formulate the equation(s) that represents the word problem.

However, there were few candidates (0.92%) who correctly answered this question. Extract 10.2 represents a sample solution of one of the candidates.

Extract 10.2

10. Solution.

(a) Given; $4x^2 - 32x + 12 = 0$.

i.e $x^2 - 8x + 3 = 0$.

From the quadratic formula;

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\Rightarrow x = \frac{8 \pm \sqrt{64 - 12}}{2}$$

$$\Rightarrow x = \frac{8 \pm \sqrt{52}}{2}$$

$$\Rightarrow x = \frac{8 \pm 2\sqrt{13}}{2} = 4 \pm \sqrt{13}$$

$\therefore$ $x = 4 + \sqrt{13}$ or $4 - \sqrt{13}$.

(b) Let; x be Jerry's age.

$\Rightarrow x - 6 =$ Anna's age.

Then; $x(x-6) = 135$.

$\Rightarrow x^2 - 6x = 135$.

$\Rightarrow x^2 - 6x - 135 = 0$.

$\Rightarrow x^2 + 9x - 15x - 135 = 0$

$\Rightarrow x(x+9) - 15(x+9) = 0$.

$\therefore \Rightarrow (x-15)(x+9) = 0$.

$\Rightarrow x = 15$ or -9.

10. (b) But; Age is always positive.

$\Rightarrow x = 15$.

Then; Jerry's age $= 15$ years

and Anna's age $= 15 - 6$

$= 9$ years.

$\therefore$ Anna is 9 years old while Jerry is 15 years old.

Extract 10.2 shows a response of a candidate who was able to apply correctly the quadratic formula and translated the word problem into a quadratic equation, thus solving it correctly by using the method of spliting the middle term.

2.11 Question 11: Linear Programming

The question was as follows: Zelda wanted to buy oranges and mangoes for her children. The oranges were sold at sh. 150 each and mangoes at sh. 200 each. She had to buy at least two kinds of each fruit but her shopping bag could not hold more than 10 fruits. Determine the number of each fruit Zelda had to buy for the shop owner to realise maximum profit if the owner of the shop made a profit of sh. 40 on each orange and sh. 60 on each mango.

The question was optional and was attempted by 110,243 candidates. The performance of candidates in this question is summarized and shown in Figure 11.

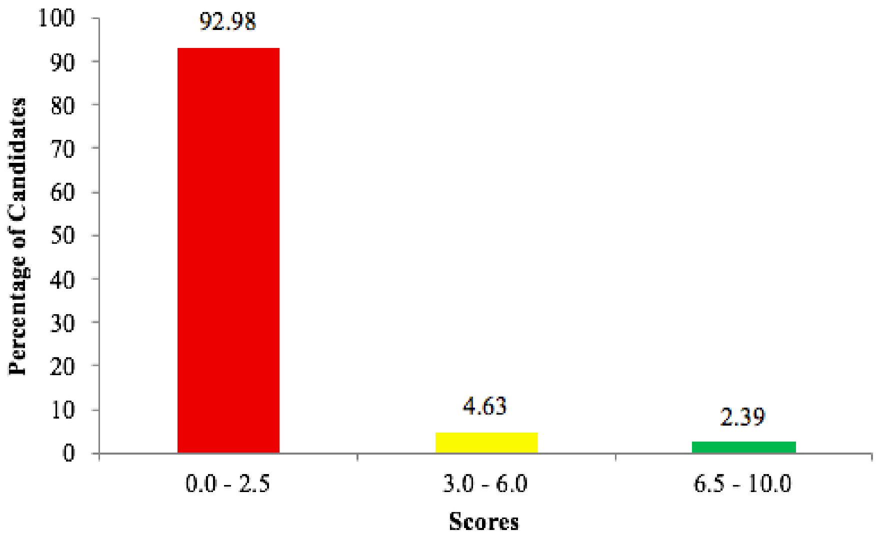


***Figure 11**: Candidates' Performance in Question 11.*

Figure 11 shows that only 7.02 percent of the candidates scored from 3 to 10 marks, therefore the question had a weak performance. The majority of candidates (92.98%) scored low marks and notably 35.63 percent scored 0. The analysis of candidates' responses shows that the following were the reasons that contributed to the weak performance in this question:

(a) Incorrect naming of the decision/unknown variables. For example, some of the candidates wrote "let x be oranges and y be mangoes" instead of writing "let x be the number of oranges and y be the number of mangoes."

(b) Inability to formulate the correct objective function. Many candidates wrongly used the given selling prices and as a result obtained the incorrect objective function $f(x, y) = 150x + 200y$. They were supposed to use the given profits in order to obtain the required objective function $f(x, y) = 40x + 60y$.

(c) Inability to formulate the constraints or linear inequalities from the given linear programming problem. For example, one candidate formulated the inequalities as $40x + 60y \geq 10, x \geq 0, y \geq 0$ and another candidate as $150x + 200y \geq 700,\ 2x + 2y \leq 10, x \geq 0, y \geq 0$. The correct inequalities were $x + y \leq 10$, $x \geq 2$, $y \geq 2$.

(d) Failure to represent the linear inequalities graphically. A few candidates formulated correct linear inequalities but were unable to represent them graphically, hence failed to obtain the required feasible region.

(e) Inability to correctly substitute each of the corner points into the objective function. A few candidates got the correct corner points but failed to correctly substitute them into the objective function. Hence, they were unable to conclude on the number of oranges and mangoes that would be bought to get maximum profit.

Extract 11.1 represents a sample solution of a candidate who failed to answer this question.

Extract 11.1

11 Soln.

let x to be the number of mangoes

y to be the number of oranges

Construction of inequality.

$2x + y \leq 60$

$x + 2y \leq 40$

$x \geq 0$

$y \geq 0$

Objective function: \$ 200x+150y.

$2x + y = 60$

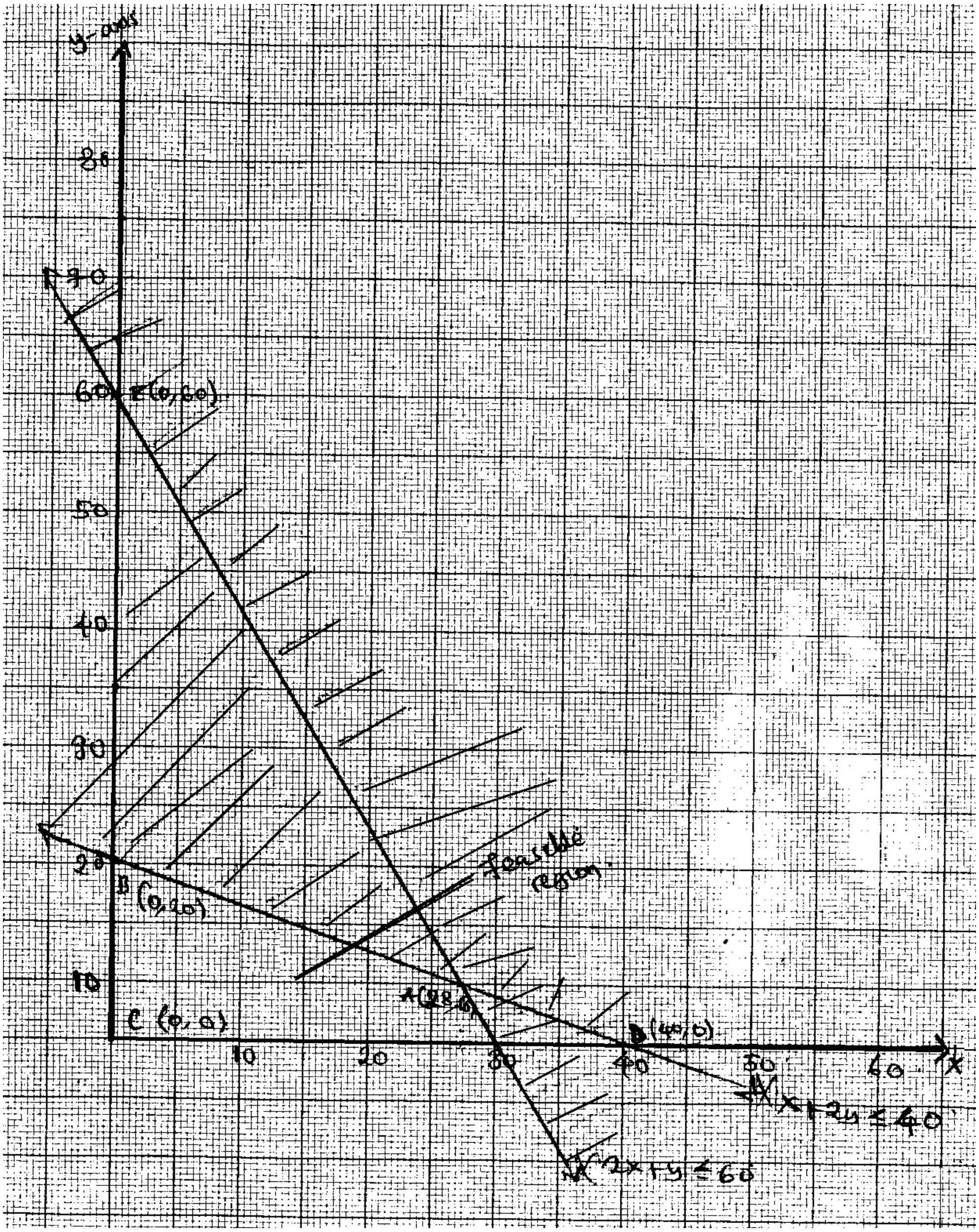
x	0	80
y	60	0

$x + 2y = 40$

x	0	40
y	20	0

Conner point	Objective function 200x+150y
f(x,y) A (28, 10)	200 (28) + 150(10) = 7100/=
B (0, 20)	0 + 150(20) = 3000/=
C (0, 0)	0 + 0 = 0

∴ the fruit of each kind to maximum profit is 28 mangoes and 10 oranges. (28, 10)



Extract 11.1 shows a sample solution of a candidate who formulated incorrect constraints and objective function.

However, 1,317 (0.41%) candidates provided correct answers. Extract 11.2 shows the work of one of the candidates.

Extract 11.2

11. solution

Let the number of oranges be x

the number of mangoes be y

$x + y \leq 10$ - - (i)

$x \geq 2$ - - - (ii)

$y \geq 2$ - - - (iii)

Objective function;

$f(x,y) = 40x + 60y \rightarrow$ maximum

$x + y \leq 10$

$x = 10$

$y = 10$

$x \geq 2$

$y \geq 2$

From the graph; corner points are

$(2,8)$, $(8,2)$, $(2,2)$

$f(x,y) = 40x + 60y \rightarrow$ maximum

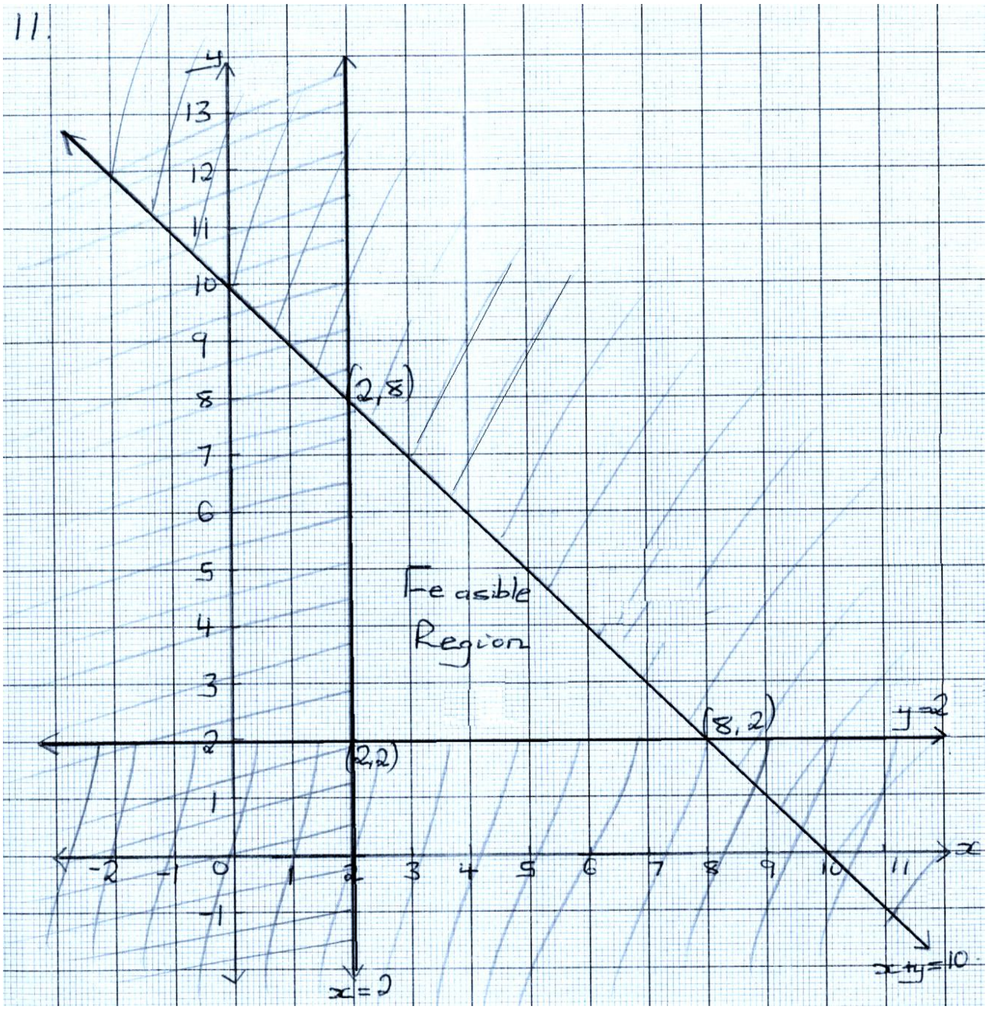
$f(2,8) = 40(2) + 60(8) \Rightarrow 560$

$f(8,2) = 40(8) + 60(2) = 440$

$f(2,2) = 40(2) + 60(2) = 200$

$(2,8) =$ maximum

$\therefore$ Zolda should buy 2 oranges and 8 mangoes for the shop owner to realise maximum profit.



Extract 11.2 shows a response of a candidate who was able to formulate and represent the linear inequalities graphically; identify the corner points of the feasible region; and determine the number of oranges and mangoes that should be bought.

2.12 Question 12: Statistics

The candidates were given that;

The heights of 50 plants recorded by a certain researcher are given below:

56	82	70	69	72	37	28	96	52	88
41	42	50	40	51	56	48	79	29	30
66	90	99	49	77	66	61	64	97	84
72	43	73	76	76	22	46	49	48	53
98	45	87	88	27	48	80	73	54	79

In part (a), they were required to copy and complete this tally table for the data given above.

Height (cm)	Tally	Frequency
21– 30		
31– 40		
41 – 50		
51 – 60		
61 – 70		
71 – 80		
81 – 90		
91 - 100		

Using this table, they were required in part (b) to draw a histogram for the heights of the plants and in part (c) to find the mean height of the plants without using the assumed mean method and in part (d) to find the median of the heights of the plants.

Question 12 was optional, and it was attempted by 267,777 (84.35%) candidates. The candidates' performance is presented in Figure 12.

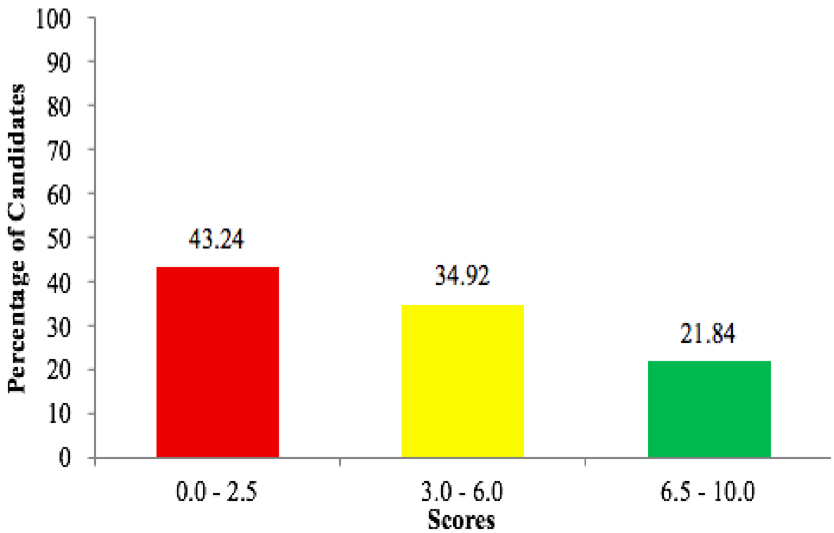


***Figure 12**: Candidates' Performance in Question 12.*

Figure 12 shows that 56.76 percent of the candidates scored from 3 to 10 marks. Therefore the question had an average performance. Notably 21.84

percent got high marks and among them 0.94 percent scored full marks. Most of the candidates in this category managed to correctly complete the tally table; draw a histogram for the heights of the plants; calculate the mean and median of the heights of the plants. Extract 12.1 shows a sample solution of one of the candidates who performed well in this question.

Extract 12.1

12 a) FREQUENCY DISTRIBUTION TABLE

Height (cm)	Tally	Frequency
21 – 30	||||/	5
31 – 40	||	2
41 – 50	||||/ ||||/		11
51 – 60	||||/		6
61 – 70	||||/		6
71 – 80	||||/ ||||/	10
81 – 90	||||/		6
91 – 100	||||	4

b).

Height (cm)	frequency	Class mark (x)	fx
21 - 30	5	25.5	127.5
31 - 40	2	35.5	71
41 - 50	11	45.5	500.5
51 - 60	6	55.5	333
61 - 70	6	65.5	393
71 - 80	10	75.5	755
81 - 90	6	85.5	513
91 - 100	4	95.5	382
	$\Sigma f = 50$		$\Sigma fx = 3075$

c). Mean $= \Sigma fx / \Sigma f$

$= 3075/50$

$= 61.5$

Mean is 61.5cm

12. d) Median $= L_i + \left(\frac{N/2 - n_b}{n_w}\right) i$

Where L_i = Real lower limit of median class = 60.5

N = Total frequency = 50 $\therefore 50/2 = 25$

n_b = frequency below median class = 24

n_w = frequency within median class = 6

i = Class interval = 10

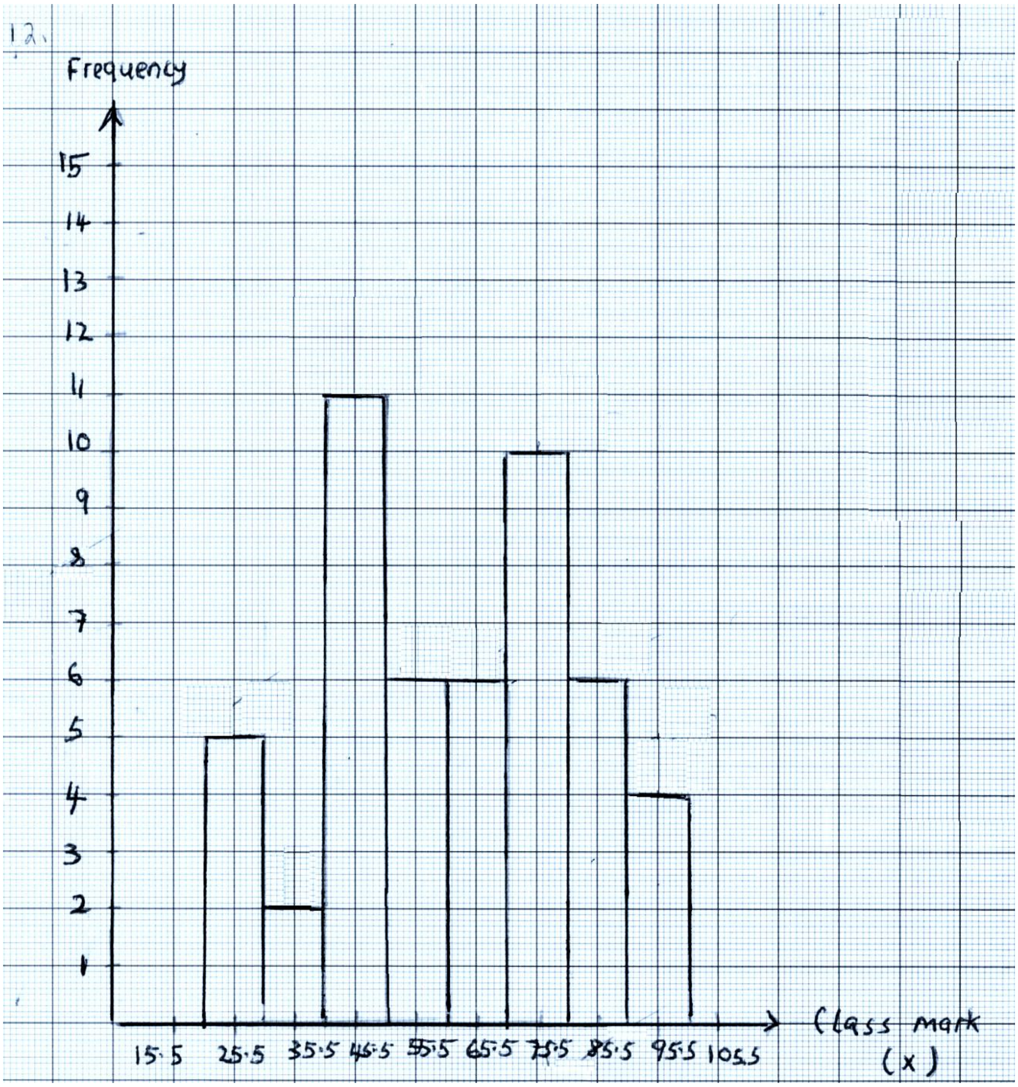
$= 60.5 + \left(\frac{25 - 24}{6}\right) 10$

$= 60.5 + \left(\frac{1}{6}\right) 10$

$= 60.5 + 1.67$

$= 62.17$

$\therefore$ Median is 62.17 cm



Extract 12.1 shows a response of a candidate who correctly answered the question.

Figure 12 also shows that 43.24 percent of the candidates scored low marks from 0 to 2.5 out of 10. Failure to give correct responses was contributed by the following factors.

In part (a), the candidates lacked knowledge and skills in representing data in frequency distribution tables. Some of these candidates incorrectly entered the class marks in the tally column whereas others incorrectly tallied the marks. These mistakes also led to incorrect values in the frequency column and in turn incorrect solutions to parts (b), (c) and (d).

However, some candidates prepared correct frequency distribution tables in part (a) but could not correctly drew the histogram in part (b). For example, there were candidates who used incorrect frequencies, incorrect class marks and used upper real limits on the horizontal axis instead of class marks. Further analysis shows that other candidates drew frequency polygons, bar graphs and cumulative frequency curves which were contrary to the requirements of the question.

In part (c), some of the candidates failed to recall the correct formula for finding the mean which consequently led into wrong answers. However, some candidates managed to recall it. That is, $Mean = \frac{\sum fx}{\sum f}$ but failed to correctly calculate the values of $\sum fx$ and $\sum f$ while others used incorrect data. Furthermore, there were candidates who applied the assumed mean method, that is, $Mean = A + \frac{\sum fd}{\sum f}$, contrary to the instructions given in the question.

In part (d), there were candidates who correctly completed the tally table in part (a) and correctly recalled the formula for finding the median, that is, $Median = L + \left(\frac{\frac{N}{2} - f_b}{f_m} \right) i$ but failed to obtain the required answer. Most of them could not identify the median class. Some were not able to correctly find the lower class boundary (L) of the median class, class width (i), sum of the frequencies below the median class (f_b) and the frequency for the median class (f_m). Other candidates considered the modal class instead of the median class whereas a number of candidates used incorrect formulae, such as $median = L + \left(\frac{t_1}{t_1 + t_2} \right) i$ and $median = L_1 + \left(\frac{n}{2} - \frac{n_b}{n_w} \right)$. Extract 12.2 is a sample solution from one of the candidates who failed to answer this question correctly.

Extract 12.2

12 (a) Solution.

Height(cm)	Tally	Frequency.
21-30	25.5	5
31 - 40	35.5	2
41 - 50	45.5	11
51 - 60	55.5	6
61 - 70	65.5	5
71 - 80	75.5	10
81 - 90	85.5	7
91 - 100	95.5	4
	= 38815	Σf 250

(c)

~~Data~~ Solution.

$$x = \frac{\Sigma fd}{\Sigma d}$$

$$= \frac{38815}{50}$$

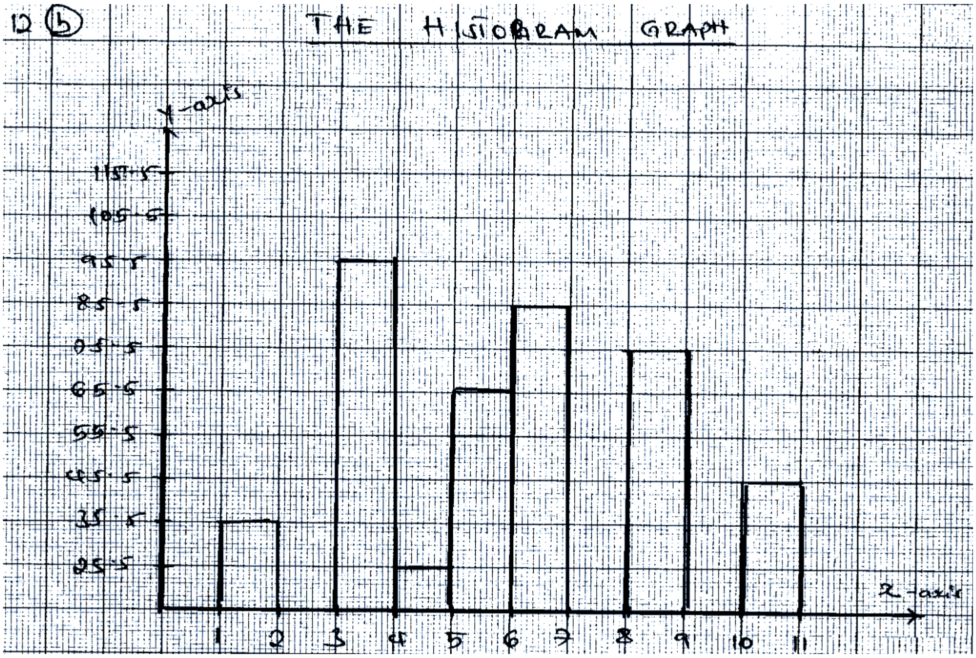
Mean = 776.3

(d)

$$L = \left(\frac{f/2 + fb}{n}\right)i$$

$$45.5 = \left(\frac{11/2 + 7}{50}\right)5$$

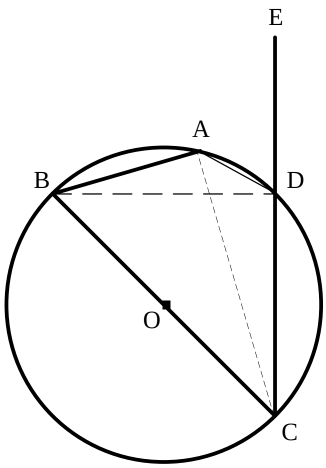
Median = 776.3



Extract 12.2 shows a sample solution of a candidate who did not understand the meaning of 'tally' and used incorrect data and formulae in finding the mean and median. He/she could not correctly draw the histogram.

2.13 Question 13: Circles

In the following figure, the candidates were given that, BC is a diameter of the circle, O is the centre of the circle and side CD of the cyclic quadrilateral ABCD is produced to E.



The candidates were required to: (a) name, with reasons, the right angles in the figure, (b) show that $A\hat{D}E = A\hat{B}C$ and (c) find (i) the value of $A\hat{B}D$ (ii) the lengths AB and BD, given that $\text{CB} = 10\,\text{cm}$, $A\hat{D}E = 60^\circ$ and $C\hat{A}D = 25^\circ$.

This question was attempted by 29,183 (9%) candidates, implying that the majority did not opt it. The candidates' performance in Figure 13 shows that only 8.31 percent scored from 3 to 10 marks, thus the question had a weak performance.

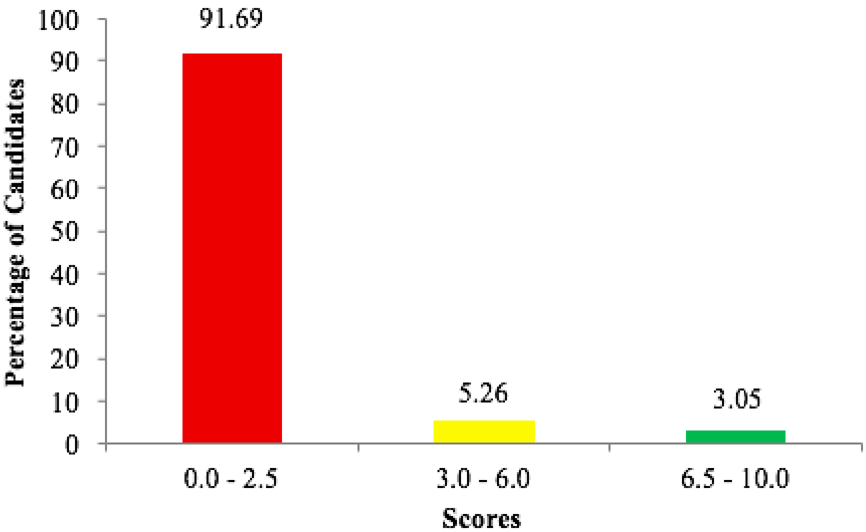


***Figure 13**: Candidates' Performance in Question 13.*

In part (a), majority of the candidates failed to correctly name the right angles in the given figure indicating that they did not understand the properties of the angles inscribed in a semi-circle. The candidates gave acute/obtuse angles, such as ABC, BAD and ADC instead of the right angles BAC and BDC. Other candidates named the right angles correctly but failed to give reasons to support their answers.

In part (b), most candidates failed to correctly show that $A\hat{D}E = A\hat{B}C$. They could not make use of the fact that 'opposite angles in a cyclic quadrilateral are supplementary and the angles on one side of a straight line add up to 180^{o}.'

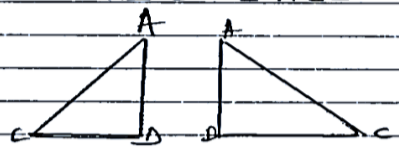
The candidates were unable to obtain the equations: $A\hat{B}C + A\hat{D}C = 180°$ and $A\hat{D}E + A\hat{D}C = 180°$ from the given figure; that were necessary in carrying out the proof.

Likewise in part (c)(i), most candidates failed to correctly apply the circle properties. In particular, they could not apply the property stating that *the exterior angle of a cyclic quadrilateral is equal to the opposite interior angle* in obtaining the result $A\hat{D}E = A\hat{B}C = 60^\circ$ and the property stating *the angles in the same segment are equal* in obtaining the second result $C\hat{B}D = C\hat{A}D = 25^\circ$. Failure in applying these properties led to candidates writing solutions that were not related to what they were asked. Part (c)(ii) was also poorly done as the candidates lacked knowledge and skills to apply either the definitions of trigonometric ratios or the sine rule. Extract 13.1 shows a sample work of one of the candidates who failed to correctly answer this question.

Extract 13.1

13 (a) Angle of this figure triangular Angles

(b) $A\hat{D}E = ABC$



$ADE = A\hat{B}C$

$A\hat{E}B + A\hat{C}B$

$B\hat{A}D = C\hat{A}B$

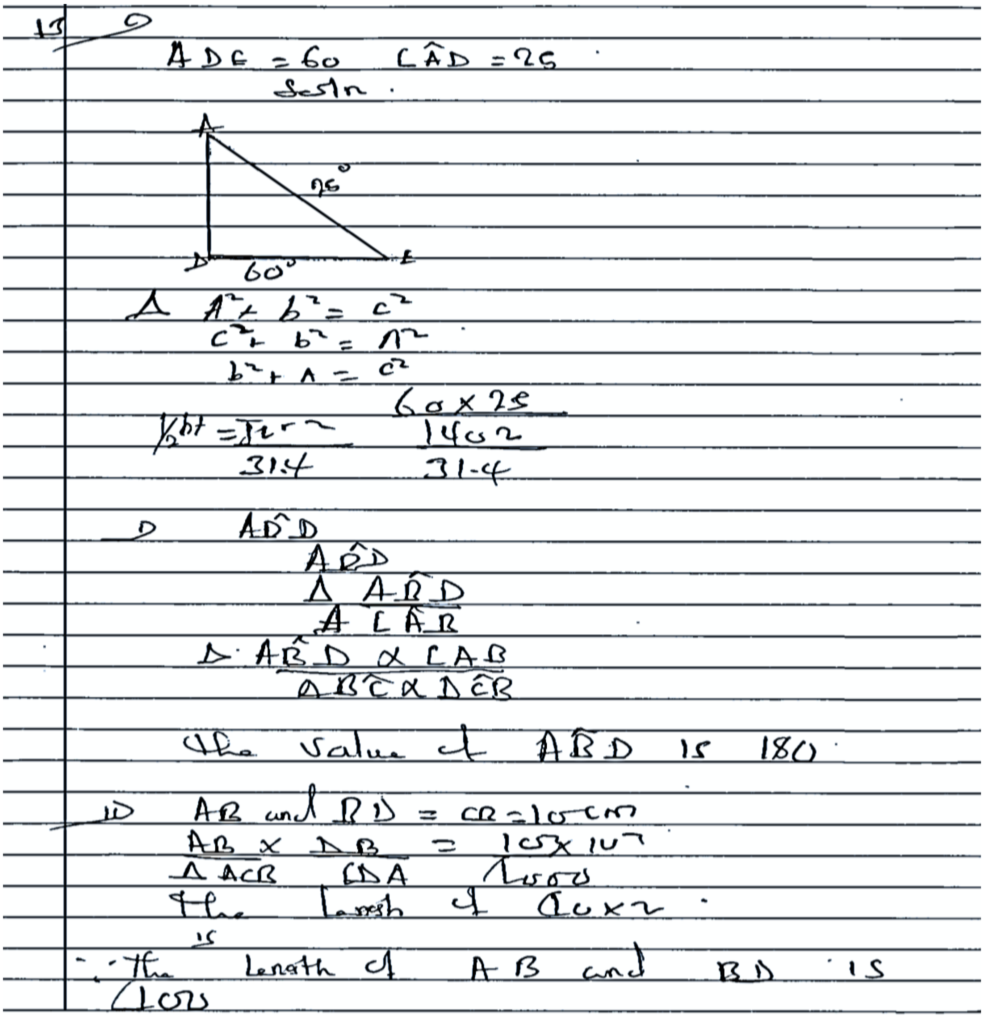
$A\hat{E}B = D\hat{E}A$

$A\hat{B}C = C\hat{D}A$

$A\hat{B}C = C\hat{D}B$

$A\hat{B}C = D\hat{C}B$

$\frac{AEB}{\Delta ADB} = \frac{CDB}{AEC}$



13 a) $ADE = 60$ $C\hat{A}D = 25$.

Soln.

Δ $A^2 + b^2 = c^2$

$c^2 + b^2 = A^2$

$b^2 + A = c^2$

$\frac{1}{2}bh = \pi r^2$ $\quad \frac{60 \times 25}{1402}$

314 $\quad 31.4$

b) $A\hat{D}D$

$A\hat{B}D$

Δ $A\hat{B}D$

A $C\hat{A}B$

$\Delta \cdot A\hat{B}D \;\alpha\; CAB$

$\Delta B\hat{C}\alpha D\hat{C}B$

The value of $A\hat{B}D$ is 180.

c) AB and BD = CB = 10cm

$AB \times DB = 10 \times 10$

Δ ACB CDA 1000

The length of 10×2.

is

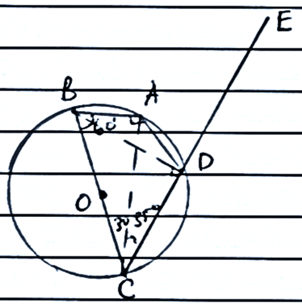
∴ The length of AB and BD is 10cm

Extract 13.1 shows a sample solution which is meaningless, indicating the candidate lacked knowledge on the tested concepts.

In this question, 127 out of 29,183 candidates who answered it, managed to give the correct responses. A sample solution from one of the candidates is shown in Extract 13.2.

Extract 13.2

13.



(a) $C\hat{A}B = 90°$ (is a right angle).

$C\hat{D}B = 90°$ (is a right angle)

This is because the angle subtended at the circumference by the diameter is $90°$

Also. The angle subtended at the circumference is half that subtended at the centre. That is

$A\hat{O}C = 2(C\hat{D}B)$

$180° = 2C\hat{D}B$

$C\hat{D}B = 90°$

$A\hat{O}C = 2(C\hat{A}B)$

$180° = 2(C\hat{A}B)$

$C\hat{A}B = 90°$

Required to show $A\hat{D}E = A\hat{B}C$

(b). $C\hat{B}A + C\hat{D}A = 180°$ -- sum of opposite angles in a cyclic

$C\hat{D}A = 180° - C\hat{B}A$

$C\hat{B}A = 180° - C\hat{D}A$ . . . (i)

$A\hat{B}C = 180° - C\hat{D}A$

$C\hat{D}A + A\hat{D}E = 180°$ . . . Sum of angles in a straight line

$A\hat{D}E = 180° - C\hat{D}A$ . . . (ii)

By comparing (i) and (ii)

$180° - C\hat{D}A = 180° - C\hat{D}A$

$\therefore A\hat{B}C = A\hat{D}E$, hence shown (e)(ii) $\cos 60^\circ = \frac{BA}{10}$

$\frac{1}{2} \times \frac{BA}{10}$

$2BA = 10$

$BA = 5$ cm

$\frac{\sin 65^\circ}{1} \times \frac{BD}{10}$

$BD = 10 \sin 65^\circ$ cm

$BD = 9.063$ cm.

(i) $A\hat{B}D = A\hat{C}D = 35^\circ$

$\therefore A\hat{B}D = 35^\circ.$

Because.

$\because A\hat{B}D = A\hat{C}D$

Then: $A\hat{B}D + 30^\circ + 90^\circ + 25^\circ = 180$ ... Sum of opp of a circle

$A\hat{B}D = 180 - 90 - 55$

$A\hat{B}D = 90 - 55$

$A\hat{B}D = 35^\circ$

Extract 13.2 shows how a candidate was able to correctly apply the circle properties and trigonometric ratios for sine and cosine in answering this question.

2.14 Question 14: Accounts

This question had parts (a) and (b). In part (a), the candidates were required to define a trial balance and state its main purpose. In part (b), it was given that; On January 1st 2015, Semolina Women Group started a business with capital in cash 2,000,000/=

January	2	Purchased goods for cash 1,400,000/=
	3	Sold goods for cash 1,000,000/=
	6	Purchased goods for cash 600,000/=
	15	Paid for cash for rent 220,000/=
	26	Paid for cash for wages 220,000/=
	15	Sold goods for cash 620,000/=

Using these data, the candidates were required to prepare: (i) the cash account and balance it and (ii) the trial balance.

This question was answered by 208,048 (65.54%) candidates. The percentages of candidates who scored low, average and high marks are shown in Figure 14.

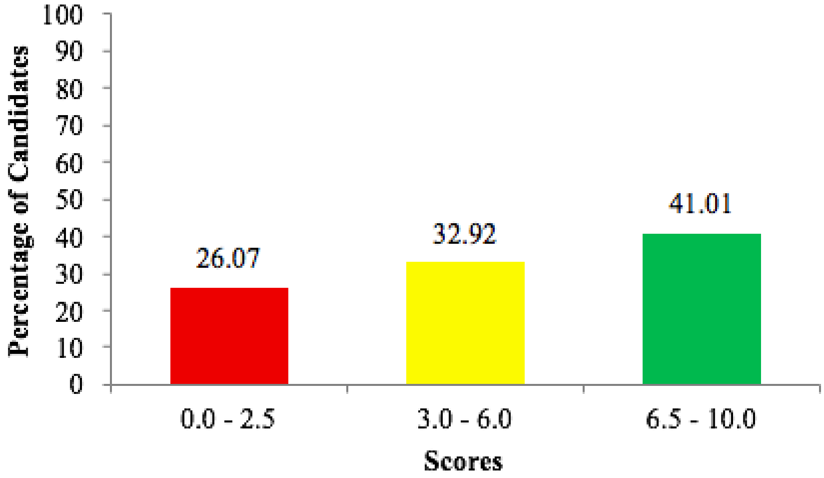


***Figure 14**: Candidates' Performnace in Question 14.*

Figure 14 shows that 73.93 percent of the candidates scored from 3 to 10 marks, therefore the question had a good performance. In this question, 41.01 percent scored high marks. Most candidates in this category were able to define the term "trial balance" and state its main purpose. They were also able to correctly prepare a cash account and a trial balance as illustrated in a sample answer in Extract 14.1.

Extract 14.1

14. (a)•) Trial balance is a statement that shows a list of debit and credit balances of accounts extracted from various ledgers to check the arithmetical accuracy of double entry recording at any given date, usually at the end of the year

•) The main purpose of Trial balance is to check the arithmetical accuracy of double entry recording at any given date also used to provide information to be used in creating final accounts and balance sheet.

b) i)

DR CASH ACCOUNT L·1 CR

Date	Particulars	Folio	Amount	Date	Particulars	Folio	Amount
1.1.2015	Capital	2	2,000,000	2.1.2015	Purchases	3	1,400,000
3.1.2015	Sales	4	1,000,000	6.1.2015	Purchases	3	600,000
15.1.2015	Sales	4	620,000	15.1.2015	Rent	5	220,000
				26.1.2015	Wages	6	220,000
				30.1.2015	Balance	c/d	1,180,000
			3620,000				3,620,000
1.2.2015	Balance	b/d	1,180,000				

ii) TRIAL BALANCE AS AT 30th Jan 2015

S/N	PARTICULARS	FOLIO	DR	CR
1.	Cash		1,180,000	
2.	Capital			2,000,000
3.	Purchases		2,000,000	
4.	Sales			1,620,000
5.	Rent		220,000	
6.	Wages		220,000	
	TOTAL		3,620,000	3,620,000

Extract 14.1 shows a sample solution of a candidate who correctly answered the question.

Figure 14 also shows that 26.07 percent scored from 0 to 2.5 out of 10 marks and among them 13.41 percent scored zero. In part (a), most of them could not correctly define a trial balance and state its main purpose. For example, one of the candidates wrote "*a trial balance is the book of account which used to determine if the balance are balanced and its main purpose is to determine the balance of transaction if are balanced*"; another candidate wrote "*trial balance is the balance brought down by comparing both sides of profit and loss and its main purpose is to check the balance profit or loss of the company.*" These responses show that the candidates did not understand the concept of trial balance.

In part (b), most of the candidates who scored low marks were unable to correctly prepare the cash account and trial balance. They posted some of the transactions on the wrong sides of the cash account and trial balance. For example in the cash account, they posted the capital or sales on the credit side; and purchases, wages or rents on the debit side. Also, some candidates failed to correctly balance the cash account and the trial balance. Additionally, there were some candidates who opened the ledgers instead of preparing cash account and others who prepared a balance sheet or a trading, profit and loss account instead of the trial balance. Extract 14.2 is a sample solution of a candidate who failed to correctly answer this question.

Extract 14.2

14 Trial balance; Is the exchange of Debit to credit or Interchange Value of credit to debit in the Cash account.

Main purpose: Is to determining gross loss or profit of trading.

(b) (i) THE CASH ACCOUNT AND BALANCE OF SEMOLINE ~~AVOMENT~~ CAPITA A/C

Dr							Cr
Date	particulars	F	Amount	Date	particulars	F	Amount
				1 Jany	Capital		200000

PARCHASED A/C

Dr							Cr
Date	particulars	F	Amount	Date	particulars	F	Amount
2 Jany	Parchased		1400000				
			60 000				
			800000				

PAID WAGES A/C

Dr							Cr
Date	particulars	F	Amount	Date	particulars	F	Amount
15 Jany	Paid		200000	15 Jany	Paid		220000
26 Jany	Paid		200000	26 Jan	Paid		20000

14(b) ii THE TRIAL BALANCE OF SEMOLINA WOMEN GROUP STARTED A BUSNES ~~OF~~ WITH CAPITAL IN CASH

Name of account	Dr	Cr
Capita	2000000 ×	~~800000~~
purchased		800000
paid wages		000,000 0
Sold		520000
Paid	220000	
RtzC.	420000	4200000

Extract 14.2 shows a solution of a candidate who lacked knowledge and skills on the tested concepts of cash account and the trial balance.

2.15 Question 15: Matrices and Transformations

This question had three parts, (a), (b) and (c). In part (a), the candidates were required to find the inverse and identity matrices of $A=\begin{pmatrix} 6 & 4 \\ -2 & 5 \end{pmatrix}$. In part (b), they were given that triangle OAB had its vertices at O (0, 0), A (2, 1) and B (-1, 3), and they were required to find the vertices of the triangle if the triangle was enlarged by $E=\begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$ and then translated by $T=\begin{pmatrix} -3 \\ -5 \end{pmatrix}$. In part (c), the candidates were required to draw, on the same xy - plane, the triangle OAB and the images after being (i) enlarged (ii) translated.

This question was opted by 172,551 (54.35%) candidates. The performance of the candidates is shown in Figure 15.

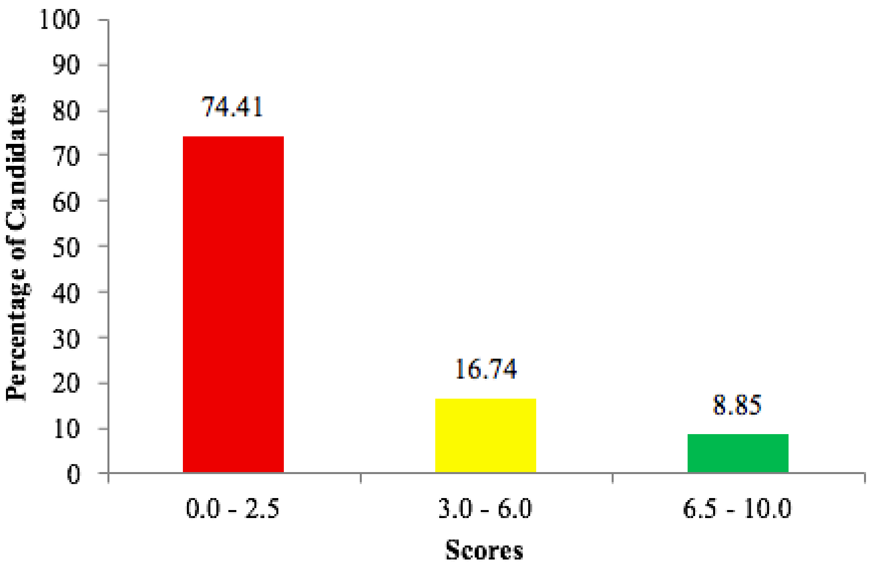


Figure 15: *Candidates' Performance in Question 15.*

Figure 15 shows that 25.59 percent of the candidates who attempted the question scored from 3 to 10 marks, implying that the question had a weak performance.

Figure 15 also depicts that 74.41 percent scored from 0 to 2.5 marks. Further analysis of the data revealed that 48.43 percent scored 0, indicating that these candidates had inadequate knowledge on the tested concepts.

In part (a), most candidates failed to correctly find the determinant of matrix *A*. For example, some wrote $|A| = 6\times5 - 2\times4 = 22$ instead of writing $|A| = 6\times5 - (-2\times4) = 38$. However, other candidates managed to correctly find the determinant but failed to find its inverse. Those candidates lacked understanding on how to find minors and cofactors. For example some wrote $A^{-1} = \frac{1}{38}\begin{pmatrix} 5 & 4 \\ -2 & 6 \end{pmatrix}$, while others wrote $A^{-1} = \frac{1}{38}\begin{pmatrix} 6 & -4 \\ 2 & 5 \end{pmatrix}$ instead of writing $A^{-1} = \frac{1}{38}\begin{pmatrix} 5 & -4 \\ 2 & 6 \end{pmatrix}$. Majority of the candidates could not use the property $A^{-1}A = I$ to find the identity matrix *I*.

In part (b), majority of the candidates were unable to correctly find the image of the vertices of triangle OAB after being enlarged and then translated. They were unable to realize that the image of each of the vertices were to be obtained by premultiplying the points by the enlargement matrix and then add the result to the translation vector. For example, to get the image of point O, they were to follow the steps: $\begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}\begin{pmatrix} 0 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} = O'(0,0)$; $\begin{pmatrix} 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -3 \\ -5 \end{pmatrix} = \begin{pmatrix} -3 \\ -5 \end{pmatrix} = O''(-3,-5)$. Furthermore, other candidates pre-multiplied the vertices of the enlarged triangle by the translating matrix $T = \begin{pmatrix} -3 \\ -5 \end{pmatrix}$, instead of adding those vertices to the translating matrix to get the correct answer. Further analysis of candidates' responses shows that some candidates determined the image of triangle OAB under the translation vector and then enlarged it. This indicates that the candidates did not understand the requirements of the question. Failure of many candidates in answering part (b) also led into incorrect solutions to part (c). Extract 15.1 shows a sample solution of one of the candidates who failed to correctly answer this question.

Extract 15.1

15 (a) Soln

$A^{-1} = \frac{1}{|A|}\begin{pmatrix} 5 & -4 \\ 2 & 6 \end{pmatrix}$

But $|A| = 6 \times 5 - (-2 \times 4)$

$= 30 - 8$

$= 22$

$A^{-1} = \frac{1}{22}\begin{pmatrix} 5 & -4 \\ 2 & 6 \end{pmatrix}$

$\therefore A^{-} = \begin{pmatrix} 5/22 & -2/11 \\ 1/11 & 3/11 \end{pmatrix}$

The identity of A = IA

Where $I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

$$= \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 6 & 4 \\ -2 & 5 \end{pmatrix}$$

$$= \begin{pmatrix} 6-2 & 4+0 \\ 0-2 & 0+5 \end{pmatrix} = \begin{pmatrix} 4 & 4 \\ -2 & 5 \end{pmatrix}$$

$\therefore$ The identity matrix $= \begin{pmatrix} 4 & 4 \\ -2 & 5 \end{pmatrix}$

15. b) Enlagements $\begin{pmatrix} -3 \\ -5 \end{pmatrix} \times \begin{pmatrix} 2 \\ 2 \end{pmatrix} = O\begin{pmatrix} -6 \\ -10 \end{pmatrix}$

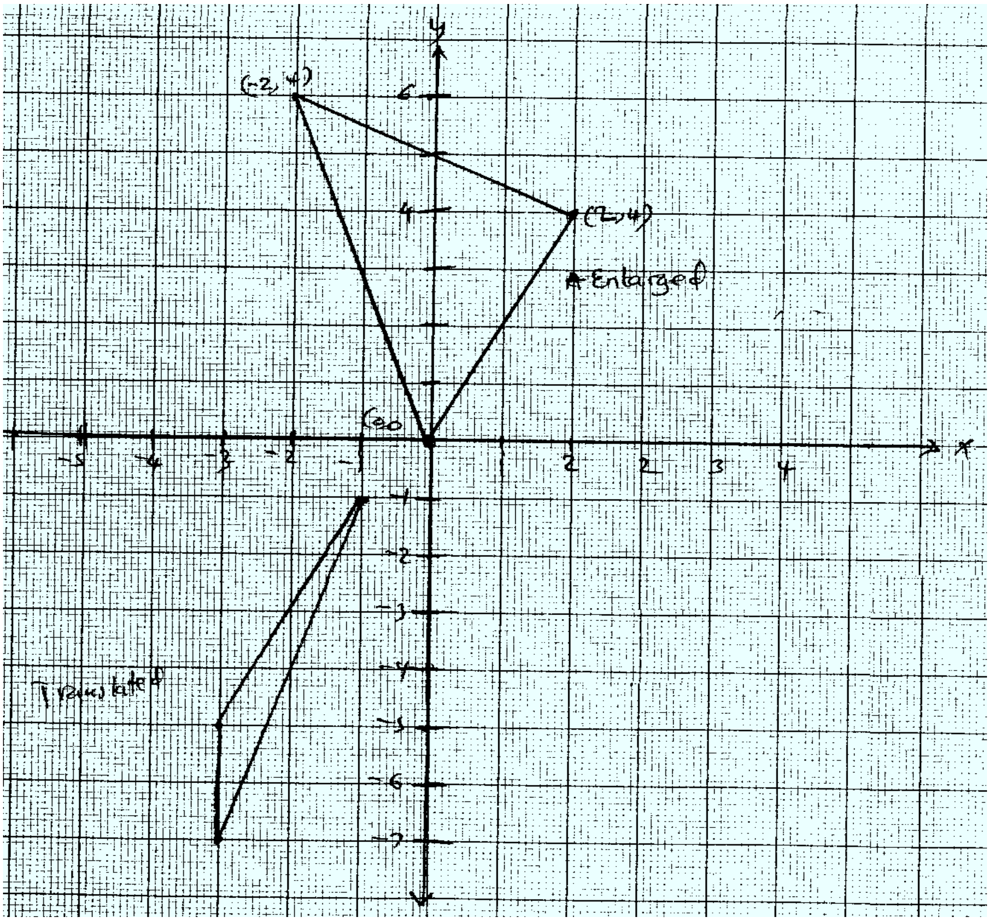
$$\begin{pmatrix} -3 \\ -5 \end{pmatrix} \times \begin{pmatrix} 4 \\ 2 \end{pmatrix} = A\begin{pmatrix} -12 \\ -10 \end{pmatrix}$$

$$\begin{pmatrix} -3 \\ -5 \end{pmatrix} \times \begin{pmatrix} -2 \\ 6 \end{pmatrix} = B\begin{pmatrix} 6 \\ -30 \end{pmatrix}$$

$\therefore$ vertices of the triangle = O (-6, -10)

A (-12, -10)

B (6, -30)



Extract 15.1 shows a solution of a candidate who incorrectly found the determinant, identity matrix and the image of the vertices of the enlarged triangle.

Despite the weak performance, there were 966 (0.3%) candidates who answered correctly this question. Those candidates were able to find the inverse and identity matrix, images of the triangle after enlarged and then translated and finally represented them in the same xy-plane. Extract 15.2 represents a sample answer from one of the candidates.

Extract 15.2

15 a, $A = \begin{bmatrix} 6 & 4 \\ -2 & 5 \end{bmatrix}$

$|A| = (6 \times 5) - (4 \times -2)$

$|A| = 30 - {}^{-}8$

$|A| = 30 + 8$

$|A| = 38$

$\frac{1}{38}\begin{bmatrix} 5 & -4 \\ 2 & 6 \end{bmatrix}$

$\therefore$ The inverse of A (A^{-1}) is $\frac{1}{38}\begin{bmatrix} 5 & -4 \\ 2 & 6 \end{bmatrix}$

Identity matrix = $A^{-1} \times A$

$\frac{1}{38}\begin{bmatrix} 5 & -4 \\ 2 & 6 \end{bmatrix}\begin{bmatrix} 6 & 4 \\ -2 & 5 \end{bmatrix}$

$\begin{bmatrix} 5/38 & -4/38 \\ 2/38 & 6/38 \end{bmatrix}\begin{bmatrix} 6 & 4 \\ -2 & 5 \end{bmatrix}$

$\begin{bmatrix} \frac{20}{38} + \frac{8}{38} & \frac{20}{38} + \frac{-20}{38} \\ 12/38 + {-12}/38 & 8/38 + \frac{30}{38} \end{bmatrix}$

$\begin{bmatrix} \frac{38}{38} & 0/38 \\ 0/38 & 38/38 \end{bmatrix}$

$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

$\therefore$ Identity matrix of A = $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

15 b) O (0, 0) , A (2, 1) , B (-1, 3)

Enlargement $E = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$

Translation $= \begin{bmatrix} -3 \\ -5 \end{bmatrix}$

For; Enlarged $E = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$

$(0, 0) = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

$(2, 1) = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 4+0 \\ 0+2 \end{bmatrix} = \begin{bmatrix} 4 \\ 2 \end{bmatrix}$

$(-1, 3) \quad \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} -1 \\ 3 \end{bmatrix} = \begin{bmatrix} -2+0 \\ 0+6 \end{bmatrix} = \begin{bmatrix} -2 \\ 6 \end{bmatrix}$

Then translated. (0, 0)

$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} a \\ b \end{pmatrix}$

$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -3 \\ -5 \end{pmatrix}$

$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} -3 \\ -5 \end{pmatrix}$

For: (4, 2)

$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 4 \\ 2 \end{pmatrix} + \begin{pmatrix} -3 \\ -5 \end{pmatrix} = \begin{pmatrix} 4-3 \\ 2-5 \end{pmatrix}$

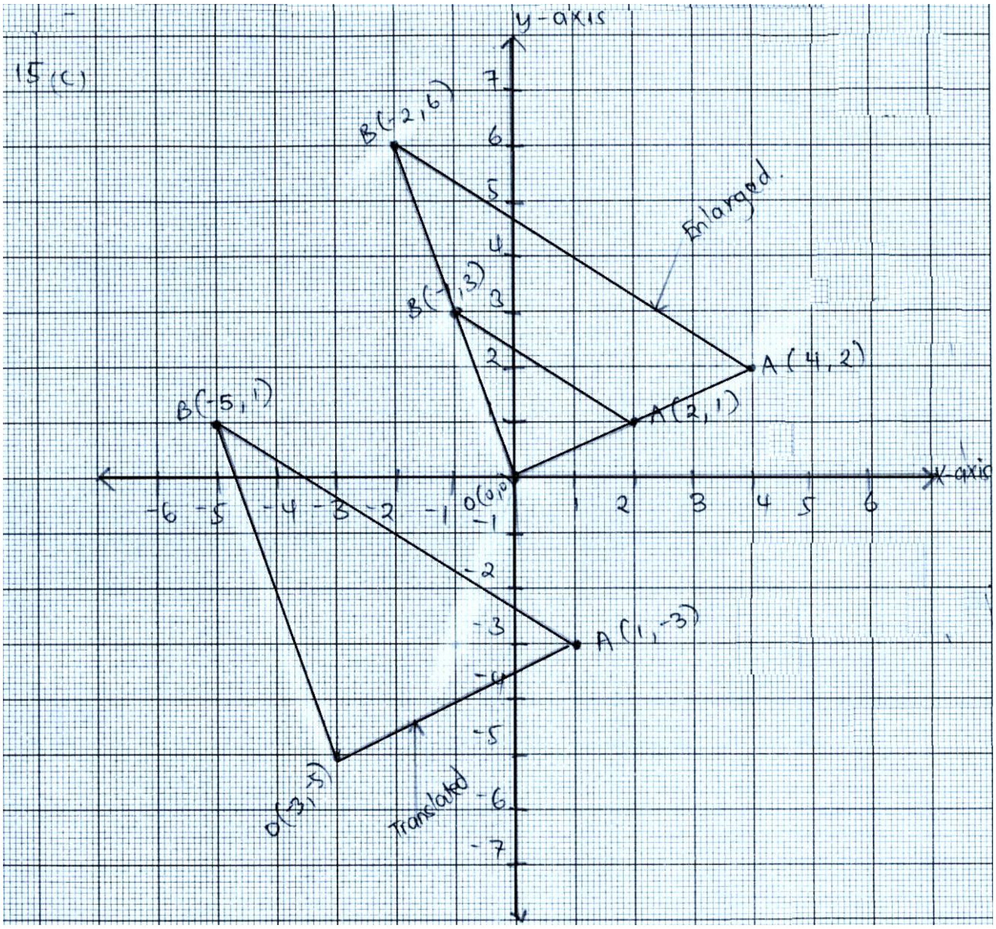
$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 \\ -3 \end{pmatrix}$

For; (-2, 6)

$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} -2 \\ 6 \end{pmatrix} + \begin{pmatrix} -3 \\ -5 \end{pmatrix} = \begin{pmatrix} -2-3 \\ 6-5 \end{pmatrix}$

$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} -5 \\ 1 \end{pmatrix}$

$\therefore$ The vertices of triangle will be at O (-3, -5) , A (1, -3) and B (-5, 1)



Extract 15.2 shows how a candidate correctly answered Question 15.

2.16 Question 16: Functions and Probability

This question had three parts, (a), (b) and (c). In part (a), the candidates were required to draw a pictorial diagram for $f(x)$ and find the domain and range of $f(x)$, whereas the function was defined on the set of integers as:

$$f(x)=\begin{cases} 1+x & 1\le x<2 \\ 2x-1 & 2\le x<4 \\ 3x-10 & 4\le x<6 \end{cases}$$

In part (b), the candidates were required to find $f^{-1}(4)$ given that $f(x)=\dfrac{5x+7}{x+2}$. In part (c), they were given that, in a car yard there were 500 vehicles of which 160 were cars, 130 were vans and the remaining were lorries. They were also given that every vehicle had an equal chance to leave and were required to find the probability of; (i) a van leaving first, (ii) a lorry leaving first and (iii) a car leaving second if either a lorry or a van had left first.

This question was opted by 157,129 (49.5%) candidates. The candidates' performance in this question is presented in Figure 16.

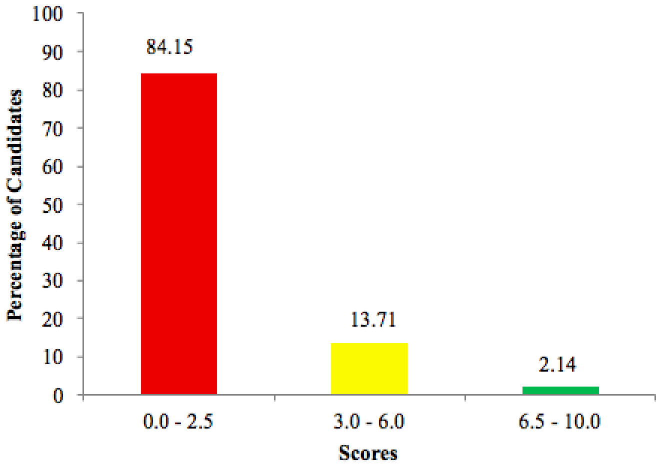


***Figure 16**: Candidates' Performance in Question 16.*

Figure 16 shows that 15.85 percent of the candidates scored from 3 to 10 marks and therefore the question had a weak performance. The majority (84.15%) scored low marks and among them, 60.51 percent scored 0.

In part (a), majority of the candidates were unable to correctly draw the pictorial diagram. They could not identify the set of values of x that corresponds with the values of the function at the x – values (see Extract 16.1). Many candidates prepared incorrect table of values that led into incorrect pictorial diagrams and in turn incorrect domain and range. For example, some candidates wrote that the domain and the range were the sets of all real numbers. Others gave the domain and the range as the sets of all real numbers, such that $\{2 \le x \le 8\}$; $\{2 \le y \le 8\}$. These candidates generally lacked understanding on the concept of domain and range and also failed to comprehend the demand of question because the given function was defined on the set of integers $\{1 \le x \le 5\}$ and not on real numbers. The range for the function was supposed to be $\{y \in Z : y = 2, 3, 5\}$.

In part (b), majority of the candidates lacked the skills to find the inverse of the given function. Most candidates wrongly substituted $x = 4$ in

$f(x) = \frac{5x+7}{x+2}$ and concluded that $f^{-1}(4) = \frac{5(4)+7}{4+2} = \frac{9}{2}$. These candidates were supposed to re-write the function as $x = \frac{5y+7}{y+2}$, then make y the subject of the equation to get $y = \frac{7-2x}{x-5}$ and finaly write $f^{-1}(x) = \frac{7-2x}{x-5}$.

In part (c), most of the candidates faced problems in answering part (iii). They incorrectly wrote that the probability of a car leaving second if either a lorry or van had left as $\frac{160}{500} = \frac{8}{25}$. The candidates were unable to recognize that if either a lorry or a van had left first, the number of vehicles left in the yard would be $500 - 1 = 499$ and thus the required probability was $\frac{160}{499}$.

Extract 16.1

16 (a) $y = \cancel{1}x + x$

(i)

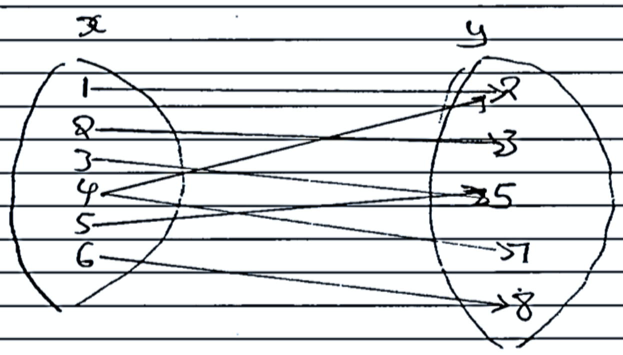
x	1	2
y	2	3

$y = 2x + 1$

x	2	3	4
y	3	5	7

$y = 3x - 10$

x	4	5	6
y	2	5	8



(ii) Domain $= \{x : 1 \le x \le 6\}$

Range $= \{y : y = 2, 3, 5, 7, 8\}$

b) ~~$f(x) = 5x+7$~~

$f^{-1}(4) =$

$\frac{4}{1} = \frac{5(4)+7}{4+2}$

$= 4(4+2) = 20+7$

$= 16+2 = 27$

$= 18 = 27$

$= 27-18 = 9$

$\therefore f^{-1}(4) = 9$

c) i) $P(n) = \frac{P(E)}{P(S)}$

$P(n) = \frac{130}{500}$

$\therefore$ The probability of a van leaving first is $\frac{13}{50}$.

ii) $P(E) = \cancel{160}\ (160+130-500)$

$P(E) = 1\ 310$

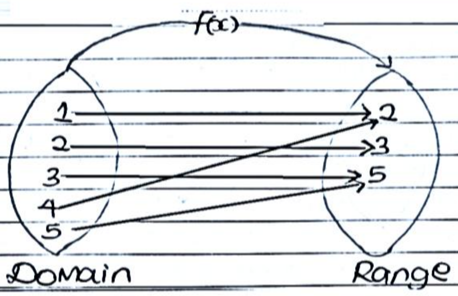
$P(n) = \frac{P(E)}{P(S)}$

Extract 16.1 shows that a candidate lacked skills to represent functions using pictorial diagrams, find inverses and solve probability problems.

On the other side, there were candidates who answered this question correctly. They managed to draw a correct pictorial diagram and find the domain and range of the given function. They were also able to find the inverse of the given function and solve the word problem related to probability (see Extract 16.2).

Extract 16.2

16a)



Domain = {1, 2, 3, 4, 5}

Range = {2, 3, 5}.

b) $f(x) = \frac{5x+7}{x+2}$.

$y = \frac{5x+7}{x+2}$

$f^{-1} \rightarrow \quad x = \frac{5y+7}{y+2}$

$\frac{x}{1} = \frac{5y+7}{y+2}$

$x(y+2) = 5y+7$

$xy + 2x = 5y + 7$

$2x - 7 = (5y - xy)\, y$

$\frac{2x-7}{5-x} = \frac{(5-x)y}{5-x}$

$y = \frac{2x-7}{5-x}$.

$f^{-1}(4) = \frac{2(4)-7}{5-4}$

$= \frac{8-7}{5-4}$

$= \frac{1}{1}$.

$\therefore \quad f^{-1}(4) = 1$.

16 c) Solution:

Given:

Total number of vehicles (Sample space)	= 500
Number of cars	= 160
Number of vans	= 130
Number of lorries	= ?

$n(\psi) = 500$

$n(c) = 160$

$n(v) = 130$

$n(L) = ?$

Then; No of lorries $= 500 - (160 + 130)$

$= 500 - 290$

$= 210$.

i) Probability of a van to leave first.

$n(\varphi) = 500$

$n(V) = 130$.

$P(E) = \frac{130}{500}$

$= 0.26$.

∴ The probability of van to leave first is 0.26.

ii) A lorry to leave first.

$n(\varphi) = 500$

$n(L) = 210$

Probability $= \frac{210}{500} = 0.42$

∴ Probability of lorry to leave first is 0.42.

16 c (iii) If the lorry or van will leave

Then $n(\varphi) = 500 - 1$

$= 499$

Then; Probability of car to leave

$= \frac{160}{499} = 0.32$.

∴ Probability that the car will leave after a van or lorry has left is 0.32.

Extract 16.2 shows how the candidates correctly answered parts (a), (b) and (c).

3.0 CONCLUSION AND RECOMMENDATIONS

3.1 Conclusion

The analysis of the candidates' performance in each question has shown that out of the 16 questions that were tested, one question on *Accounts* had good performance and one question on *Statistics* had average performance. The remaining 14 questions had a weak performance. These questions were set from the topics of *Matrices and Transformations, Approximations, Radicals, Decimals, Rates and Variation, Algebra, Sets, Probability, Functions, Exponents, Logarithms, Vectors, Coordinate Geometry, Circles, Quadratic Equations, Linear Programming, Percentages, Trigonometry, Sequences and Series, Geometry and Similarity*.

The candidates weak performance on these topics was contributed by: inability to identify the requirements of the questions; inability to correctly perform mathematical operations; failure to formulate equations/inequalities from given information, inability to correctly represent given information in diagrams; lack of skills to draw graphs; failure to follow given instructions; inadequate knowledge and skills in using the laws, formulae; theorems and other mathematical concepts in answering the questions; and substituting incorrect data in these formulae.

3.2 Recommendations

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

(a) The students should put more emphasis on the topics which had a weak performance, namely *Matrices and Transformations*, *Approximations, Radicals*, *Decimals, Rates and Variation, Algebra, Sets, Probability, Functions, Exponents, Logarithms, Vectors, Coordinate Geometry, Circles, Quadratic Equations, Linear Programming, Percentages, Trigonometry, Sequences and Series*, *Geometry* and *Similarity*. The emphasis includes:

(i) Revising various concepts, theorems and mathematical properties by solving related problems;

(ii) Forming discussion groups and participating effectively in solving questions;

(iii) Participating fully in mathematics clubs in order to solve problems they face in different topics;

(iv) Making self-evaluation on different topics that have been taught and, where necessary, consulting their teachers for any concepts that need more clarification in order to master the topic.

(b) The teachers should;

(i) Teach all the topics in time and according to the syllabus to enable the students to get enough time for making revision on various topics;

(ii) Use participatory methods in the teaching and learning processes;

(iii) Allow students' timely consultations where necessary;

(iv) Initiate and supervise the discussion groups and mathematics clubs so as to inculcate the spirit of students' cooperation in solving mathematical problems;

(v) Provide exercises frequently; assess the students according to their abilities and device a mechanism of assisting them in improving their performance.

(vi) Use simple teaching aids and daily life examples to enhance students understanding of various mathematical concepts.

(c) The government should;

(i) Make sure that all secondary schools have enough and competent mathematics teachers;

(ii) Make follow-ups on teaching and learning processes in order to ensure that the topics are covered on time and according to syllabus;

(iii) Facilitate in-house training for teachers in order to update their knowledge and skills in the Mathematics subject.

Appendix

ANALYSIS OF THE CANDIDATES' PERFORMANCE TOPIC-WISE CSEE 2017

S/N	Topic/Subtopic	Question Number	The Percentage of Candidates who Passed	Remarks
1	Accounts	14	73.93	Good
2	Statistics	12	56.76	Average
3	Matrices and Transformations	15	25.59	Weak
4	Approximations, Radicals and Decimals	1	23.16	Weak
5	Rates and Variations	6	22.75	Weak
6	Algebra and Sets	3	19.03	Weak
7	Probability and Functions	16	15.85	Weak
8	Exponents and Logarithms	2	15.27	Weak
9	Vectors and Coordinate Geometry	4	14.59	Weak
10	Circles	13	8.31	Weak
11	Quadratic Equations	10	7.77	Weak
12	Linear Programming	11	7.02	Weak
13	Percentages	7	5.07	Weak
14	Trigonometry	9	3.41	Weak
15	Sequences and Series	8	2.70	Weak
16	Geometry and Similarity	5	2.48	Weak