# CANDIDATES' ITEM RESPONSE ANALYSIS REPORT ON DIPLOMA IN SECONDARY EDUCATION EXAMINATION (DSEE) 2022 

## MATHEMATICS

## THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

# CANDIDATES' ITEM RESPONSE ANALYSIS REPORT ON DIPLOMA IN SECONDARY EDUCATION EXAMINATION (DSEE) 2022 

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## FOREWORD

This report presents the Candidates' Items Response Analysis (CIRA) on the Diploma in Secondary Education Examination (DSEE) in Mathematics which was conducted in May 2022. This report aims to give feedback to all education stakeholders on the contributory factors to the candidates' performance in Mathematics. This summative evaluation measures the effectiveness of the teaching and learning process at the end of the course.

Moreover, the report aims to highlight the possible reasons behind the candidates' performance in the Mathematics subject examination. It also points out the factors that made some candidates score either low, average, or high marks. The factors that caused them to register low performance include partial knowledge of the topics assessed, failure to understand the requirements of the questions and their incorrect use of mathematical formula. On the other hand, candidates, who scored high marks, had adequate knowledge of the topics assessed and, therefore, the strength of their responses and clarity of their calculations added to their advantage. The general performance for this paper was average.

The National Examinations Council of Tanzania (NECTA) expects that the feedback provided in this report will shed light on the challenges for the education stakeholders to take proper measures aimed to improve the teaching and learning of the Mathematics subject. Ultimately, the students would acquire knowledge, skills and competences as stipulated in the syllabus for better performance in future examinations administered by the Council.

Overall, the Council appreciates the contribution of all those who participated in writing this report.


Athumani S. Amasi
EXECUTIVE SECRETARY

### 1.0 INTRODUCTION

This report analyses the performance of the candidates who had sat for the Mathematics subject for the Diploma in Secondary Education Examination (DSEE) in 2022. The examination was set in accordance with the Mathematics syllabus of 2009 and the examination format of 2021.

The examination had sections A and B. Section A had ten (10) questions. Each question carried four (4) marks, hence a total of forty (40) marks. Sections B had four (4) questions, each carrying fifteen (15) marks, making a total of sixty (60) marks. All the questions from each section were mandatory for the candidates to answer.

The analysis of the candidates' performance on each item considers the percentage of candidates who attempted the question and the percentage of those who scored various marks based on their responses. Additionally, the report presents samples of extracts of candidates' responses.

The report uses three categories of performance to analyse the candidates' performance for each topic. The performance classification is as follows: 70100 percent is good presented in green colour; 40-69 percent is average denoted by yellow; and 0-39 percent is weak performance and is marked by red. The candidates' performance for each topic is summarised in the Appendix. Finally, the report presents the conclusion and recommendations based on the analysis of the candidates' performance.

### 2.0 ANALYSIS OF THE CANDIDATES' RESPONSES IN EACH QUESTION

This part analyses both statistical data and candidates' responses on each question in Mathematics Subject. The statistics in each question are presented with the aid of figures or tables while the description of responses are supported by the use of extracts.

### 2.1 Section A: Short Answer Questions

In this section, there were ten (10) compulsory short answer questions. The candidates had to attempt all the questions. Each question carried four (4) marks, hence a total of forty (40) marks.

### 2.1.1 Question 1: Logic

Candidates were required to use symbols to test the validity of the argument: "If I like logic, I will study arguments. I will study arguments if and only if I have a logical mind. I do not like logic; therefore I will not study arguments." The question examined candidates' ability to apply knowledge of logical statements to simplify the compound statement and then interpret its meaning

A total of 1,291 ( $100 \%$ ) candidates attempted this question, whereas 796 ( $61.7 \%$ ) candidates failed after scoring from 0 to 1.5 marks, 113 ( $8.8 \%$ ) candidates scored from 3 to 4 marks and 382 (29.6\%) candidates scored from 2 to 2.5 marks. The general performance of the candidates in this question was weak since $61.7 \%$ of the candidates scores 0 to 1.5 marks. Figure 1 shows the performance of the candidates on question 1.


Figure 1: Candidates' Performance on Question 1
The data analysis reveals that the candidates who scored low marks ( 0 to 1.5) failed to interpret the requirements of the question. Some of them wrote the inverse, converse and contrapositive of the given statements instead of forming the compound statement, simplifying it and concluding.

Some candidates changed the given argument in symbolic form as; $p \rightarrow(p \leftrightarrow q) \sim p \vee \sim q$. They combined it wrongly to become $p \rightarrow(p \leftrightarrow q) \square(p \vee q)$ and concluded that the argument is valid. Others used the wrong truth table whose last column had truth values; $\mathrm{F}, \mathrm{T} ; \mathrm{F}, \mathrm{T} ; \mathrm{F}$, T , which is the wrong answer. Extract 1.1 shows the sample of the incorrect answers from one of the candidates.


Extract 1.1: A sample of incorrect responses to question 1.
In Extract 1.1, the candidate failed to understand the requirements of the question. Therefore, he/she wrote the converse, inverse and contrapositive of the wrongly formulated statements.

Despite the low performance of the candidates in this question, 113 (8.8\%) candidates scored between 3 to 4 marks. Such candidates recognised the requirements of the question. They formulated the compound statement correctly, simplified it and managed to prove that the argument was not valid. Others used the truth table to show that the argument was invalid as shown in Extract 1.2.


Extract 1.2: A sample of correct responses to question 1.
In Extract 1.2, the candidate used the truth table correctly to verify that the argument is invalid.
2.1.2 Question 2: Calculating Devices

This question assessed candidates' knowledge of writing the procedures for computing the determinant of a matrix $\left(\begin{array}{ccc}4 & 1 & 6 \\ 3 & -2 & 5 \\ 1 & 1 & 7\end{array}\right)$ using a nonprogrammable calculator. They were then required to compute the determinant of such a matrix.

A total of 1,291 ( $100 \%$ ) candidates attempted the question, 689 (53.4\%) candidates scored from 0 to 1.5 marks, $276(21.4 \%)$ candidates scored from

2 to 2.5 marks and $326(25.3 \%)$ candidates scored from 3 to 4 marks, The general performance of the candidates in this question was poor since 689 ( $53.4 \%$ ) candidates failed while 602 ( $46.7 \%$ ) scored from 2 to 4 marks. Figure 2 shows the performance of the candidates' on question 2.


Figure 2: Candidates' Performance on Question 2

The analysis of data shows that 689 (53.4\%) candidates got low marks in the question had inadequate knowledge of the steps for computing the determinant of a matrix using a non-programmable calculator. Some candidates wrote wrong steps that could not lead them to the required answer. For example, one candidate wrote the steps as follows; choose the row which you are going to use $\left(\begin{array}{ccc}4 & 1 & 6 \\ 3 & -2 & 5 \\ 1 & 1 & 7\end{array}\right)$, keep constant the first row and column in order to obtain the determinant of $\left|\begin{array}{cc}-2 & 5 \\ 1 & 7\end{array}\right|$, keep constant the second row and column in order to obtain the determinant of $\left|\begin{array}{ll}3 & 5 \\ 1 & 7\end{array}\right|$, keep constant the third row and column in order to obtain the determinant of $\left|\begin{array}{cc}3 & -2 \\ 1 & 1\end{array}\right|$ and if you are using first row you should join the determinants by $(+\quad-\quad+)$ by adding, subtracting and adding, which are wrong steps.

Other candidates used the long method for calculating the determinant of a matrix which led them to a wrong answer as shown in Extract 2.2.

| $A$ | $=\left(\begin{array}{ccc}4 & 1 & 6 \\ 3 & -2 & 5 \\ 1 & 1 & 7\end{array}\right)$ |
| ---: | :--- |
|  | $\|A\|=4\|-14-5\|-1\|5-21\|+6\|3+2\|-3\|7-6\|-2\|28-6\|$ |
|  | $-5\|3+2\|+\|\|5+12\|-1\| 20-18\|+7\|-8-3 \mid$ |
|  | $\|A\|=4(-19)-1 \mid-16)+6 \mid 6)-3(1)-2(22)-5(5)+1(17) \mid$ |
|  | $-1(2)+7(-11)$ |
|  | $\|A\|=-76+16+36-3-44-25+17-2-77$ |
|  | DeterminarfgMatix $A=15$ |
| $\therefore\|A\|=15$ |  |

Extract 2.2: A sample of incorrect responses to question 2.
In Extract 2.2, the candidate applied the long method of computing the determinant of a matrix which led him/her to a wrong answer.

On the other hand the candidates who scored all 4 marks allocated to this question was able to correctly write the steps required for computing the determinants of matrix. The steps are to set the nonprogrammable scientific calculator into matrix mode by pressing mode three times, and pressing key number 2 ; to choose the dimension of the matrix and name by pressing shift, then number 4 , followed by number $1,+$ number 1 for the name of the matrix; to insert the order of matrix; to insert the elements of the matrix by using the format; $\mathrm{A}=\left(\begin{array}{lll}A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33}\end{array}\right)$ and determine the determinant as follows; press shift +4 , press right arrow of cursor control button, select and insert the matrix A again. That is; press shift $+4,3,1$ then $=$, so that the
determinant, $|\mathrm{A}|=-62$. Extract 2.1 shows a sample of responses from one of the candidates who managed to attempt this question.

| First: Place Mode in non programmable calculator |
| :---: |
| then three time up to the word written |
| MAT which have an oppoition of 2 |
| Second: After that place shift followed by 4 ker |
| which written MAT, thon chose Dim which have |
| opposition of 1 |
| Third: After choose Dim will give you three |
| latter that $A, B, C$ so You neef to choose one |
| of tiom let sar $A$. that has apposition of |
| will give you a requet to fill how many |
| Column and row you matrix have ltian |
| $(m \times n)$ so feed $m=3, n=3$. |
| : After tiat You fill you eliment in sutemati |
| You Gart with $4,1,6,3,-2,5,1,1,7$ |
| Fifte: Place Ohift followed by key 4 . Then place rishe |
| direction will see Det which have apponition of |
| 1, then place Ghift followed byker 4 choose |
| Mat that has uppontion of 3, then flace 1 that |
| * a matrix A efter trat ylace equal ition |
| will sive you determinant that is -62 . |
| Hence |
| The Detorminant of Matrix $A$ is -62 . |

Extract 2.1: A sample of correct responses to question 2.
In Extract 2.1, the candidate wrote the correct steps of comparing the determinant using a non-programmable calculator.

### 2.1.3 Question 3: Planning and Preparation for Teaching Mathematics

This question examined candidates' ability to remember how to write the specific objectives of the lesson plan for teaching the sub-topic of "Elimination Method" as a method of solving the simultaneous equation.

The question was attempted by 1,291 ( $100 \%$ ) candidates, whereby 845 ( $65.5 \%$ ) candidates scored from 0 to 1.5 marks, 341 ( $23.7 \%$ ) scored from 2to 2.5 marks and a total of 101 ( $10.8 \%$ ) candidates scored from 3 to 4 marks. Therefore, the general performance of the candidates in this question was weak as majority candidates 845 ( $65.5 \%$ ) failed. Figure 3 shows performance of candidate on question 3 .


Figure 3: Candidates' Performance on Question 3

The analysis of data shows that most candidates failed to understand the requirement of the question. Some of them wrote the types of equations in Mathematics. For example, one candidate stated that by the end of 45 minutes of the lesson each student should be able to eliminate angles from the given equation, solve the equation with angles and identify the trigonometrical identities of the rational function.

Some candidates wrote the element of the lesson plan. For example, one candidate wrote: the titles; main topic, reinforcement, new knowledge, introduction reflection and consolidation. Some candidates listed the importance of simultaneous equations Extract 3.1 is a sample of the incorrect responses in the question.

| 3 | a) measurable of the sub-topic |
| :--- | :--- |
|  | b) valuable of the sub-topic |
|  | c) valichity of the sub-topic |
|  | d) Relevance of sub-topic. |

Extract 3.1: A sample of incorrect responses to question 3.
In Extract 3.1, the candidate listed the analysis of the sub topic focused on by the question.

On the other hand, 101 ( $10.8 \%$ ) candidates scored from 3 to 4 marks in the question. These candidates were able to remember the specific objectives of the lesson plan for teaching the sub-topic of "Elimination Method" as a method of solving the simultaneous equation. They were able to remember and write the correct objectives as indicated in Extract 3.2.


Extract 3.2: A sample of correct responses to question 3.
In Extract 3.2, the candidate wrote the correct specific objectives that were required.

### 2.1.4 Question 4: Coordinate Geometry II

Candidates were given that a cone has a radius of 18 cm and height of 20 cm . They were required to find the volume of a frustrum of the cone whose radius is 12 cm . This question aimed at assessing candidates' ability to apply the formula for calculating the volume of a frustrum.

The question was attempted by 1,291 ( $100 \%$ ) candidates, out of which $1,281(99.2 \%)$ candidates scored from 0 to 1.5 marks and 8 ( $0.6 \%$ ) candidates scored from 2 to 2.5 marks and only 3 ( $0.2 \%$ ) candidates scored from 3 to 4 marks. The general performance of the candidates in this question was weak. Table 1 gives a summary of the candidates' performance on question 4.

Table 1: Candidates' Performance on Question 4

| Percentage of the <br> Candidates | 99.2 | 0.6 | 0.2 |
| :--- | :---: | :---: | :---: |
| Grade (Marks range) | $0.0-1.5$ | $2.0-2.5$ | $3.0-4.0$ |

Most of the candidates failed to remember the correct formula for calculating the volume of a frustrum which is; $V=\frac{1}{3} \pi\left(R^{2} H-r^{2} h\right)$, where $H=20 \mathrm{~cm}, h=\frac{40}{3} \mathrm{~cm}, R=18 \mathrm{~cm}$ and $r=12 \mathrm{~cm}$. If $V=$ Volume of the frustrum, $R=$ radius of a cone, $H=$ height of the cone, $r=$ radius of a frustrum and $h=$ height of the frustrum.

Majority of them used the dimensions of the cone to calculate the volume of the frustrum while ignoring its dimensions. So they wrote the formula as; $V=\frac{1}{3} \pi\left(R^{2} H\right)$, and substitute in the values as; $V=\frac{1}{3} \pi\left(18^{2}(20)\right)$ to get $V=6,480 \mathrm{~cm}$ which is a wrong answer. Some of them used the same formula by substituting the dimensions of the frustrum only as; $V=\frac{1}{3} \pi\left(r^{2} h\right)=\frac{1}{3} \pi\left(12^{2}\left(\frac{40}{3}\right)\right)$, so they got $V=1,920 \mathrm{~cm}$ which is also a wrong answer. Most of the candidates applied a wrong formula to calculate the volume as revealed in Extract. 1.2.

| soln. |
| :---: |
| Radius $=18 \mathrm{~cm}$ |
| Height $=20 \mathrm{~cm}$ |
| From |
| $v=/ 1 \pi^{2} h$. |
| 3 |
| But |
| $v_{1}=1 / 3 \times \pi \times 18^{2} \times 20$ |
|  |  |
|  |
|  |
| $6785.8 \mathrm{~cm}^{3}=1 / 3 \times \pi \times 12^{2} \times h .$ |
|  |  |
|  |
| 3 |
| 20,357.4 $=452.16 \mathrm{~h}$ |
|  |
| $h=45.02 \mathrm{~cm}$. |
| $v=1 / \pi r^{2} h$ |
| 3 |
|  |
| $V=\frac{1 / 3}{3} \times 11 \times 144 \times 45 \cdot 02$ |
|  |  |
|  |
| $\therefore$ Volume is $6785.8 \mathrm{~cm}^{3}$. |

Extract 4.1: A sample of incorrect responses to question 4.
In Extract 4.1, the candidate used a wrong formula and wrong data, which resulted in an incorrect answer.

Despite the weak performance, $3(0.2 \%)$ candidates answered the question correctly. The candidates applied the correct formula for calculating the volume of the frustrum $V=\frac{1}{3} \pi\left(R^{2} H-r^{2} h\right)$ and used correct dimension values to get the required answer as shown in Extract 4.2.


Extract 4.2: A sample of correct responses to question 4.
In Extract 4.2, the candidate interpreted correctly all data and used the correct formula.

### 2.1.5 Question 5: Algebra

This question assessed candidates' ability to use knowledge of the imparted standard result for $\sum r^{2}$ and $\sum r^{3}$ to show that; $\sum_{r=1}^{n} r^{2}(r+1)=\frac{n}{12}(n+1)(n+2)(3 n+1)$ and how to evaluate $\sum_{r=6}^{10} r^{2}(r+1)$.

A total of $1,291(100 \%)$ candidates attempted this question, out of which $976(75.6 \%)$ candidates scored from 0 to 1.5 marks, 203 ( $15.8 \%$ ) candidates scored from 2 to 2.5 and 112 ( $8.7 \%$ ) scored from 3 to 4 marks. The general performance of the candidates in this question was weak as $75.6 \%$ of the candidate scored below the pass marks. Figure 4 illustrates the candidates' performance on question 5 .


Figure 4: Candidates' Performance on Question 5

The analysis of data in this question the candidates who scored zero marks applied incorrect formula for standard results as $\sum r^{2}$ and $\sum r^{3}$. Some of these wrote $\quad \sum r^{2}=\frac{n}{12}(n+1)(n+2)(3 n+1) \quad$ instead of $\sum r^{2}=\frac{n}{6}(n+1)(2 n+1) \quad$ and $\quad \sum r^{3}=\frac{n}{2}(n+1)(n+2) \quad$ instead $\quad$ of $\sum r^{3}=\frac{n^{2}}{4}(n+1)^{2}$, which resulted in wrong simplifications. Some changed the series into Arithmetic progression. For example, one candidate started by writing; $1+2+3+4+5 \ldots+(n+1)$ and proceeded with wrong procedures as revealed in Extract 5.1.


Extract 5.1: A sample of incorrect responses to question 5.
In Extract 5.1, the candidate used wrong formula and wrong data which resulted in an incorrect answer.

On the other hand, 315 (24.5\%) candidates scored marks from 2 to 4 . These candidates remembered the standard formula for $\sum r^{2}$ and $\sum r^{3}$. Thus, they made the correct substitution to the equation $\sum_{r=1}^{n} r^{2}(r+1)=\frac{n}{12}(n+1)(n+2)(3 n+1)$ and simplified it to get the correct answer as shown in Extract 5.2.


Extract 5.2: A sample of correct responses to question 5.
In Extract 5.2, the candidate used the correct formula and made the correct substitution, then simplified it to get the required answer.
2.1.6 Question 6: Assessment in Mathematics

The question assessed candidates' knowledge of identifying the distinction between the assessment and evaluation.

A total of 1,291 ( $100 \%$ ) candidates attempted the question, out of which $1,256(97.3 \%)$ candidates scored from 0 to 1.5 marks, 28 ( $2.2 \%$ ) candidates scored from 2 to 2.5 marks and 7 ( $0.6 \%$ ) candidates scored from 3 to 4
marks, The general performance of the candidates in this question was weak as 97.3 scored from 0 to 1.5 marks. Figure 5 shows the candidates' performance on question 6 .


Figure 5: Candidates' Performance on Question 6

The analysis of data shows that the candidates who failed to get the correct answer lacked knowledge of the difference between the assessment and evaluation. Most of the candidates failed to remember the difference between the two terms, likely due to the use of the word "distinction" instead of "difference"; Extract 6.1 shows responses of two candidates who wrote wrong answers.



Extract 6.1: Samples of incorrect responses to question 6.
On the other hand, seven candidates managed to respond in this question correctly. These knew the difference between the assessment and evaluation, as shown in Extract 6.2.


Extract 6.2: A sample of correct responses to question 6.

### 2.1.7 Question 7: Vectors

This question intended to examine candidates' ability to find the area of a parallelogram whose adjacent sides were given. They were given that; if the area of a parallelogram whose adjacent sides are $\underline{i}-2 \underline{j}+n \underline{k}$ and $2 \underline{i}+\underline{j}-4 \underline{k}$ is $5 \sqrt{6}$ and $5 \sqrt{6}$ square units, find the value of $n$.

A total of $1,291(100 \%)$ candidates attempted the question, whereby 1,056 ( $81.8 \%$ ) candidates scored from 0 to 1.5 marks, 17 ( $1.4 \%$ ) candidates scored from 2 to 2.5 marks and 218 ( $16.9 \%$ ) candidates scored from 3 to 4 marks. The general performance of the candidates in this question was weak as $1,056(81.8 \%)$ candidates failed. Figure 6 displays the performance of the candidates on question 7 .


Figure 6: Candidates' Performance on Question 7
The analysis of data shows that most of the candidates scored low marks due to the lack of knowledge of how to find the area of the parallelogram by using the concept of vectors. Some wrote the area as the dot product of the
given vectors as; Area $=\left(\begin{array}{c}\underline{i} \\ -2 \\ \underline{j} \underline{k}\end{array}\right) \bullet\left(\begin{array}{c}2 \underline{i} \\ \underline{j} \\ -4 \underline{k}\end{array}\right)=5 \sqrt{6}$ and proceeded to simplify it in order to get the value of $n$, which was a wrong procedure. Likewise, some candidates applied the definition of Pythagoras to find the area as; $a^{2}+b^{2}=c^{2}$ where $a$ and $b$ represented the two given vectors and $\mathbf{c}$ represented the area. So they calculated it as follows; $|a|^{2}+|b|^{2}=|c|^{2}$ for $a=\underline{i}+2 \underline{j}+n \underline{k}$ and $b=2 \underline{i}+\underline{j}-4 \underline{k}$ which was a wrong procedure.

Some candidates attempted finding the area by using the idea that, Area=base $\times$ height. So, they computed the value of $n$ by equating as; $5 \sqrt{6}=\left(\begin{array}{c}1 \\ -2 \\ n\end{array}\right) \times\left(\begin{array}{c}2 \\ 1 \\ -4\end{array}\right)$ as shown in Extract 7.1.

| Consider diagram of parallelogram below, |
| ---: |

Extract 7.1: A sample of incorrect responses to question 7.
In Extract 7.1, the candidate assumed the area to be equal to basexheight then multiply the values of the vectors.

The candidates who answered the question correctly expressed the area of the parallelogram as the cross product of the adjacent sides as follows: If $\underline{a}=\underline{i}-2 \underline{j}+n \underline{k}$ and $\underline{b}=\underline{2}+\underline{j}-4 \underline{k}$ It implies that;

$$
\underline{a} \times \underline{b}=\left|\begin{array}{ccc}
\underline{i} & \underline{j} & \underline{k} \\
1 & -2 & n \\
2 & 1 & -4
\end{array}\right|
$$

$\underline{a} \times \underline{b}=(8-n) \underline{i}+(-4-2 n) \underline{j}+5 \underline{k}$

The area of the parallelogram is given by; $|\underline{a} \times \underline{b}|$, then preceded to the correct answer. Extract 7.2 shows one of the candidates' correct responses in question 7.


Extract 7.2: A sample of correct responses to question 7.
In Extract 7.2, the candidate used the correct formula and simplified it to get the required answer.

### 2.1.8 Question 8: Differentiation

This question assessed candidates' knowledge of the application of differentiation in moving objects. The candidates were given that; at any time $t$ seconds the distance $x$ meters of a particle moving in straight line from a fixed point is given by $x=4 t+\ln (1-t)$, then they were asked to determine:
(a) the velocity and acceleration after 1.5 sec .
(b) the time when the particle is at rest.

The question was attempted by $1,291(100 \%)$ candidates, out of which $1,136(88 \%)$ candidates scored from 0 to 1.5 marks 1,136 ( 88 ), 8 ( $6.4 \%$ ) scored from 2 to 2.5 marks and 72 ( $5.6 \%$ ) scored from 3 to 4 marks. Hence, the general performance in this question was weak. Figure 7 shows the performance of the candidates on question 8.


Figure 7: Candidates' Performance on Question 8
The analysis shows that $1,136(88 \%)$ candidates who scored between 0 and 1.5 marks in this question were not aware that the velocity of a particle is the derivative of the distance moved by the particle, while the acceleration is the second derivative of the distance. Some candidates wrote the formula for velocity as; Velocity=$=\frac{\text { Distance }}{\text { Time }}$ in part (a) and that when the object is at rest, the time $=0$. Such candidates failed to get the required velocity in part
(a) and time in part (b). Some candidates failed to identify the given distance due to the lack of knowledge of the differentiation of natural logarithm. They wrote $x=4 t+\ln (1-t)$ then, $\frac{d x}{d t}=4-\ln (1-t)$ and $\frac{d^{2} x}{d t^{2}}=\ln (1-t)$. From here, they substituted the given time to get wrong velocity and time. Some candidates used the integration instead of differentiation as indicated in extract 8.1.


Extract 8.1: A sample of incorrect responses to question 8.
In Extract 8.1, the candidate incorrectly integrated part of the given distance to obtain the velocity.

Nevertheless, 72 ( $5.6 \%$ ) candidates who scored from 3 to 4 marks were able to remember and use knowledge of the differentiation to get the velocity and the second derivative to get the acceleration. They remembered that the time when a particle is at rest is obtained if the velocity is equal to zero. So, they wrote as; Distance $x=4 t+\ln (1-t)$, Velocity $=\frac{d x}{d t}+\frac{-1}{1-t} \quad$ and Acceleration $=\frac{d^{2} x}{d t^{2}}$. Thereafter, they used the given data properly to get the correct answer (as shown in extract 8.2)


Extract 8.2: A sample of correct responses to question 8.
In Extract 8.2, the candidate used the correct procedures and made a good substitution of data to get the required answer.

### 2.1.9 Question 9: Linear Programming

Candidates were given the graphical representation of a certain linear programming problem shown below;


They were required to:
(a) identify the corner point of the feasible region.
(b) list the constraints of the linear programming model.
(c) find the minimum and maximum corner points of the feasible region, if the objective function of the linear programming model is

$$
f(x, y)=12000 x+15000 y,
$$

A total of $1,291(100 \%)$ candidates attempted the question. Out of which 213 ( $16.5 \%$ ) candidates scored from 0 to 1.5 marks, 330 ( $25.6 \%$ ) scored from 2 to 2.5 marks and 748 ( $57.9 \%$ ) candidates scored from 3 to 4 marks. The general performance of the candidates in the question was good since $1,078(83.5 \%)$ candidates scored from 2 to 4 marks. Figure 8 presents a summary candidates' performance on question 9 .


Figure 8: Candidates' Performance on Question 9
The analysis shows that many candidates managed to answer this question correctly. The candidates were able to identify all the requirements that allowed the candidates to answer the question correctly. Extract 9.1 is a sample of the correct answers from one of the candidates.


Extract 9.1: A sample of correct responses to question 9.
In Extract 9.1, the candidate remembered how to find the corner points, constraints and optimum values required.

On the other hand, $213(16.5 \%)$ candidates failed to get it correctly due to the inability to identify the corner points of the graph, constraints and optimum values. Some of them wrote imaginary points estimated by looking at the graph. Some copied the written constraints from the graph.

Extract 9.2 is a sample of the incorrect responses from a candidate who failed to read the graph hence wrote incorrect answers.


Extract 9.2: A sample of incorrect responses to question 9.
In Extract 9.2, the candidate wrote estimated points and therefore failed to get the optimum values required.

### 2.1.10 Question 10: Planning and Preparation for Teaching Mathematics

This question examined candidates' ability to remember the essential aspects in preparation of the table of specifications. The question required the candidates to outline four essential aspects.

The question was attempted by $1,291(100 \%)$ candidates out of which n 405 ( $31 \%$ ) scored from 0 to 1.5 marks, 333 ( $25.8 \%$ ) scored from 2 to 2.5 marks and $553(42.8 \%)$ candidates scored from 3 to 4 marks. The general
performance of the candidates in this question was average, since 886 $(68.6 \%)$ candidates scored from 2 to 4 marks. Figure 9 shows the performance of the candidates on question 10.


Figure 9: Candidates' Performance on Question 10

The analysis of the candidates who managed to answer this question correctly remembered the essential aspects about the construction of the table of specifications as shown in Extract 10.1.


Extract 10.1: A sample of incorrect responses to question 10.
In Extract 10.1, the candidate remembered and outlined the correct requirements in the preparation of the table of specifications.

Meanwhile, 220 ( $17 \%$ ) candidates scored zero marks due to failure to remember the requirements in constructing the table of specifications. Some candidates in this category wrote the Bloom's taxonomy levels, where
others wrote the procedures for preparing the scheme of work. Some wrote the steps for preparing the lesson plan. Extract 10.2 shows the sample of the wrong answers from one of the candidates.

| 10 | $\Rightarrow$ Essenfial whenpueparing table specification. |
| :---: | :---: |
|  | 1) To identery topic or content. |
|  | 1) To identify table speciflcatzon compo |
|  | nent like knowledge |
|  | ii) To dentify or show percentage of each |
|  | topic |
|  | (v) To show all percentage. |
|  | Table specificatron component are - |
|  | 1) Knowledse |
|  | ii) Comprehesion |
|  | iii) Application |
|  | IV) Analusis |
|  | v) Synthesis |
|  | vi) Evalaation. |

Extract 10.2: A sample of incorrect responses to question 10.
In Extract 10.2, the candidate wrote the procedures for preparing a test instead of the essential aspects in the preparation the table of specifications.

### 2.2 Section B: Essay Questions

This section had four compulsory questions. Each question carried fifteen (15) marks, hence a total of sixty (60) marks.

### 2.2.1 Question 11: Hyperbolic Functions

The question assessed candidates' knowledge of the properties and identities of hyperbolic functions. They were required to determine the condition, such that the equation $a \cosh x+b \sinh x=c$ has equal roots.

The question was attempted by 1,291 ( $100 \%$ ) candidates, ought of which $54.2 \%$ scored from 0 to 5.5 marks, $23.3 \%$ scored from 6 to 10 marks and $22.5 \%$ scored from 10.5 to 15 marks. The general performance of the candidates in the question was weak as $54.2 \%$ scored from $0-5.5$ marks. Figure 10 shows the performance of the candidates on question 11.


Figure 10: Candidates' Performance on Question 11

The analysis of data shows that 700 ( $54.4 \%$ ) candidates who scored from 0 to 5.5 marks, had an inadequate knowledge of the definitions of hyperbolic functions. Their challenge was on how to define $\cosh x$ and $\sinh x$. some of them failed to understand the requirement of the question, given that they wrote conditions such as; the same trigonometric identity, are trigonometric of $\sin$ and cos, are trigonometric functions and there is a hyperbolic function of $\sin$ and cos. Some of them used the triangle to define trigonometric ratios to define hyperbolic functions. As a result, they failed to provide the correct definition of hyperbolic functions. Some candidates failed to understand the difference between hyperbolic functions and conic sections as shown in Extract 11.2.


Extract 11.2: A sample of incorrect responses to question 11.
In Extract 11.2, the candidate wrote the procedures for formulating the formula for an ellipse in conic sections which was not the requirement of the question.

On the other hand the candidates who scored high marks were knowledgeable on how to use the identities of hyperbolic functions. As a result, they defined $\cosh x$ and $\sinh x$ correctly as; $\cosh x=\frac{e^{x}+e^{-x}}{2}$ and $\sinh x=\frac{e^{x}-e^{-x}}{2}$, then made substitution and simplification correctly as shown in Extract 11.1.



Extract 11.1: A sample of correct responses to question 11.

In Extract 11.1, the candidate remembered the identities used to define hyperbolic functions and simplified it correctly to get the correct answer.

### 2.2.2 Question 12: Integration

This question assessed the candidates' ability to apply the integration to find the area of a curve. They were given the following word problem: "A curve passes through point $P$, where $x=0$ and $y=1$. If the gradient at any point is $\frac{3}{2}+x-\frac{1}{2} x^{2}, "$ the candidate were asked to find the equation of the curve and the area enclosed by the curve, $x$-axiswith the ordinates $x=1$ and $x=3$.

The question was attempted by 1,291 ( $100 \%$ ) candidates, of whom, 1,242 ( $96.2 \%$ ) candidates scored from 0 to 5.5 marks, 38 ( $2.9 \%$ ) candidates scored from 6 to 10 marks and 11 ( $0.9 \%$ ) candidates scored from 10.5 to 15 marks. The general performance in this question was weak since $96.2 \%$ of the candidates score below pass marks. Figure 11 shows the performance of the candidates on question 12.


Figure 11: The candidates' Performance on Question 12
The data analysis in Figure 11 shows, 96.2 per cent, equivalent to 1,242 candidates obtained low marks. These candidates failed to interpret the given problem to form the equation and apply the integration techniques to find the area of the curve.

Most of the candidates used the given ordinates $x=1$ and $x=3$ as the limits of the curve to find the area by using the equation of the gradient
$\frac{3}{2}+x-\frac{1}{2} x^{2}$. So they calculated the area as follows; Area $=\left[\frac{3}{2}+x-\frac{1}{2} x^{2}\right]_{3}^{1}$.
Then, they simplified this to get Area $=2$ sq units, which is a wrong answer. Some tried to find the slope of the given curve which is also a wrong procedure. Some candidates used the idea of both derivatives and integration, as shown in Extract 12.1.


Extract 12.1: A sample of correct responses to question 12.
In Extract 12.1, the candidate used the integration method to find the slope which was not the requirement of the question.

However, 11 ( $0.9 \%$ ) candidates scored from 10.5 to 14.5 marks. Such candidates knew the application of the integration in calculating the area of
the curves. They managed to formulate the equation and got the correct limits to use in finding the area of the curve. Extract 12.2 shows the appropriate answer from one of the candidates.



Extract 12.2: A sample of incorrect responses to question 12.
In Extract 12.2, the candidate managed to find the equation and the area correctly.

### 2.2.3 Question 13: Analysis of Mathematics Curriculum Materials

The question required the candidates to briefly explain five merits of the improvisation of the teaching and learning resources.

The question was attempted by 1,291 ( $100 \%$ ) candidates out of which 25 ( $1.9 \%$ ) candidates scored from 0 to 5.5 marks, of which 5 ( $0.4 \%$ ) candidates scored zero mark, 545 ( $42.2 \%$ ) candidates scored from 6 to 10 marks and $721(55.8 \%)$ candidates scored from 10.5 to 15 marks. Therefore, the general performance of the candidates in this question was good since 1,266 ( $98 \%$ ) scored from 6 to 15 marks. Figure 12 displays the candidates' performance on question 13.


Figure 12: The candidates' Performance on Question 13

The analysis of data shows that the candidates who scored 10.5 marks and above, were able to present the importance of improvisation of teaching and learning resources because they have been doing it in their training. Extract 13.1 shows an example of the correct responses in this question.

Improvisation of leaching, and earning resources is the process of updating /repreckuing the mateinals/thinas known as dirty in order fomake be useful. Improvisation is the itheation where by the resounds that decrease the effuicite of work ass improved in order to work efficiency, forexample when we talking a bout training andlearming resources are computer, projector, Television, reach s broactiast, smartphone et.
Improvisation has the following merits in effectue teaching and learning.'

It helps to simplify the whole process of teaching and learning:- A teacher can use thole improvisation resources during teaching session effectively because when the verounes are improvised It improved the efficiency of work example computes prosector et ".

It decrease cost:- instead of teacher going to buy new teaching and learning resources helshe improvise that resources in order to save money, so a mathematics teacher can use improvisation resources instead of using aloft of money to buy another resources.

It saves time:- forrxample when a teacher Each though radio and that rachis does not have signal lt is difficult to a cher teacher to intend or achieve histher objectives but when that device hasebeen improvised it is easy to teach and for time planned.


Extract 13.1: A sample of correct responses to question 13.
In Extract 13.1, the candidate wrote the correct merits of the teaching and learning resources.

Moreover, 25 ( $1.9 \%$ ) candidates who attempted this question scored low marks because they were unable to explain the importance of teaching and learning resources. Some of them defined the meaning of the effective teaching and learning, then explained the importance of the effective teaching and learning instead of explaining the importance of the teaching and learning resources. Others explained the importance of books, teacher's guide and textbooks as the teaching and learning resources. Extract 13.2 is a sample of the incorrect response from one of the candidates.


Extract 13.2: A sample of incorrect responses to question 13.
In Extract 13.2, the candidate explained the importance of books, teachers guidelines and manuals instead of the teaching and learning resources in the local environment.

### 2.2.4 Question 14: Analysis of Mathematics Curriculum Materials

This question examined candidates' competence to analyse the mathematics curriculum materials. They were required to justify the contention by giving four points, "In spite of having the relevant textbook for lesson preparation, a Mathematics teacher is still required to have a syllabus."

The question was attempted by $1,291(100 \%)$ candidates of which 49 ( $3.8 \%$ ) scored from 0 to 5.5 marks, 175 ( $13.6 \%$ ) scored from 6 to 10 marks and $1,067(82.6 \%)$ scored from 10.5 to 15 marks. The general performance of the candidates in this question was good as 1,242 ( $96.2 \%$ ) candidates scored from 6 to 15 marks. The candidates' performance is illustrated in Figure 13.


Figure 13: Candidates' Performance on Question 14.
The analysis of data shows that most of the candidates answered this question correctly because they were familiar with the planning and preparation for teaching in their day to day activities. Thus, they were able to explain the use of the syllabus because they use it in their daily learning process. Extract 14.1 is a sample of the correct responses in the question.

Syllabus Refer to the curriculum mate rat that a contain the list of Topic and their leaching tools aspell as objectives of the whole subject. The syllabus its divided info two topes also $1 \frac{1}{}$ every subject they have a specially syllabus like Geography, Hrstoms and Bulosy Also Mathematic syllabus: Inspite of the textbook but the mathematics leader should be have the syllabus.

The following are the function of five syllabus to the Mathematics teacher:

Its Use for the preparation of $s$ cheme of work and lesson plane, is means that If they have the toxbook but we need the Mathematic is syllabus for the preparation Of the scheme of work and lesion plane soft one among the importance.

Its show the time bonding for each
topic its Mean that the syllabus they show the topic and their time to learn forexample from January upte februans the leacher should be to leach the one topic only. so the leader was latoresled to use it. it's like.

Its glide a teacher a number of period that used fer each subtopic : Itrmans that the teacher espeaafly the Matte mates Teachemill be Used, them suas to increase their effectively because the text book diduot shew the pen od of the each lopic


Extract 14.1: A sample of correct responses to question 14.
In Extract 14.1, the candidate remembered and listed the advantages of syllabus over the textbook.

However, 49 ( $3.8 \%$ ) candidates got low marks in the question. This was due to misunderstanding of the requirement of the question. Some of them defined the term "relevant textbook" instead of explaining the advantages of the syllabus compared to the textbook during the preparation of the lesson plan. Some listed the differences between the textbook and the syllabus. Extract 14.2 is a sample answer from a candidate who failed to understand the requirement of the question.


Extract 14.2: A sample of incorrect responses to question 14.
In Extract 14.2, the candidate explained the characteristics of the textbook instead of the importance of the syllabus in the preparation of the lesson plan.

### 3.0 THE ANALYSIS OF THE CANDIDATES' PERFORMANCE IN EACH TOPIC

The analysis of the candidates' performance in each topic shows that two topics out of 12 topics examined had a good performance. The topics were; Analysis of Mathematics Curriculum Materials (97.1\%), and Linear Programming (83.5\%).

Three topics with an average performance, were; Planning and Preparation for Teaching Mathematics (51.6\%), Calculating Devices (46.7\%) and Hyperbolic Functions (45.8\%). Further analysis shows that the candidates had a weak performance in seven topics, namely Coordinate Geometry II (0.8\%), Assessment in Mathematics (2.7\%), Integration (3.8\%), Differentiation (12\%), Vector (18.3\%), Algebra (24.5\%) and Logic (38.4\%). The weak performance was due to candidates' lack of knowledge of the formula and techniques required for calculating given questions from the topics.

More analysis shows that three questions had a good performance. These questions were numbers: 13 ( $98.0 \%$ ), 14 ( $96.2 \%$ ) and question 9 ( $83.5 \%$ ). Questions with an average performance were numbers 10 (68.6\%), 2 (46.7\%) and $11(45.8 \%)$. Furthermore, questions with a weak performance were numbers: 4 ( $0.8 \%$ ), $6(2.7 \%), 12(3.8 \%), 8(12 \%), 7(18.3), 5(24.5 \%)$ and 1 $(38.4 \%)$. The candidates scored low marks because of failure to the interpret the questions' requirements and the lack of sufficient skills in mathematical concepts. Some made errors in performing mathematical computations.

### 4.0 CONCLUSION

The general performance in 740-Mathematics subject in 2022 examination dropped by $23.8 \%$ compared to that of 2021. In 2022, the average performance is $41.0 \%$ while an overall average score in 2021 was $64.8 \%$. The performance of candidates on Vector topic has been poor for three consecutive years (from 2020 to 2022). In 2020, the performance was 21.3 per cent; in 2021 it was. 1.6 per cent while in 2022 it is 18.3 per cent in 2022. This problem can be attributed to the candidates' failure to interpret questions and inadequate competence in applying the relevant formula.

### 5.0 RECOMMENDATIONS

In order to improve the performance of the prospective candidates, it is recommended that:
(a) tutors should be advised to teach students various techniques of answering different questions and guide them on how to identify the requirements of questions by giving them regular exercises, tests and examinations.
(b) students teachers should be encouraged to read various recommended readings, including textbooks and reference books, in order to acquire more knowledge and skills in Mathematics.
(c) tutors should enhance their skills in teaching various mathematical topics, for example, they should use group discussions and presentations, internet search, Library search, pair reflections and the use of project work.
(d) students should be encouraged to form mathematics clubs that will help them to gain techniques in different types of questions so that they widen their ability to solve the mathematical problems.

## APPENDIX

## SUMMARY OF THE CANDIDATES' PERFORMANCE IN MATHEMATICS SUBJECT

| 2021 |  |  |  |  |  | 2022 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\underset{\sim}{Z}$ | $\begin{aligned} & 0 \\ & 0 \\ & 0 \end{aligned}$ |  |  |  |  |  |  |  |  |
| 1 | Analysis of Mathematics Curriculum Materials | 9 | 98.1 | 98.1 | Good | 13 <br> 14 | $98$ $96.2$ | 97.1 | Good |
| 2 | Linear <br> Programming | 12 | 83.2 | 83.2 | Good | 9 | 83.5 | 83.5 | Good |
| 3 | Planning and preparation for teaching Mathematics | $\frac{14}{16}$ | 98.3 <br> 99.0 | 98.7 | Good | 3 10 | 34.5 68.6 | 51.6 | Average |
| 4 | Calculating Devices | - | - | - | - | 2 | 46.7 | 46.7 | Average |
| 5 | Hyperbolic <br> Functions | - | - | - | - | 11 | 45.8 | 45.8 | Average |
| 6 | Logic | - | - | - | - | 1 | 38.4 | 38.4 | Weak |
| 7 | Algebra | 11 | $\begin{array}{r} 49.6 \\ \hline 57.4 \end{array}$ | 53.5 | Average | 5 | 24.5 | 24.5 | Weak |


| 2021 |  |  |  |  |  | 2022 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\underset{\sim}{Z}$ | - |  |  |  |  |  |  |  |  |
| 8 | Vector | 10 | 1.6 | 1.6 | Weak | 7 | 18.3 | 18.3 | Weak |
| 9 | Differentiation | 1 | 81.3 | 81.3 | Good | 8 | 12 | 12 | Weak |
| 10 | Integration | 7 | 52.4 | 52.4 | Average | 12 | 3.8 | 3.8 | Weak |
| 11 | Assessment in Mathematics | - | - | - | - | 6 | 2.7 | 2.7 | Weak |
| 12 | Coordinate Geometry II | 2 8 | 61.1 37.3 | 49.2 | Average | 4 | 0.8 | 0.8 | Weak |

