THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEM RESPONSE ANALYSIS REPORT ON THE FORM TWO NATIONAL ASSESSMENT (FTNA) 2025

MATHEMATICS

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

STUDENTS' ITEM RESPONSE ANALYSIS REPORT ON THE FORM TWO NATIONAL ASSESSMENT (FTNA) 2025

043 MATHEMATICS

Published by:

The National Examinations Council of Tanzania,

P.O. Box 2624,

Dar es Salaam, Tanzania.

Table of Contents

FOREWORD

The National Examinations Council of Tanzania (NECTA) presents the Students' Item Response Analysis (SIRA) report for the 2025 Form Two National Assessment (FTNA) in Mathematics.

This report fulfils the Council's mandate to monitor and improve educational quality through systematic assessments and evidence-based evaluations. It provides a detailed analysis of student response patterns at both the item and competence levels, offering valuable insights into learner achievement, curriculum implementation, and instructional effectiveness in ordinary secondary schools in Tanzania.

The findings aim to assist educators, curriculum developers, and policymakers in making informed decisions to address teaching and learning challenges. Hence, guide stakeholders' interventions expected to improve mathematics teaching, learning, and assessment practices in ordinary secondary schools.

The Council sincerely appreciates the examination officials, subject experts, and all professionals who dedicated their time and expertise in preparing this report. Their commitment has played a crucial role in ensuring the thoroughness, accuracy and overall quality of the findings presented.

Prof. Said Ally Mohamed

EXECUTIVE SECRETARY

1.0 INTRODUCTION

The 043 Mathematics assessment paper for the Form Two National Assessment (FTNA) 2025 was set in accordance with the Mathematics Syllabus for Ordinary Secondary Education (2023) and the 2025 assessment format. The paper consisted of ten (10) compulsory questions, each worth ten (10) marks, making a total of 100 marks.

A total of 2,199 students sat the examination, achieving a pass rate of 40.54 per cent. The grade distribution is shown in Figure 1.

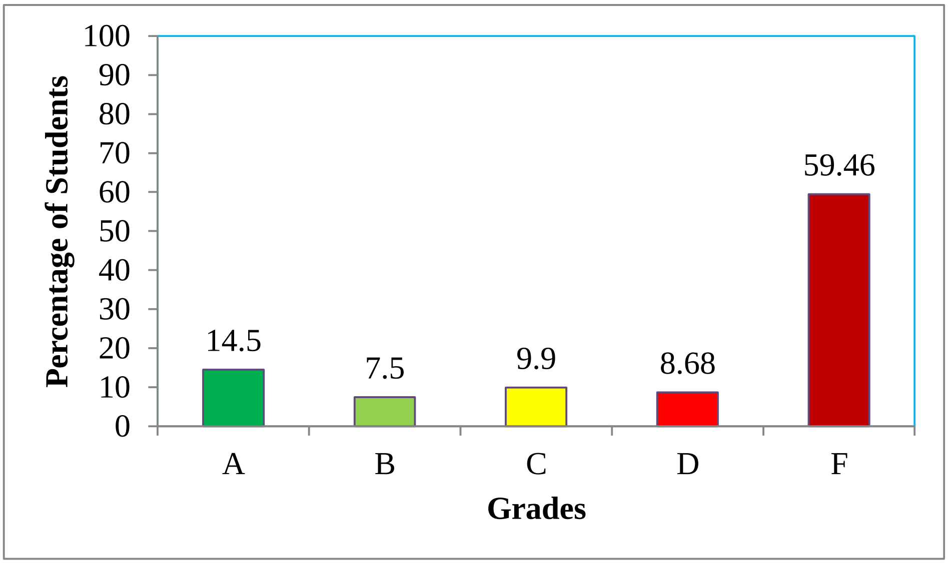


Figure 1: *Distribution of Students by Grade in 2025*

The observed grade distribution is strongly bimodal, with the majority of students (59.46%) failing, while (14.5%) scored grade A. Intermediate grades (B, C and D) represent only 26.04% of students. This pattern indicates limited instructional effectiveness in the learning process and suggests the need for instructional interventions by stakeholders.

This report is organised into four sections: Section 1 presents a general introduction; Section 2 offers a competence-based analysis of student responses. Section 3 presents a comprehensive, competence-based assessment of performance aligned with the syllabus; Finally, section 4 provides a conclusion and recommendations. Appendices I and II contain detailed performance data, providing supplementary evidence to support informed decision-making by education stakeholders.

2.0 ANALYSIS OF STUDENTS' RESPONSES TO EACH QUESTION

Students' overall performance on each question is classified by the proportion of students who scored 3.0 marks or above. The performance is categorised as follows: good (65–100%), average (30–64.9%), and weak (0–29.9%). In the graphs and charts presented, these categories are represented by colours; green, yellow and red, respectively. The subsequent analysis systematically evaluated the competencies demonstrated by students on each examined knowledge, concept or skill, as shown by extracts highlighting actual students' responses.

2.1 Question 1: Use Numerical Skills, Ratios and Proportions in Daily Life

This question examined students' ability to convert repeating decimals into fractions and solve ratio and proportion problems. The question was as follows:

(a) *Convert* $2.1\dot{3}$ *into a fraction.*

(b) *(i)* *A village has 150 people, of which 80 are women, and the rest are men. What is the ratio of men in the village?*

(ii) *If* $a:b = 21:45$, *express* $(2a+b):(a+2b)$ *in its lowest form.*

As shown in Figure 2, about 48.89 per cent (1,075 students) scored 3.0 or higher, indicating that overall student performance on this question was average.

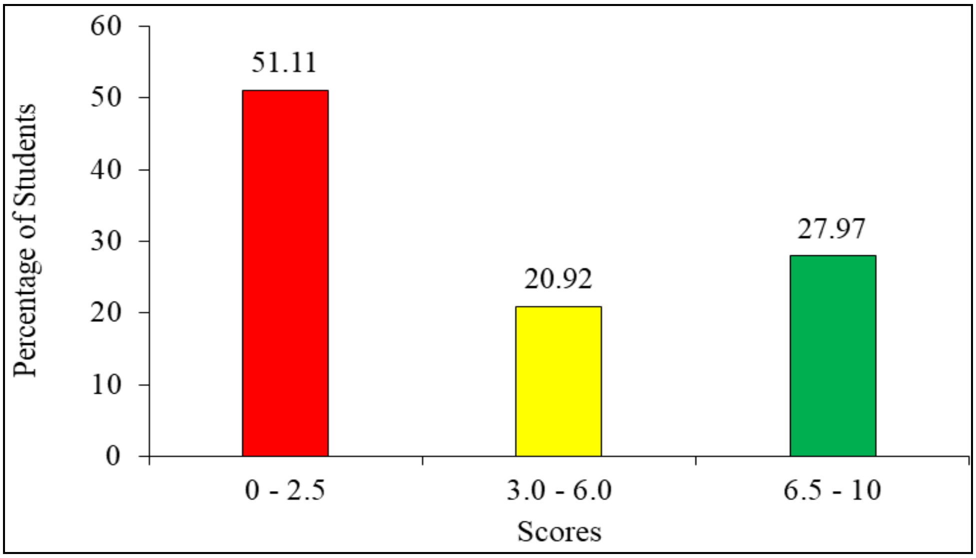


Figure 2: *Students' performance on question 1*

In this question, 243 (11.05%) students correctly responded to all parts. In part (a), most of these students opted to solve the problem by first cancelling out the recurring decimal part. They let the recurring decimal $2.1\dot{3}$ be represented by a variable, particularly x, producing an equation $x = 2.1\dot{3}$ and named it as (i). They then multiplied both sides of the equation by 10, resulting in equation that was named as (ii). Next, they subtracted equation (i) from equation (ii) and resulted in an equation $90x = 192$ and consequently $x = \frac{32}{15}$ or $x = 2\frac{2}{15}$. Other students opted to respond to this part without cancelling the recurring decimal, as in Extract 1.1.

In part (b) (i), students who correctly recognised that the total number of people in the village is 150 and noted that 80 of them were women. They then found the number of men by subtracting the number of women from the total population, giving 70 men. After that, they expressed the ratio of men to the total number of people in the village as $70:150$ and finally $7:15$ after simplification.

In part (b) (ii), The students who responded by first expressing a and b in terms of a common multiplier. They let $a = 21k$ and $b = 45k$, where k is a constant. They then substituted these expressions into the ratio

$(2a+b):(a+2b)$ producing $2(21k)+45k:21k+2(45k)$, giving $87k:111k$ and simplified to $29:37$.

1. (a) Covert $2.1\dot{3}$ into fraction.

let $x = 2.1\dot{3}$ ----(i)
$10 \times x = 2.1\dot{3} \times 10$
$10x = 21.\dot{3}$ ----(ii)
(ii - i)
$10x - x = 21.\dot{3} - 2.1\dot{3}$
$\frac{9x}{9} = \frac{19.2}{9}$
$x = 32/15$
$\therefore \underline{2.1\dot{3} = 32/15}$

Extract 1.1: A sample of correct responses to question 1

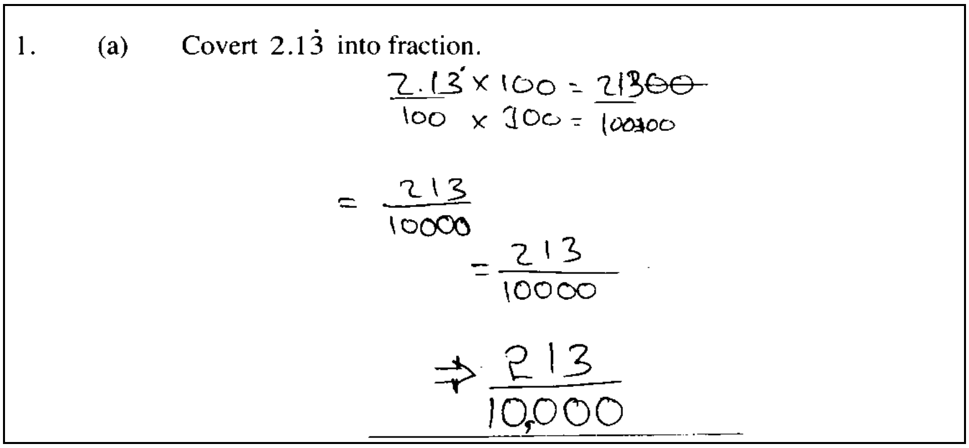
In Extract 1.1, the student correctly formulated equations $x = 2.1\dot{3}$ and $10x = 21.\dot{3}$ and used them to get $\frac{32}{15}$.

On the other hand, 1,956 (88.95%) students lost some marks in this question, due various weaknesses. In part (a), many students treated the recurring decimal as terminating one as a result, they wrote $2.1\dot{3} = \frac{213}{100}$. Some students wrongly identified the repeating part. For instance, most of these students assumed that both digits after the decimal point were recurring. They misinterpreted $2.1\dot{3}$ as $2.\dot{1}\dot{3}$, resulting in an incorrect fraction $2.1\dot{3} = \frac{213}{100}$ instead of $2\frac{2}{15}$. While other students used the correct algebraic method but set it up incorrectly, showing confusion in aligning the recurring digits before subtraction. They correctly wrote $x = 2.1\dot{3}$ and $10x = 21.\dot{3}$ and then subtracted incorrectly to get $9x = 19$ instead of $9x = 19.2$, leading to an incorrect fraction $2\frac{1}{9}$. There were also some cases where students formed the correct equation but made arithmetic mistakes.

For example, after obtaining $9x = 19.2$, some divided incorrectly and wrote $x = \frac{19.2}{90}$. Furthermore, few students reached a correct fraction but failed to simplify it to its lowest terms, leaving $\frac{192}{90}$ as the final answer.

In part (b) (i), some students (qualify it by writing the number or percentage) wrote 80:150 or 8:15, indicating that the number of men is 80 (instead of 70) . They were supposed to subtract the number of women (80) from the total population (150), to get the correct number of men (70), and consequently, a correct ratio of 7:15. Another misconception involved misunderstanding what "the ratio of men in the village" meant. For example, some students assumed the ratio was men to women and wrote the incorrect ratio, 70:80. This interpretation was incorrect because it was based on the number of men and women. In contrast, the question is based on the number of men and total population in the village. Some students expressed the answer as a fraction or a percentage rather than a ratio. For instance, they wrote $\frac{70}{150}$ or 46.7%, instead of 7:15 . It was also noted that some students correctly formed the ratio but did not simplify it. For example, they wrote 70:150 which is not , in its simplest form.

In part (b) (ii), some students misinterpreted ratios. For instance, some students incorrectly interpreted the ratio $a:b = 21:45$ as $a = 21$ and $b = 21 + 45 = 66$, which is incorrect. Using this wrong interpretation, they worked on incorrect expressions $2a + b = 2(21) + 66$ and $a + 2b = 21 + 2(66)$, leading to entirely incorrect ratios. Some students also made incorrect substitutions, which led to errors in forming the expressions. In particular, some students incorrectly wrote $2a + b$ as $2(a + b)$, resulting in $2(21 + 45) = 132$ instead of 87. Another frequent weakness was failure to simplify the final ratio to its lowest terms. Even when students correctly obtained values such as 58:74, some left the answer unsimplified or simplified it incorrectly. For instance, some students wrote $58:74 = 29:32$, showing an error in dividing both terms by a common factor. Extract 1.2 shows a response of one of the students who incorrectly answered this question.


1. (a) Covert $2.1\dot{3}$ into fraction.

$\frac{2.13}{100} \times \frac{100}{300} = \frac{213\cancel{00}}{100300}$

$= \frac{213}{10000}$

$= \frac{213}{10000}$

$\Rightarrow \frac{213}{10,000}$

Extract 1.2: *A sample of incorrect responses to question 1*

In Extract 1.2, the student did not recognise repeating digits in a given decimal and also failed to identify the appropriate factor for multiplication.

2.2 Question 2: Use Rates and Variations in Different Contexts

The question intended to assess students' competence in solving problems involving rates and variations. It consisted of the following parts:

(a) *How much is 136 USD worth in Tanzanian Shillings if $1USD = Tshs\ 2{,}650$?*

(b) *A truck travels 600 kilometres in 10 hours while a bus travels the same distance in 7.5 hours.*

(i) *Calculate the speed of each vehicle.*

(ii) *Which vehicle travels faster?*

The data show that 1,319 (59.98%) students scored between 3.0 and 10. Therefore, students' performance on this question was generally average. Figure 3 shows the percentage of students with low, average, and good performance on this question.

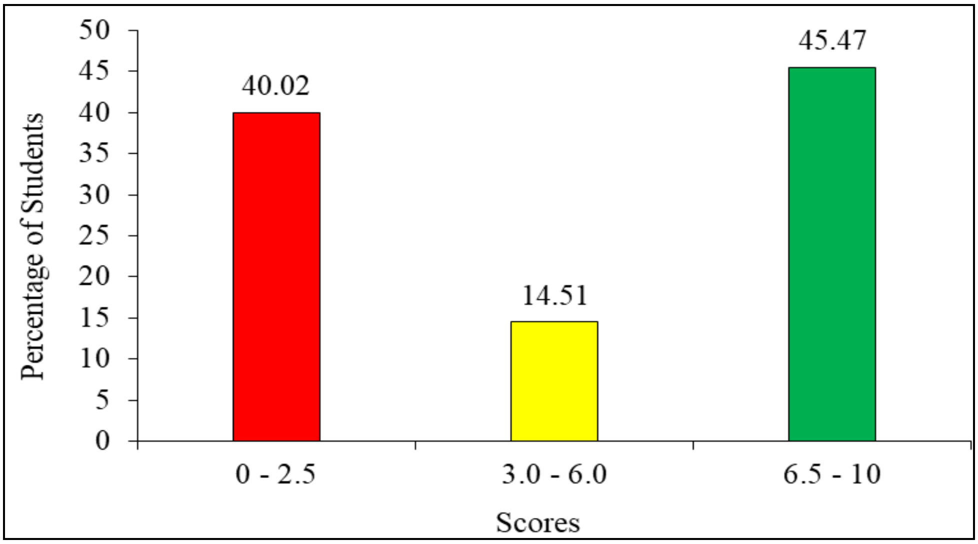


Figure 3: Students' performance on question 2

In this question, 664 (30.20%) students answered correctly. In part (a), these students realised that the total value in Tanzanian shillings is found by multiplying the amount in US dollars by the exchange rate. They therefore correctly multiplied 136 by 2,650 and concluded that 136 USD is worth Tshs 360,400.

In part (b) (i), the students correctly used the formula for calculating speed, which is distance divided by time. For the truck, they divided 600 kilometres by 10 hours and obtained a speed of 60 km/h. For the bus, they divided the 600 kilometres by 7.5 hours to obtain a speed of 80 km/h. These values of speed enabled the students to answer part (b) (ii) perfectly as shown in Extract 2.1.

(b) A truck travels 600 kilometres in 10 hours while a bus travels the same distar in 7.5 hours.

(i) Calculate the speed of each vehicle.

Given: Distance = 600 km

Time used by the truck = 10 hrs

Time used by the bus = 7·5 hrs

Speed of the truck = $\frac{\text{Distance}}{\text{Time taken}}$

Speed of the truck = $\frac{600 \text{ km}}{10 \text{ h}}$

Speed of the truck = 60 km/h

Speed of the bus = $\frac{\text{Distance}}{\text{Time taken}}$

Speed of the bus = $\frac{600 \text{ km}}{7·5 \text{ h}}$

Speed of the bus = 80 km/h

∴ The truck's speed = 60 km/h and The buse's speed = 80 km/h

(ii) Which vehicle travels faster?

Make comparison; Truck = 60 km/h

Bus = 80 km/h

Bus > Truck

∴ The bus travels faster than the truck.

Extract 2.1: A sample of correct responses to question 2

In Extract 2.1, the student correctly calculated and compared the two speeds and correctly concluded that the bus, which travels at 80 km/h, is faster than the truck, which travels at 60 km/h.

In this question, 1,535 (69.80%) students lost some marks while 660 (30.10%) got zero. In part (a), most of these students performed inappropriate operation, as Extract 2.2 illustrates. For instance, some students divided 136 by 2,650 obtaining 0.0513, indicating lack of knowledge on exchange rate among students. Some students also omitted the currency unit in their final answers or mixed up the units, suggesting insufficient attention to units. Additionally, few students unnecessarily rounded the exchange rate or approximated the calculation, leading to inaccurate results. Furthermore, some students correctly set up the calculation as 136×2650, but made arithmetic mistakes when carrying out the multiplication. For example, some wrote answers such as Tshs 3,604,000, indicating errors in place value.

In part (b) (i), a common misconception was failure to recall the correct formula for calculating speed. Some students divided time by distance instead of dividing distance by time as wrote $\frac{10 \text{ h}}{600 \text{ km}}$ and obtained incorrect value for speed 0.167 km/h. Some students also incorrectly handled the time values. Most of these students misinterpreted 7.5 hours as 7 hours 50 minutes or 7 hours 5 minutes. This led to wrong speed values for the bus, even when the correct formula was used. Few students also wrote the bus's speed as 70 km/h instead of 80 km/h, indicating weaknesses in division with decimals. In part (b) (ii), several students failed to interpret their results correctly. Some stated that the truck was faster simply because it took more time, rather than comparing the calculated speeds. Others did not justify their answer, even when they had obtained correct speed values. These observations highlighted difficulties in drawing conclusions from numerical results.

2. (a) How much is 136 USD worth in Tanzanian Shillings if 1 USD = Tshs 2,650?

Soln

136 USD worth in Tz shilings if 1USD = Tshs 2,650?

$$\begin{array}{r} 2650 \\ -\ 136 \\ \hline \text{Tshs } 2{,}514 \\ \hline \end{array}$$

∴ The worth in Tz shilings if 1 USD is

Tshs 2,514. Answer.

Extract 2.2: A sample of incorrect responses to question 2

In Extract 2.2, the student incorrectly calculated the value of 136 USD in Tanzanian shillings by subtracting the US dollar amount from the exchange rate rather than multiplying it by the exchange rate.

2.3 Question 3: Use Approximations in Various Contexts

This question examined students' ability to round numbers and estimate the values of expressions. The question comprised the following parts:

(a) *(i)* *Subtract 35.4 from 234 and give the answer to the nearest hundreds.*

(ii) *Estimate the cost of 27 kg of meat sold at Tshs 8,150 per kilogram.*

(b) *A vehicle consumes 1.13 litres of fuel to cover a distance of 11.65 km.*

(i) *Estimate the rate of fuel consumption of the vehicle in km per litre.*

(ii) *Estimate the amount of fuel the vehicle will have consumed if it travelled 35.78 km.*

The data reveal that 781 (35.52%) students scored between 3.0 and 10 marks, indicating that overall student performance was average. Figure 4 illustrates performance on this question.

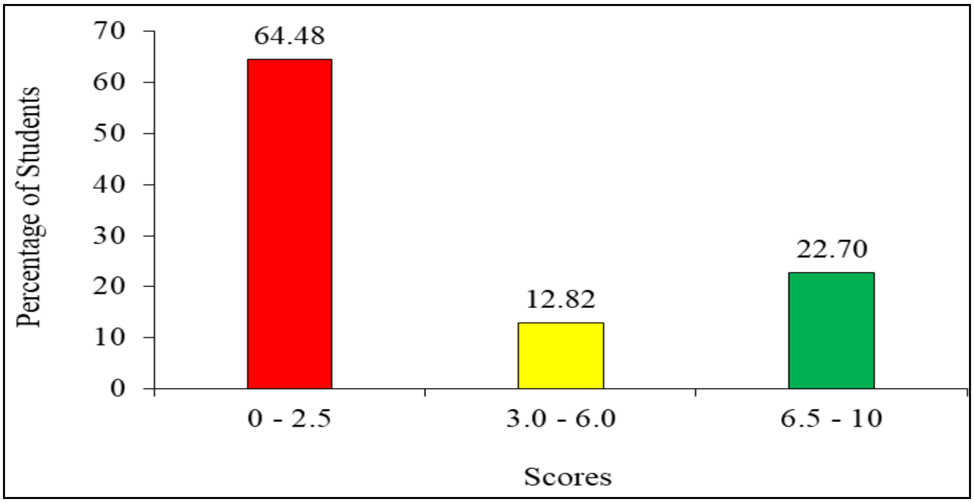


Figure 4: *Students' performance on question 3*

In part (a) (i), competent students correctly subtracted 35.4 from 234, obtaining 198.6. They then rounded this result to the nearest hundreds, and obtained 200. In part (a) (ii), the students recognised that the question required them to estimate, so they rounded off 27 kg to 30 kg and the price per kilogram, Tshs 8,150, to Tshs 8,000. They then correctly calculated $30 \times 8,000$ to obtain+ Tshs 240,000.

For part (b) (i), the students estimated the rate of fuel consumption by dividing the estimated distance by the estimated fuel used, as Extract 3.1 shows. For part (b) (ii), they used the estimated rate to find the amount of fuel needed to travel 35.78 km. They rounded 35.78 km to 36 km and then divided by the estimated rate of 12 km per litre, concluding that the vehicle would consume approximately 3 litres of fuel to travel 35.78 km.

(b) A vehicle consumes 1.13 litres of fuel to cover a distance of 11.65 km.

(i) Estimate the rate of fuel consumption of the vehicle in km per litre.

soln

A vehicle consume 1.13 litres

distance = 11.65 km

$$\text{Rate of Consumption} = \frac{\text{distance}}{\text{Volume of fuel}} = \frac{11.65\,\text{Km}}{1.13\,\text{litre}} = \frac{12}{1}\,\text{Km}$$

∴ The rate is 12 Km/litres

(ii) Estimate the amount of fuel the vehicle will have consumed if it travelled 35.78 km.

Given that

1.13 litres = 11.65 Km

? = 35.78 Km

$$\frac{11.65\,x\,\text{Km}}{11.65\,\text{Km}} = \frac{1.13\,\text{litres} \times 35.78\,\text{Km}}{11.65\,\text{Km}}$$

soln

$$= \frac{1.13 \times 35.78}{11.65}\ \text{litres}$$

$$\approx \frac{1 \times 36}{12}\ \text{litres}$$

$= 3L$

∴ Is equal to 3 litres of fuel

Extract 3.1: A sample of correct responses to question 3

In Extract 3.1, the student correctly rounded 11.65 km to 12 km and 1.13 litres to 1 litre, and hence, obtained a rate of 12 km per litre.

On the other hand, 1,418 (64.48%) scored low marks. In part (a) (i), many students performed subtraction incorrectly. For instance, some students failed to align the decimal points. As a result, they treated both numbers as whole numbers, resulting in incorrect answers of 201.6 or 208.6. Another frequent error occurred when rounding the answer. For instance, some students correctly obtained 198.6 but rounded it down to 100 instead of 200, indicating a misunderstanding of rounding rules. These students seemed to focus only on the hundreds digit (1) and ignored the tens digit (9), which dectates round up or down. With this mistake, some students first approximated the numbers before subtracting. They rounded 234 to 200 and 35.4 to 40, then subtracted, leading to 160, which is incorrect answer. This showed a lack of knowledge on rounding off problems.. Moreover, other students ignored the instruction "to the nearest hundreds" and left their final answer as 198.6.

In part (a) (ii), many students approached the question as if it required an exact calculation rather than an estimate. They multiplied 27 kg by 8,150 and provided a precise answer of 220,050, indicating they failed to recognise the need to approximate the values first. Additionally, some students rounded the numbers incorrectly. For instance, some rounded 27 kg to 20 kg instead of 30 kg, and others rounded 8,150 to 8,200 instead of 8,000, leading to incorrect calculations. Furthermore, some students rounded only one of the quantities, leaving the other unchanged. For example, some of these students wrote the calculation as 27 kg × 8,200, indicating they rounded 8,150 to 8,200 and left 27 unchanged. There were also instances of arithmetic errors. For example, some students successfully approximated the numbers but then miscalculated the product, arriving at incorrect results like 24,000.

A common misconception in part (b) (i) was confusion about interpreting rates, particularly the phrase "rate of fuel consumption in km per litre". Some students incorrectly calculated the rate by dividing 1.13 by 11.65 rather than 11.65 by 1.13. As a result, they obtained the fuel consumption rate in litres per kilometre rather than kilometres per litre. As in part (a) (ii), many students failed to estimate appropriately, as illustrated in Extract 3.2. Some students approximated only one quantity and leaving the other unchanged. For example, students approximated 1.13 to 1 and leaving 11.65 unchanged and obtained the incorrect rate of 11.65 km per litre.

In part (b) (ii), some students failed to link the result from part (b) (i) to solve the problem. Instead of using the estimated rate (km per litre) to estimate fuel consumption, they performed unrelated calculations. For instance, some directly multiplied the distance travelled (35.78 km) by the amount of fuel consumed to cover 11.65 km (1.13 litres). This calculation is meaningless because it distorts the meaning of the fuel consumption rate and cannot be interpreted mathematically. Other students ignored the estimation and calculated exact values, see Extract 3.2.

(b) A vehicle consumes 1.13 litres of fuel to cover a distance of 11.65 km.

(i) Estimate the rate of fuel consumption of the vehicle in km per litre.

Given that

1.13 litres of fuels

11.65 distance covered

but telled to estimate this means (÷)

$1.13 \div 11.65 = \frac{1.13\text{ litres}}{11.65\text{ km}}\ \frac{11.65\text{ km}}{1.13\text{ litre}} = \underline{\underline{10.31\text{ km/litre}}}$

(ii) Estimate the amount of fuel the vehicle will have consumed if it travelled 35.78 km.

Given

distance = 35.78 km

Fuel = 1.13 litres

$\frac{35.78\text{ km}}{1.13\text{ litre}} = \underline{31.66\text{ km/litre}}$

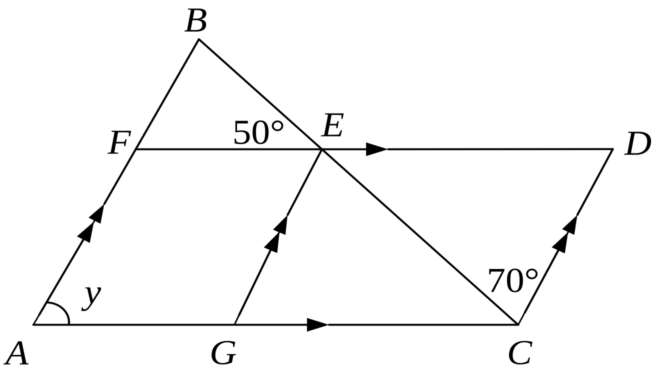
Extract 3.2: A sample of incorrect responses to question 3

In Extract 3.2, the student incorrectly answered parts (b) (i) and (b) (ii) by using exact values of the quantities. However, in part (b) (ii), the student also divided 35.78 km by 1.13 litres rather than multiplying their approximated values.

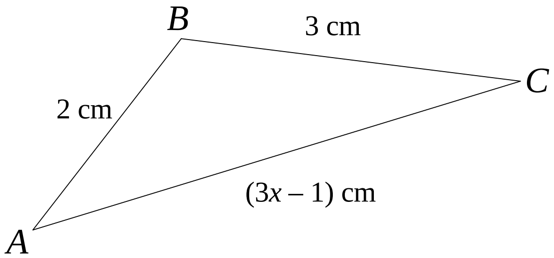
2.4 Question 4: Use Geometry in Various Contexts

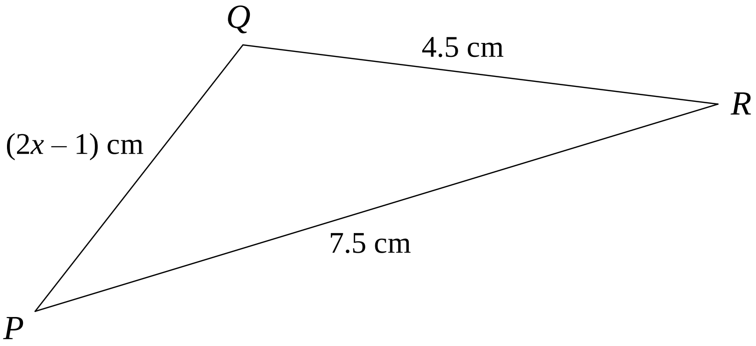
This question assessed the students' ability to recognise angle properties and similar triangles. The question is stated as follows:

(a) Find the value of y in the following figure:



(b) *In the following figures, ΔABC is similar to ΔPQR. Find the value of x.*





A total of 756 (34.38%) students scored between 3.0 and 10, indicating average performance. Figure 5 summarises students' performance on this question.

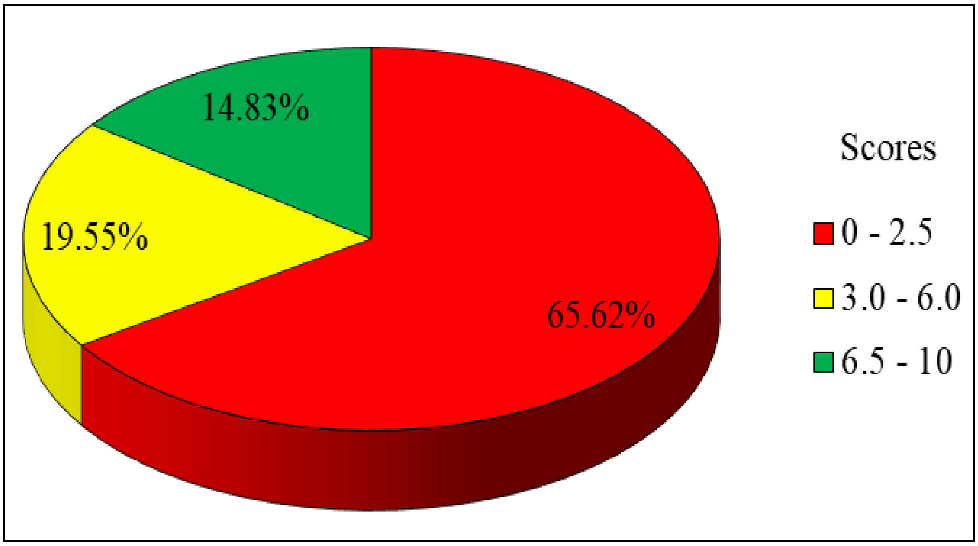
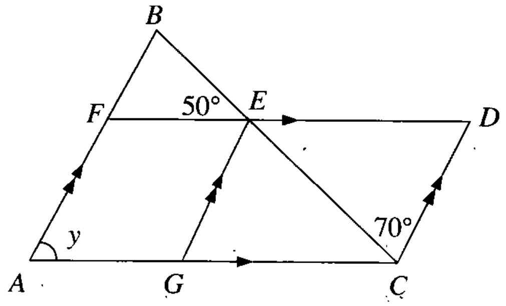


Figure 5: Students' performance on question 4

In this question, 150 students (6.82%) answered all parts correctly. In part (a), the students correctly used the properties of parallel lines and transversal as shown in the diagram. They first recognised that the slanted lines AF, EG and CD in the diagram are parallel, the horizontal lines FD and AC are also parallel and the diagonal line acts as a transversal. From the diagram, the angle between the diagonal and the right-slanted side at point C is 70°. Thus, they realised that because the right slanted side is parallel to the left slanted side, the corresponding angle between the diagonal and the left slanted side is also 70°. At point E, the angle between the diagonal and the horizontal line is 50°. These two angles, along with the angle between the left slanted side and the horizontal line, form a straight-line triangle. Therefore, the students added the known angles $\left(50^\circ \text{ and } 70^\circ\right)$ and subtracted the obtained sum from 180°, resulting in $180^\circ - \left(50^\circ + 70^\circ\right) = 60^\circ$. They also recognised that the angle y at point A, corresponds to the angle between the left slanted side and the bottom horizontal line, is 60°.

In part (b), students were conversant with the fact that the ratio of all pairs of corresponding sides of given triangles is the same. They also identified that the side of length 3 cm in the first triangle corresponds to the side of length 4.5 cm in the second triangle, giving a scale factor of $3:4.5$, which simplifies to $2:3$. They then compared the obtained ratio to another pair of corresponding sides, namely $(3x-1)$ cm in the first triangle and 7.5 cm in the second triangle. They then formed the equation $\frac{2}{3} = \frac{3x-1}{7.5}$ and correctly solved it and obtained $x = 2$.

4. (a) Find the value of y in the following figure:



$\hat{FAG} = \hat{EGC} = \hat{FEG}$

$\cancel{\hat{GED}} = \hat{GEC} = \hat{DCE} = 70^\circ$ ——— internal alternate angles.

$\hat{BEF} = \hat{DEC} = 50^\circ$ ——— Opposite angles.

$\hat{FEG} + \hat{GEC} + \hat{DEC} = 180^\circ$ ——— Straight angle.

$\hat{FEG} + 70^\circ + 50^\circ = 180^\circ$

$\hat{EFB} = 180 - 120 = 60^\circ$

$y = \hat{EFB}$ --- corresponding angles

$\therefore y = 60^\circ$

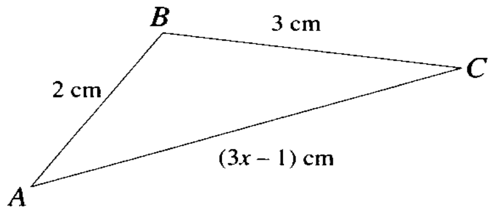
Extract 4.1: A sample of correct responses to question 4

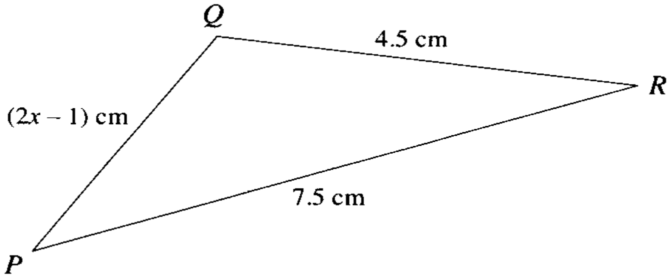
As illustrated in Extract 4.1, the student correctly identified the angles forming a straight angle that enabled them to get $y = 60^\circ$.

In contrast, 2,049 (93.18%) students did not score full marks. In part (a), many students failed to identify parallel lines and their corresponding angles relationships. Some students did not recognise that the lines AF, EG and CD in the diagram are parallel, and therefore failed to apply properties such as corresponding angles or alternate interior angles. As a result, they treated the given angles of 50° and 70° as unrelated to angle y, leading to guesses or unsupported calculations. Some students directly stated that $y = 50^\circ$ or $y = 70^\circ$, indicating a misunderstanding of vertical and corresponding angles. In addition, some students incorrectly assumed that the 50° or 70° angles were vertically opposite to angle y. This assumption was incorrect because the angles were not formed by intersecting straight lines at a single point. Some students also ignored the arrows indicating parallelism and focused only on the figure's shape. This led to the incorrect use of triangle angle-sum or straight-line angle rules, $50^\circ + 70^\circ + y = 180^\circ$ in particular.

In part (b), most students failed to identify the corresponding sides in the two similar figures correctly. For example, some incorrectly assumed that the side of length 3 cm in the first figure corresponded to the side of length 7.5 cm in the second figure rather than the corresponding 4.5 cm side. This led to incorrect ratios and hence wrong equations for finding x. Some students correctly identified corresponding sides but set up the ratios incorrectly. For instance, some wrote $\frac{3}{4.5} = \frac{7.5}{3x-1}$ instead of $\frac{3}{4.5} = \frac{3x-1}{7.5}$ or $\frac{4.5}{3} = \frac{7.5}{3x-1}$, indicating that they had inverted the ratios. In this part, some students were not conversant with the meaning of the term 'similarity'. For instance, some calculated the value of x based on the wrong assumption that the difference between corresponding sides of similar triangles is equal. As a result, they wrote incorrect equations, such as $3 - 4.5 = (3x-1) - 7.5$. This indicates lack of concepts among studends on corresponding sides of the similar trangles. Moreover, errors were also observed in basic algebraic manipulation. Even when the correct proportional equation was formed, some students struggled to solve for x. For example, after obtaining an equation such as $3(7.5) = 4.5(3x-1)$, some expanded incorrectly or failed to solve for x, producing values that are not realistic, particularly $x = -3$.

(b) In the following figures, ΔABC is similar to ΔPQR. Find the value of x.





$\Delta ABC \simeq /\Delta PQR$

$3cm + 2cm + (3x-1)cm = 4 \cdot 5cm + (2x-1)cm + 7 \cdot 5cm$

$5cm + (3x-1)cm = 12cm + (2x-1)cm$

make it like terms

$12cm - 5cm = (3x-1)cm - (2x-1)cm$

$6cm =$

$-1 + 5 + 3x = 12 - 1 + 2x$

$3x - 2x = 11 - 4$

$x = 7$

$\therefore x = 7$

Extract 4.2: A sample of incorrect responses to question 4

In Extract 4.2, the student formulated an equation by equating the sums of the sides of the first and second triangles, indicating wrong assumption that the sum of the sides of similar triangles are equal.

2.5 Question 5: Use Algebra in Problem Solving

The question examined the students' ability to write numbers in standard form and to apply the laws of logarithms to solve problems. It comprised the following parts:

(a) *Write each of the following numbers in standard form:*

(i) *29814*

(ii) *0.0136*

(b) *Given that log2 = 0.3010, log3 = 0.4771, and log3 = 0.6990 find the value of log90.*

The data revealed that 802 (36.47%) students scored 3.0 or more, of whom 377 (17.14%) scored between 3.0 and 6.0 and 425 (19.33%) between 6.5 and 10. Overall, students' performance on this question was average. Figure 6 illustrates students' performance on this question.

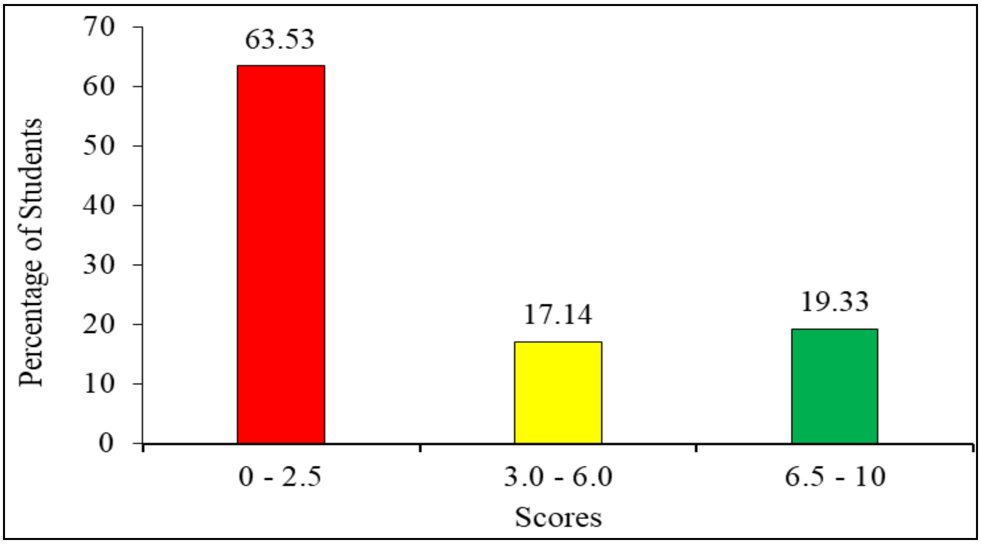


Figure 6: *Students' performance on question 5*

In part (a), competent students correctly recalled that standard form as $a \times 10^n$ where $1 \leq a < 10$. For 29814, they moved the decimal point four places to the left to obtain a number between 1 and 10, giving 2.9814. They also recognised that 29814 equals 2.9814×10000, which is equivalent to 2.9814×10^4. Similarly, for 0.0136, they moved the decimal point two places to the right to obtain 1.36. They also recognised that 0.0136 equals 1.36×0.01, which is equivalent to 1.36×10^{-2}.

In part (b), the students first expressed 90 as a product of prime factors $2 \times 3 \times 3 \times 5$, and wrote $\log 90$ as $\log(2 \times 3 \times 3 \times 5)$. Thereafter, they correctly applied laws of logarithms to obtain $\log 90 = 1.9542$, as Extract 5.1 shows.

(b) Given that $\log 2 = 0.3010$, $\log 3 = 0.4771$, and $\log 5 = 0.6990$, find the value of $\log 90$.

Soln .

$\log 2 = 0.3010$
$\log 3 = 0.4771$
$\log 5 = 0.6990$

$\log 90 = \log(5 \times 3 \times 3 \times 2)$

$\log 90 = \log 5 + \log 3 + \log 3 + \log 2$

$\log 90 = 0.6990 + 0.4771 + 0.4771 + 0.3010$

$\log 90 = 1.9542$

$\therefore$ The value of $\log 90$ is $\underline{1.9542}$.

Extract 5.1: A sample of correct responses to question 5

In Extract 5.1, the student correctly applied the laws of logarithms and made the necessary substitutions and calculations correctly.

On the other hand, 2,069 (94.09%) students scored less than 10 marks on this question, and among them, 1,078 (49.02%) students scored zero mark. In part (a), a common misconception was the misunderstanding of what standard form means. For instance, some students wrote 29.814×10^3 or shifted the decimal point, without including the power of ten, such as 2.9814. In the case of 0.0136, many students struggled with negative powers of ten. Some wrote answers such as 1.36×10^2, indicating inadequate knowledge among students about how decimal numbers less than one are expressed in standard form. Some students also failed to recognise that the decimal point should be placed between 1 and 10. For instance, answers like 13.6×10^{-3} were given. These, do not meet the definition of standard form.

In part (b), many students failed to apply the laws of logarithms correctly(see Extract 5.2). Some students had difficulty in breaking numbers into suitable factors to match the given logarithmic values. For instance, some students wrote $\log 90 = \log 81 + \log 9$ instead of

$\log 90 = \log(2\times3\times3\times5)$, indicating that they incorrectly decomposed 90 into a sum rather than a product of prime factors. Additionally, arithmetic errors were common. Even when the laws of logarithms were correctly applied and appropriate values were substituted, some students made mistakes when adding decimal numbers, leading to incorrect answers.

(b) Given that $\log 2 = 0.3010$, $\log 3 = 0.4771$, and $\log 5 = 0.6990$, find the value of $\log 90$.

$\log 90 = (2\times3\times3\times5)$

IF $\log 2 = 0.3010$

$\log 3 = 0.4771$

$\log 5 = 0.6990$

$\log 90 = \log 2 \times \log 3^2 \times \log 5)$

$\log 90 = (0.3010 \times 0.4771^2 \times 0.6990)$

$\log 90 = (0.3010 \times 0.2276 \times 0.6990)$

$\therefore \log 90 = 0.0479$

Extract 5.2: A sample of incorrect responses to question 5

In Extract 5.2, the student substituted the given logarithmic values into the prime factors of 90 without applying the laws of logarithms, thereby performing multiplication rather than addition.

2.6 Question 6: Use Algebra in Problem Solving

This question examined students' ability to solve inequalities in one unknown and to solve simultaneous equations using the elimination method. It had the following parts:

(a) *Solve the inequality* $\frac{2x+8}{-3} < 20$.

(b) *Find the solution of the following simultaneous equations by elimination method:* $\begin{cases} a+2b=1 \\ 3a-4b=8 \end{cases}$.

A total of 897 (40.79%) students scored between 3.0 and 10 marks, inclusive. Therefore, the overall performance on this question was average. Figure 7 shows the distribution of students' scores on this question.

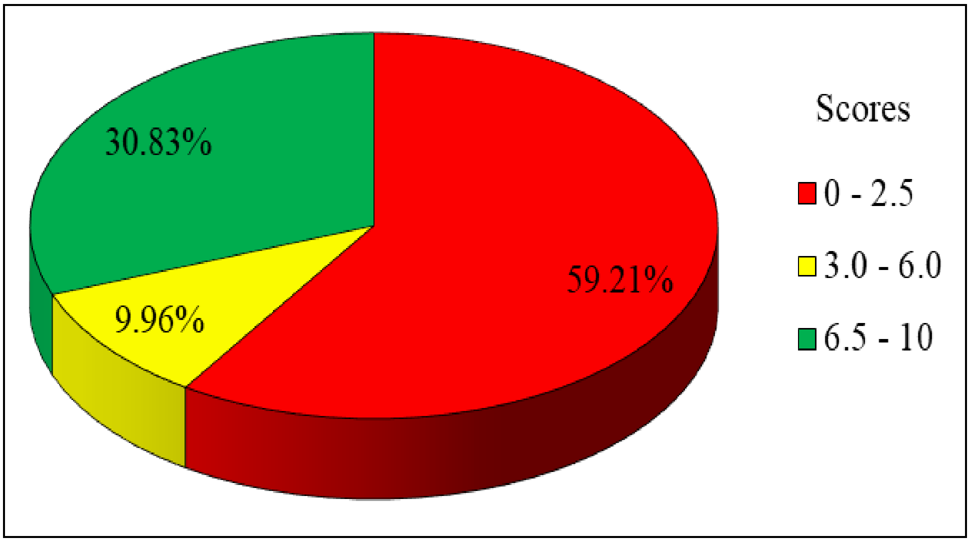


Figure 7: Students' performance on question 6

The data reveal that 130 (5.91%) students scored full marks. In part (a), these students multiplied both sides of the inequality $\frac{2x+8}{-3} < 20$ by -3 to remove the denominator. Since the denominator is negative, they reversed the inequality sign to obtain $2x+8 > -60$ that led to $x > -34$.

In part (b), the students correctly applied the elimination method. They correctly set the coefficients of one variable equal in both equations so that it could be eliminated. For instance, to eliminate b, they multiplied the equation $a+2b=1$ by 2, and obtained $2a+4b=1$. They then added this new equation to the second equation $3a-4b=8$, resulting in $5a=10$ and consequently $a=2$. Similarly, they worked on the equations to solve for b (see Extract 6.1).

(b) Find the solution of the following simultaneous equations by elimination method: $\begin{cases} a+2b=1 \\ 3a-4b=8 \end{cases}$

soln

$\begin{cases} a+2b=1 \\ 3a-4b=8 \end{cases}$

Eliminate a to get b

$\begin{matrix} 3 \\ 1 \end{matrix}\begin{cases} a+2b=1 \\ 3a-4b=8 \end{cases}$

$\begin{cases} 3a+6b=3 \\ 3a-4b=8 \end{cases}$

$6b-(-4b)=3-8$

$6b+4b=-5$

$\frac{10b}{10}=\frac{-5}{10}$

$b=-\frac{1}{2}$

Eliminate b to get a

$\begin{matrix} -4 \\ 2 \end{matrix}\begin{cases} a+2b=1 \\ 3a-4b=8 \end{cases}$

$\begin{cases} -4a-8b=-4 \\ 6a-8b=16 \end{cases}$

$-4a-6a=-4-16$

$\frac{-10a}{-10}=\frac{-20}{-10}$

$a=2$

$\therefore$ Value of $a=2$ and $b=-\frac{1}{2}$

Extract 6.1: A sample of correct responses to question 6

In Extract 6.1, the student eliminated a by multiplying 3 both sides of the equation $a+2b=1$ and then subtracting the new equation from the equation $3a-4b=8$, resulting in $b=-\frac{1}{2}$.

Conversely, 1,302 (59.21%) students scored low marks due to various misconceptions. In part (a), many students did not reverse the inequality sign when multipled a negative number (-3) obtaining $2x+8<-60$ instead of $2x+8>-60$. Some students treated the inequality as an equation. They mechanically solved the equation without considering the inequality symbol, and concluded that $x=-34$.

In part (b), most of these students did not follow the elimination method. Some students used the elimination method to solve for one variable, then the substitution method to solve for the second variable, contrary to the instructions of the question. Another frequent error was incorrect manipulation of the equations to eliminate one variable. For example, some students multiplied one or both equations by incorrect factors, producing coefficients that did not match, thereby failed to eliminate either a or b.

Some students failed to identify the appropriate operation to be performed so that one variable could be eliminated (see Extract 6.2). Few students found only one variable and failed to find the second hence, produced incomplete solution for a and b.

(b) Find the solution of the following simultaneous equations by elimination method: $\begin{cases} a+2b=1 \\ 3a-4b=8 \end{cases}$

Soln

$3\begin{cases} a+2b=1 \\ 3a-4b=8 \end{cases}$ a

$\cancel{3a}+6b=3$

$\cancel{3a}-4b=8$

$+6b-4b=11$

$\frac{2b}{2}=\frac{11}{2}$

$b=5.5$

$a+2\times5.5=1$

$a+11=1$

$a=1-11$

$a=-10$

$\therefore a=-10,\ b=5.5$

Extract 6.2: A sample of incorrect responses to question 6

In Extract 6.2, the student added the equations rather than subtracting them, resulting in an incorrect answer.

2.7 Question 7: Use Sets, Sequences and Series in Problem Solving

The question assessed students' ability to explore subsets and perform set operations. It is stated as follows:

(a) How many subsets does each of the following sets contain?

(i) $A=\{a, b, c\}$

(ii) $B=\{1, 2, 3, 4\}$

(b) *Given the universal set* $m = \{1,2,3,4,5,6,7,8, 9, 10\}$ *and the subsets* $P = \{1, 2, 3, 4, 5, 6\}$ *and* $Q = \{5,6,7,8\}$. *Find;*

(i) $P' \cap Q$

(ii) $P' \cup Q'$

This was the question with the worst performance, with only 649 (29.51%) students scored between 3.0 and 10 marks inclusive. Figure 8 shows the percentages of students who scored low, average, or high.

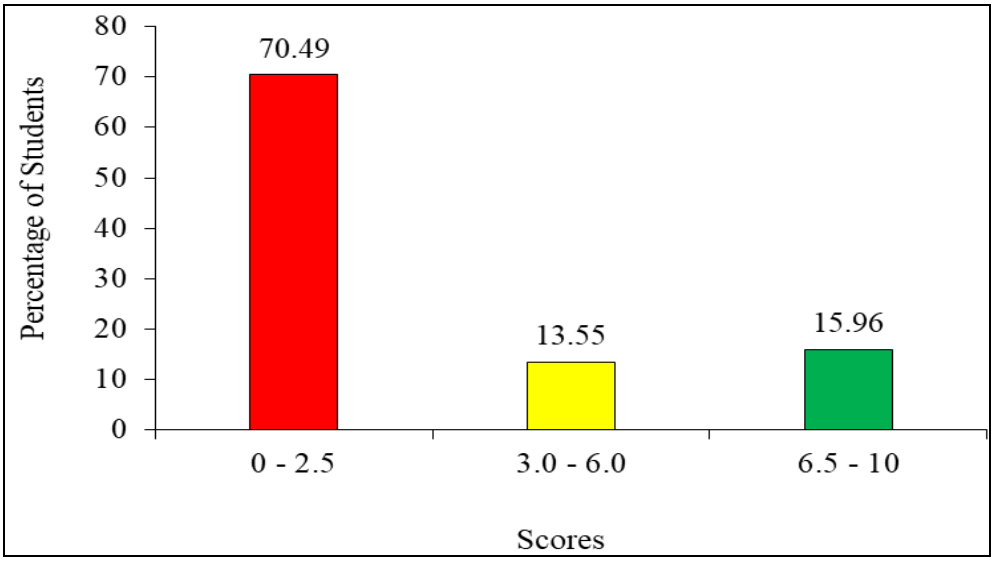


Figure 8: Students' performance on question 7

The data reveal that 1,971 (89.63%) students less than 10 marks due to various reasons. In part (a), many students failed to distinguish the number of elements in a set from the number of subsets. For example, for set $A = \{a, b, c\}$, some students wrote 3 as the subset of set A, indicating that they counted its elements instead of subsets. Some students applied the incorrect formula for finding the number of subsets of a set. For instance, for set $B = \{1, 2, 3, 4\}$, some wrote an incorrect answer of 8, indicating that they applied the incorrect formula $2n$ instead of 2^n. Some students tried to list all subsets but omitted others, particularly the empty set and the set itself. This showed that most students were incompetent in set. Some students correctly recalled the formula 2^n but substituted the wrong value for n. For example, they used $n = 2$ instead of $n = 3$ for set A, leading to an incorrect answer of 4 subsets.

In part (b), a common misconception was the misunderstanding of the meaning of the complement of a set. For example, some students wrote $P' = \{7, 8, 9\}$, leaving out 10 and some listed values that are not in the universal set, such as 0. Another frequent error was failure to distinguish between intersection and union with sets. For instance, in part (b) (i), some students wrote $P' \cap Q = \{5, 6, 7, 8, 9, 10\}$, indicating that they found that as they listed all the elements from both sets P' and Q rather than identifying only the common elements. Moreover, some students followed the incorrect order of operations with sets. For example, in part (b) (ii), some identified $P \cup Q$ and then took the complement of the result, leading to incorrect answer. Instead, they were supposed to determine P' and Q' first and then take their union.

(b) Given the universal set $\mu = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ and the subsets $P = \{1, 2, 3, 4, 5, 6\}$ and $Q = \{5, 6, 7, 8\}$. Find;

(i) $P' \cap Q$

soln

$P = \{1, 2, 3, 4, 5, 6\}$

$Q = \{5, 6, 7, 8\}$

$= P' \cap Q \{1, 2, 3, 4, 7, 8\}$

Extract 7.1*: A sample of correct responses to question 7*

In Extract 7.1, the student determined the set $P \cup Q$ instead of set $P' \cap Q$.

Despite students' overall weak performance, 228(10.37%) students, scored full marks. In part (a), the students correctly applied the rule that a set with n elements has 2^n subsets.. For set $A = \{a, b, c\}$, which has 3 elements, they calculated 2^3,and obtained 8 subsets. For set $B = \{1, 2, 3, 4\}$, which has 4 elements, they calculated 2^4 and got 16 subsets.

In part (b) (i), students first determined the complement of the set P with respect to the universal set, resulting in $P' = \{7, 8, 9, 10\}$. They then identified the elements common to both sets P' and Q, and obtained $P' \cap Q = \{7, 8\}$. For part (b) (ii), students found the complement of a set Q as $Q' = \{1, 2, 3, 4, 9, 10\}$. They then formed the union of the two sets P' and Q' by listing all the elements present in either set P' or Q', and combined set $P' \cup Q' = \{1, 2, 3, 4, 7, 8, 9, 10\}$.

(b) Given the universal set $\mu = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ and the subsets $P = \{1, 2, 3, 4, 5, 6\}$ and $Q = \{5, 6, 7, 8\}$. Find;

(i) $P' \cap Q$

Soln

$\mu = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$

$P = \{1, 2, 3, 4, 5, 6\}$

$P' = \{7, 8, 9, 10\}$

$Q = \{5, 6, 7, 8\}$

$\therefore P' \cap Q = \{7, 8\}$

(ii) $P' \cup Q'$

Soln

$\mu = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$

$Q = \{5, 6, 7, 8\}$

$Q' = \{1, 2, 3, 4, 9, 10\}$

$P' = \{7, 8, 9, 10\}$

$\therefore P' \cup Q' = \{1, 2, 3, 4, 7, 8, 9, 10\}$

Extract 7.2: A sample of correct responses to question 7

In Extract 7.2, the student demonstrated competence in performing complement, intersection, and union operations on sets.

2.8 Question 8: Use Sets, Sequences and Series in Problem Solving

This question intended to assess students' competence in representing and find sets in a Venn diagram. The question comprised the following parts:

(a) Draw Venn diagrams and shade the regions representing the following sets:

(i) $X \cup Y$

(ii) $X \subset Y$

(b) *In a certain meeting, 40 people drank water, 70 drank soda and 35 drank both water and soda. Assuming that each person drank water or soda, use a formula to find the number of people who attended the meeting.*

The students overall performance of this question is average, with 789 (35.88%) students scored between 3.0 and 10 marks inclusive. Figure 9 illustrates the distribution of students with low, average, and high-score categories.

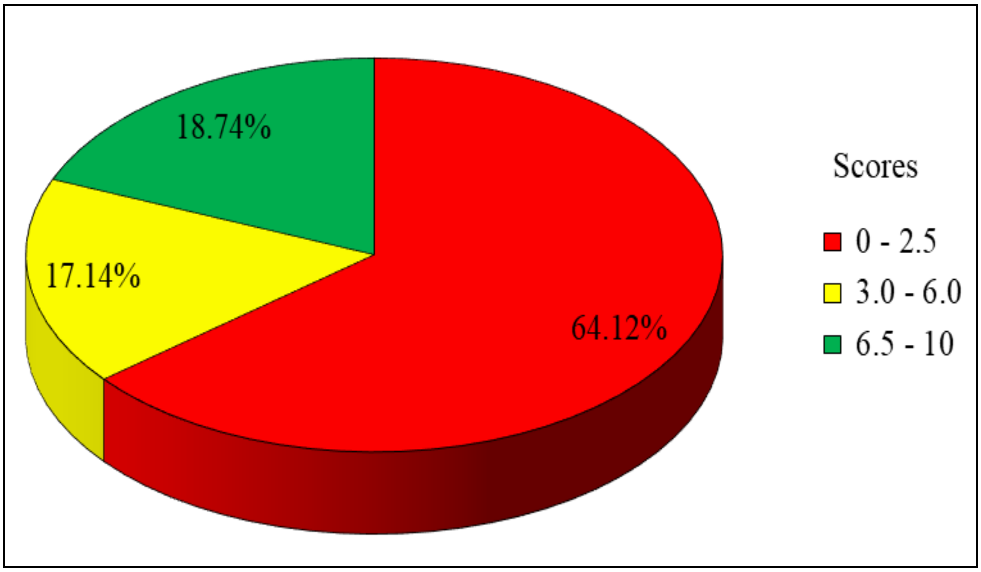


Figure 9: *Students' performance on question 8*

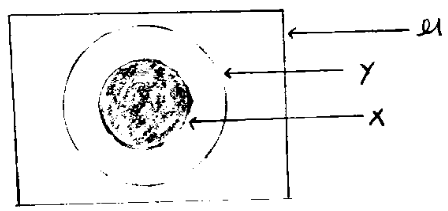
The analysis reveal that 2,008 (91.31%) students scored less than 10 marks on this question, and among them, 1,071 (48.70%) students scored zero(0) mark. In part (a), the students first drew a universal set represented by a rectangle and then drew two overlapping circles inside it to represent the sets X and Y. For part (a) (i), they understood that the union represents all elements that are in either of the two sets. Thus, they shaded all the regions that belong to set X or set Y. For part (a) (ii), they drew a set X completely inside a set Y to show that every element of X is also an element of Y (see Extract 8.1).

In part (b), the students recalled the formula for the number of elements in the union of two sets. They assigned letters to the objects under discussion, particularly W for water and S for soda. They also recognised the number of people who drank water, soda and both water and soda as $n(W)=40$, $n(S)=70$ and $n(W\cap S)=35$ respectively. They then correctly substituted the given values into the formula $n(W\cup S)=n(W)+n(S)-n(W\cap S)$ and carried out calculations, obtaining $n(W\cup S)=75$. Since everyone drank either water or soda, they concluded that 75 people attended the meeting.

8. (a) Draw Venn diagrams and shade the regions representing the following sets:

(i) $X\cup Y$

(ii) $X\subset Y$



Extract 8.1: A sample of correct responses to question 8

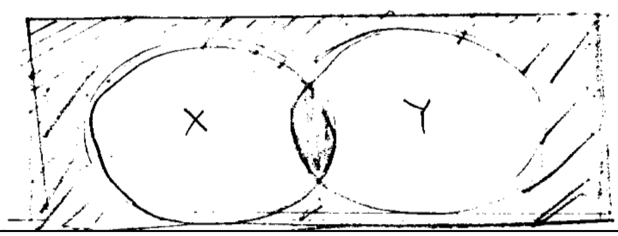
As Extract 8.1 shows, in part (a) (i), the student shaded the region belonging only to X, the region common to both X and Y, and the region belonging only to Y and in part (a) (ii) they shaded the entire region of X only, clearly indicating that X is a subset of Y.

In contrast, 2,008 (91.31%) students scored less than 10 marks in this question. In part (a) (i), some students incorrectly shaded only the overlapping region of the two sets, indicating that they had misinterpreted the symbol of union $(\cup)$ as intersection $(\cap)$. Other students shaded only one set, such as shading X and leaving Y unshaded, indicating a lack of understanding that the union includes elements from either or both sets. In part (a) (ii), some students drew two overlapping circles, suggesting that they misinterpreted the symbol $\subset$ as "overlaps with" rather than "is contained in". For instance, they drew X partly inside and partly outside Y, contradicting the definition of a subset. Other students shaded both circles instead of shading only X, showing confusion between the concept of a subset and the union of sets.

In part (b), some students mistreated the 35 people who drank both water and soda, instead of substracting these people from both the 40 who drank water and the 70 who drank soda, they added. As a result, they wrote statement $35+40+70$ and concluded that 145 people attended the meeting. Other students recalled an incorrect formula. For example, some wrote $n(W \cup S) = n(W) + n(S)$, omitting the subtraction of the intersection $(n(W \cap S))$. They wrote $n(W \cup S) = 40 + 70$, and got incorrect number of people who attended the meeting as 110. Some students also misunderstood the phrase "assuming that each person drank water or soda", which means there is no person who did not drink either water or soda. Instead, they misinterpreted it to mean that some people may not have drunk anything, thereby added unknown group.

(a) Draw Venn diagrams and shade the regions representing the following sets:

(i) $X \cup Y$



Extract 8.2: A sample of a incorrect response to question 8

In Extract 8.2, the student shaded the region indicating $(X \cup Y)'$ instead of $X \cup Y$.

2.9 Question 9: Use Basic Coordinate Geometry Skills in Daily Life

This question assessed students' ability to explore the gradient of a straight line and solve linear simultaneous equations graphically. It comprised the following parts:

(a) *Find the gradient of a straight line passing through the points* $(1,3)$ *and* $(4,5)$.

(b) *Solve graphically the following pair of simultaneous equations:*

$$\begin{cases} 2x + y = -5 \\ -x + y = -2 \end{cases}.$$

In this question, 1,002 (45.57%) students scored 3.0 or more, indicating that overall student performance was average. The distribution of students' scores is presented in Figure 9.

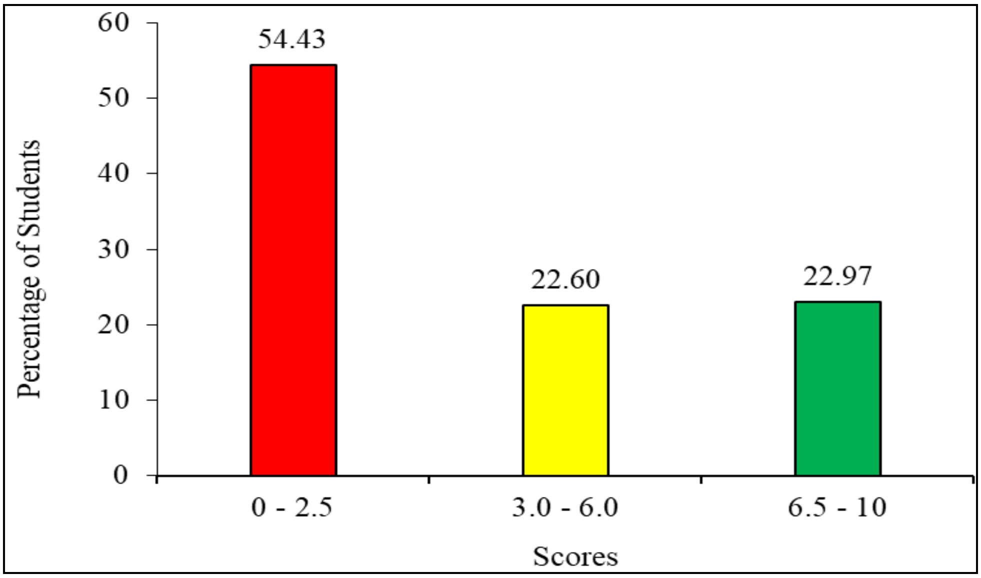
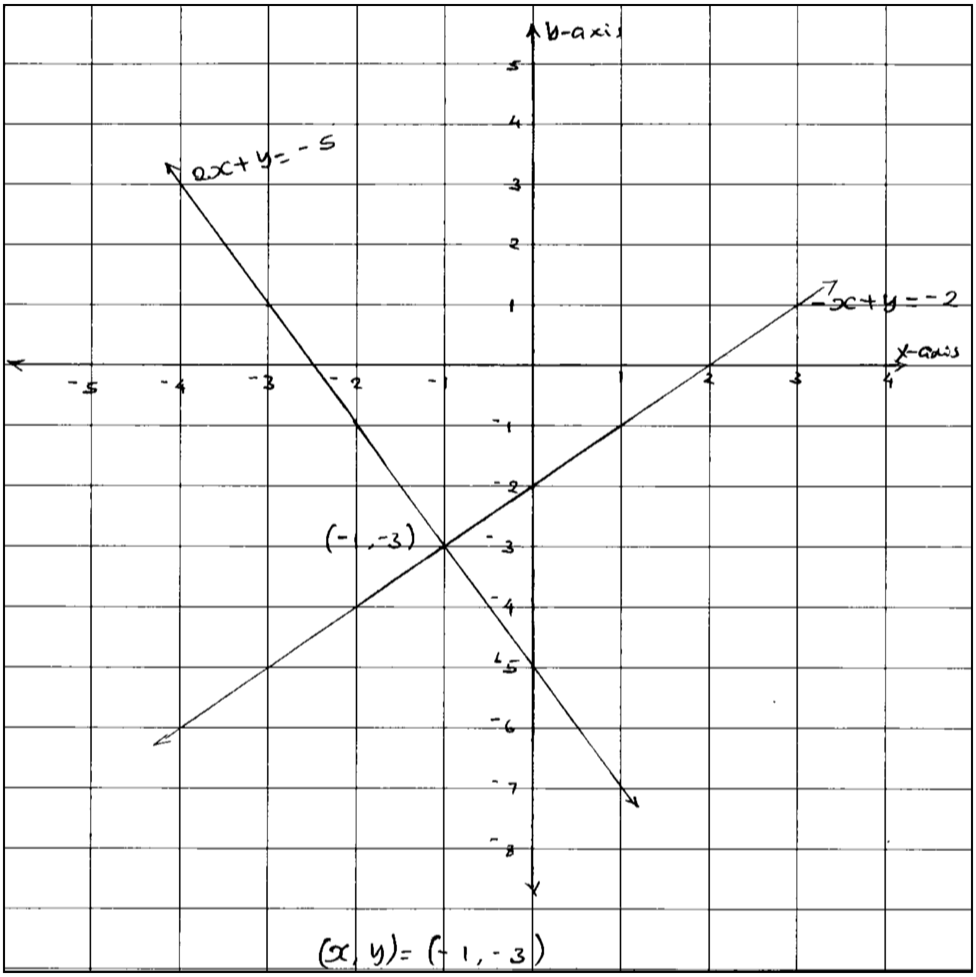


Figure 10: Students' performance on question 9

In this question, 238 (10.82%) students answered this question correctly. In part (a) (i), the students recalled correctly the formula for gradient (m) of a straight line passing through two points (x_1, y_1) and (x_2, y_2) as $m = \frac{y_2 - y_1}{x_2 - x_1}$. They then identified the given points as $(1,3)$ and $(4,5)$. Thereafter, they substituted these values into the formula and correctly obtained the gradient $\frac{2}{3}$.

In part (b), the students drew graphs of each line by choosing appropriate values of x for each equation and their corresponding values of y plotted these points on the same set of axes. They then identified the point of intersection as $(-1, -3)$. Hence, they correctly concluded that the solution of the given simultaneous equations is $x = -1$ and $y = -3$.

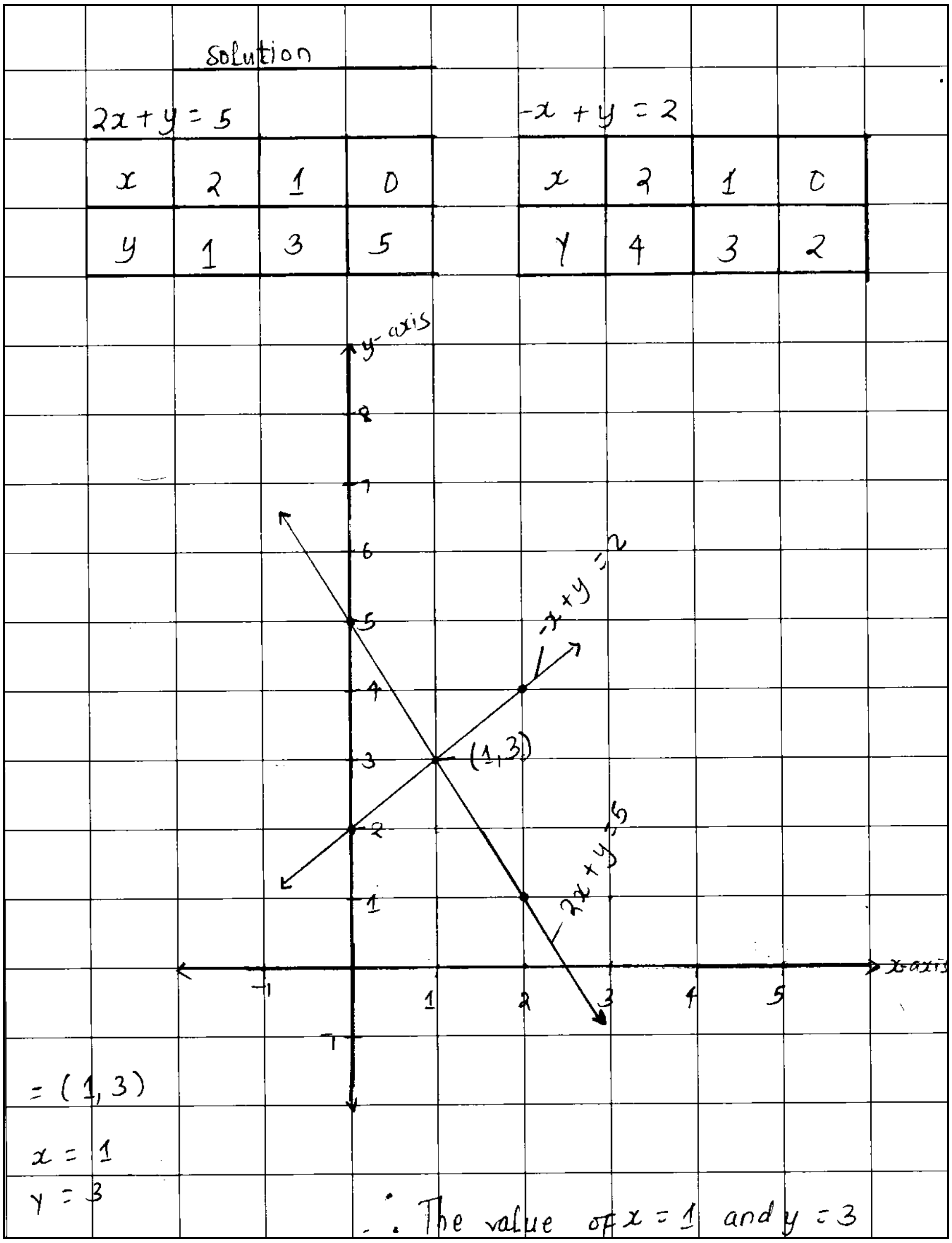


Extract 9.1: *A sample of correct responses to question 9*

In Extract 9.1, the student drew the graphs of given equations and correctly read and interpreted the point of intersection as $x = -1$ and $y = -3$.

The data reveal that 1,961 (89.18%) students scored less than 10 marks on this question, including 911 (41.43%) students who scored zero. In part (a), many students failed to recall the formula for calculating the gradient of a straight line. Some students used an incorrect formula $m=\frac{x_2-x_1}{y_2-y_1}$, which led to an incorrect answer $m=\frac{3}{2}$. Others, based on inconsistent addition or subtraction of the coordinates, resulting in $m=\frac{y_1-x_1}{y_2-x_2}$ or $m=\frac{x_1+y_1}{x_2+y_2}$, indicating a lack of understanding of what the gradient represents geometrically. In addition, few students used an inappropriate formula to calculate the gradient, commonly the distance formula. This showed that they failed to distinguish between the concepts of gradient and the distance between two points.

In part (b), many students failed to identify the points that satisfy the given equations and could be used to draw the graphs. For instance, some students found only one point and assumed it was sufficient to draw graph of a straight line, resulting in the inaccurate graph. There were also errors in graph plotting whereby some students plotted points inaccurately (see Extract 9.2). In addition, some students read only the x-coordinate or the y-coordinate of the intersection point, rather than writing the solution as an ordered pair (x, y).



Extract 9.2: A sample of incorrect responses to question 9

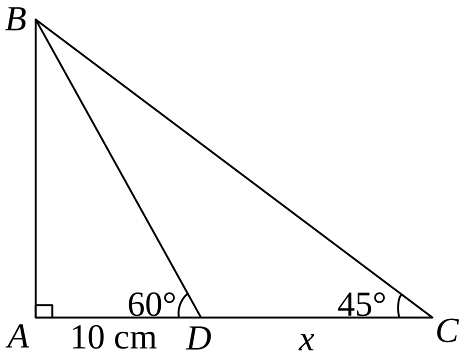
In Extract 9.2, the student plotted the points inaccurately, leading to the straight lines not intersecting at the correct point, and hence, produced incorrect solution.

2.10 Question 10: Use Basic Trigonometry Skills in Daily Life

The question examined the students' ability to explore trigonometric ratios of angles and calculate angles of elevation and depression. It is stated as follows:

(a) *(i)* *Use* $\sin\theta = \frac{4}{5}$ *to find the values of* $\cos\theta$ *and* $\tan\theta$.

(ii) *Find the value of* x *in the following figure (Leave the answer in surd form):*



(b) *A painter needs to reach a point 4 m high on the vertical wall using a ladder whose length is 4.5 m. Find the angle of elevation the ladder makes with the horizontal ground (Express the answer in one decimal place).*

Students' overall performance on this question was average. A total of 417 (18.96%) students scored between 3.0 and 6.0, and 340 (15.46%) scored between 6.5 and 10. The distribution of students' scores is shown in Figure 11.

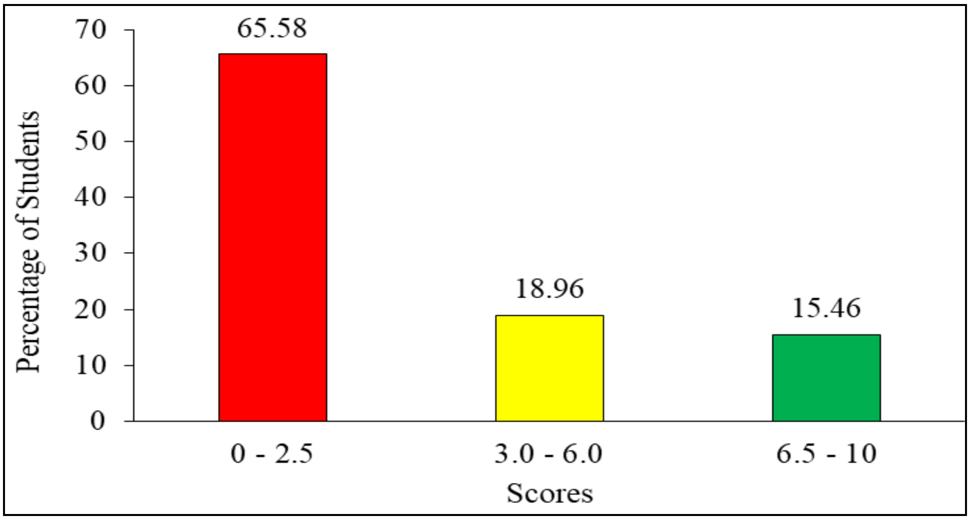


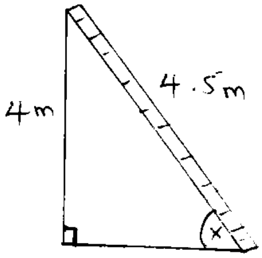
Figure 11: Students' performance on question 10

The data also shows that 130 students, equivalent to 5.91 per cent, correctly answered all parts of this question. In part (a) (i), the students used the given value $\sin\theta = \frac{4}{5}$ to construct a right-angled triangle. They recalled that $\sin\theta = \frac{\text{Opposite}}{\text{Hypotenuse}}$, and thus, interpreted the sine ratio as the opposite side being 4 units and the hypotenuse being 5 units. Using the Pythagoras theorem, they then calculated the length of the adjacent side and obtained 3 units. With all three sides known, they determined the remaining trigonometric ratios using appropriate formulae. They recalled that $\cos\theta = \frac{Adjacent}{Hypotenuse}$ and thus, calculated $\cos\theta$ by dividing the adjacent side (3 units) by the hypotenuse (5 units), giving $\cos\theta = \frac{3}{5}$. They also recalled that $\tan\theta = \frac{Opposite}{Adjacent}$ and therefore, calculated $\tan\theta$ by dividing the opposite side (4 units) by the adjacent side (3 units), and obtained $\tan\theta = \frac{4}{3}$.

In part (a) (ii), the students correctly interpreted the diagram carefully by noting that $\overline{AB}$ is vertical and $\overline{AC}$ is horizontal, so triangle ABC is right-angled at A. Thus, they calculated $\overline{AB}$ based on $\tan 60^\circ$ as $\tan 60^\circ = \frac{\overline{AB}}{10 \text{ cm}}$ and obtained $\overline{AB} = 10\sqrt{3}$ cm. After replacing $\tan 60^\circ$ in the equation with its numerical value, $\sqrt{3}$, they got calculation correct. They then considered a triangle ABC to find the value of x. Based on $\tan 45^\circ = \frac{\overline{AB}}{\overline{AC}}$ and by substituting $\tan 45^\circ = 1$, $\overline{AB} = 10\sqrt{3}$ units and $\overline{AC} = (10 + x)$ cm, resulting in $1 = \frac{10\sqrt{3}}{10 + x}$ and consequently $x = 10\left(\sqrt{3} - 1\right)$ cm.

In part (b), the students correctly identified right-angled triangle, as shown in Extract 10.1. They then used the sine ratio to identify the height reached on the wall (opposite) as 4 m and the length of the ladder (hypotenuse) as 4.5 m, writing $\sin\theta = \frac{4 \text{ m}}{4.5 \text{ m}}$ and equivalent to $\sin\theta = 0.8889$. Thus, they used a calculator (or mathematical table) to determine the angle whose sine is 0.8889 is 62.7° (correct to one decimal place).

(b) A painter needs to reach a point 4 m high on the vertical wall using a ladder whose length is 4.5 m. Find the angle of elevation the ladder makes with the horizontal ground (Express the answer in one decimal place).



$\sin X = \frac{Opp}{Hyp}$.

$\sin X = \frac{4m}{4.5m}$

$\sin X = \cancel{0.888}\ 8/9$.

$\sin X = 0.888$.

$\sin^{-1}(x) = 62.7339$

$\approx 62.7°$. (to one decimal place).

$\therefore$ The angle of elevation $= \cancel{62° 42'}\ 62$.

Extract 10.1: A sample of correct responses to question 10

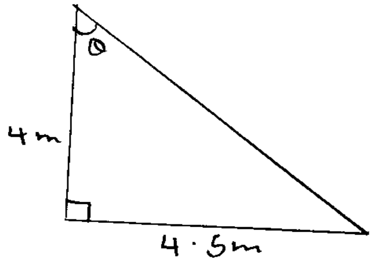
In Extract 10.1, the student correctly interpreted the word problem geometrically,identified the angle of elevation as the angle between the ladder and the horizontal ground. Thus, the ladder is the hypotenuse, the vertical wall is the opposite side, and the horizontal ground is the adjacent side.

However, the data shows that 2,069 (94.09%) students scored lowlost marks on this question, including 1,287 (58.53%) students who scored zero(0) mark. In part (a) (i), many students failed to define sine, cosine, and tangent in a right-angled triangle. Some students applied formulas mechanically without first interpreting $\sin\theta = \frac{4}{5}$ as a ratio of the opposite side to the hypotenuse. As a result, they were unable to construct the correct triangle, resulting in incorrect answers. Another frequent misconception was assuming values for $\cos\theta$ and $\tan\theta$ without using the Pythagorean theorem. For example, some students guessed incorrect values, including $\sin\theta = \frac{1}{5}$. In addition, some students had difficulty recalling or distinguishing between the basic trigonometric ratios. For example, some of them incorrectly used the incorrect ratio for tangent, such as $\tan\theta = \frac{Adjacent}{Opposite}$, $\tan\theta = \frac{Opposite}{Hypotenuse}$, instead of $\tan\theta = \frac{Opposite}{Adjacent}$.

In part (a) (ii), many students did not recognize that triangle ABD and triangle ABC share the same vertical height $\overline{AB}$, which is essential for linking the two triangles using trigonometric ratios. As a result, they treated the triangles as unrelated and directly calculated x from triangle ADC without first determining the height. Another frequent error was the use of inappropriate trigonometric ratios. For example, some students used $\sin 60^\circ$ or $\cos 45^\circ$ instead of using the tangent ratio, which is most appropriate since the opposite and adjacent sides are given. Others wrote $\tan 60^\circ = \frac{10}{\overline{AB}}$ instead of $\tan 60^\circ = \frac{\overline{AB}}{10}$, indicating that they were not conversant with the definitions of tangent.

In part (b), many students wrongly interpreted the word problem (see Extract 10.2). Some assumed that the angle of elevation is the angle between the ladder and the wall, rather than the angle to the horizontal ground. Therefore, they used the cosine ratio instead of the sine ratio, treating the 4 m height as the adjacent side rather than the opposite side. For example, some students treated the vertical wall as the hypotenuse of the right-angled triangle and applied trigonometric ratios incorrectly as $\sin\theta = \frac{4.5}{4}$. The equation is also mathematically invalid because $\sin\theta$ is always between -1 and 1. Moreover, some students used an inappropriate ratio, particularly the tangent. There were also cases in which students found the correct angle but failed to round the answer to one decimal place as instructed, or gave the answer in degrees and minutes rather than decimal form.

(b) A painter needs to reach a point 4 m high on the vertical wall using a ladder whose length is 4.5 m. Find the angle of elevation the ladder makes with the horizontal ground (Express the answer in one decimal place).



$$\tan \theta = \frac{4\cdot 5\,m}{4\,m}$$

$$\tan \theta = 1\cdot 125$$

$$\theta = \tan^{-1}(1\cdot 125)$$

$$\theta = 48\cdot 36646066$$

$$\theta = (48\cdot 4)^{\circ}$$

$\therefore$ The angle of Elevation is $(48\cdot 4)^{\circ}$

Extract 10.2: *A sample of incorrect responses to question 10*

In Extract 10.2, the student mistakenly assumed the ladder was the adjacent side rather than the hypotenuse.

3.0 ANALYSIS OF STUDENTS' PERFORMANCE IN COMPETENCES

The Mathematics paper covered eight (08) competences, where students got average performance across all competences. These competences included Use Rates and Variations in Different Contexts (59.98%); Use Numerical Skills, Ratios and Proportions in Daily Life (48.89%); Use Basic Coordinate Geometry Skills in Daily Life (45.57%); Use Algebra in Problem Solving (38.63%); Use Approximations in Various Contexts (35.52%); Use Basic Trigonometry Skills in Daily Life (34.42%); Use Geometry in Various Contexts (34.38%); and Use Sets, Sequences and Series in Problem Solving (32.70%).

This performance highlights that students had more difficulties with setconcepts specifically Venn diagram and finding the number of elements in a set.Followed by recognising properties of angles and similar triangles;

exploring trigonometric ratios of angles and calculating angles of elevation and depression; rounding numbers and estimating the values of expressions; solving inequalities in one unknown and simultaneous equations using the elimination method; writing numbers in standard form and using laws of logarithms to solve problems; exploring the gradient of a straight line and solving linear simultaneous equations graphically; converting repeating decimals into fractions and solving ratio and proportion problems; and finally, solving problems on rates and variations. Appendix I details the students' performance in each question and their competence.

4.0 CONCLUSION AND RECOMMENDATION

The analysis of students' performance in the Mathematics paper of the Form Two National Assessment (FTNA) 2025 indicates a marked polarisation in achievement, with most students performing poorly and very few attaining intermediate grade levels. Further item- and competence-level analyses identify specific areas of difficulty across the syllabus. Based on these findings, the following recommendations are proposed to improve the teaching and learning of mathematics in ordinary secondary schools in Tanzania:

(a) Targeted Remedial Instruction

Implement focused remedial interventions to address persistent areas of difficulty, including set theory (Venn diagrams and counting elements), geometry (angle properties and similar triangles), trigonometry (ratios and angles of elevation and depression), algebra (inequalities , simultaneous equations, standard form, and logarithms), numeracy (rounding, estimation, and recurring decimals), linear functions (gradients), as well as proplems involving ratio, proportion, rate, and variation.

(b) Competence-Based Curriculum Reinforcement

Review and refine instructional approaches to ensure systematic coverage of identified weak competencies by aligning teaching methods, classroom activities, and assessment items to enhance coherence and instructional effectiveness.

(c) Enhanced Visual and Practical Learning

Employ diagrams, interactive learning tools, and real-world applications to strengthen conceptual understanding, particularly in abstract topics such as geometry, trigonometry, and linear functions.

(d) Stepwise Skill Development

Introduce structured exercises and guided problem-solving strategies that progress gradually from simple to more complex tasks, thereby building learners' confidence and mastery of skills.

(e) Continuous Formative Assessment and Feedback

Conduct regular low-stakes assessments and diagnostic tests to monitor learners' progress in key competencies, providing timelyand actionable feedback to support effective learning.

(f) Professional Development for Teachers

Provide focused teachers' pedagogical skills training to improve teachers' instructional strategies, data-informed educational planning, and effective methods for addressing persistent learning gaps.

Appendix I

Summary of Students' Performance in Each Question and Competence in 043 Mathematics FTNA 2025

S/N	Competence	Question Number	Percentage of Students Who Passed (Question-wise)		Percentage of Students Who Passed (Competence-wise)	
			Percentage	Remarks	Percentage	Remarks
1	Use Rates and Variations in Different Contexts	2	59.98	Average	59.98	Average
2	Use Numerical Skills, Ratios and Proportions in Daily Life	1	48.89	Average	48.89	Average
3	Use Basic Coordinate Geometry Skills in Daily Life	9	45.57	Average	45.57	Average
4	Use Algebra in Problem Solving	6	40.79	Average	38.63	Average
		5	36.47	Average		
5	Use Approximations in Various Contexts	3	35.52	Average	35.52	Average
6	Use Basic Trigonometry Skills in Daily Life	10	34.42	Average	34.42	Average
7	Use Geometry in Various Contexts	4	34.38	Average	34.38	Average
8	Use Sets, Sequences and Series in Problem Solving	8	35.88	Average	32.7	Average
		7	29.51	Weak		

Appendix II

Students' Performance in Each Competence