CARIBBEAN EXAMINATIONS COUNCIL

CSEC® MATHEMATICS

Subject Report with Exemplars

May/June 2021

CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION

MAY/JUNE 2021

MATHEMATICS
GENERAL PROFICIENCY

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INTRODUCTION

The CSEC Mathematics examination is offered in January and May/June of each year. The examination comprises the following papers.

- Paper 01 — Multiple Choice
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In May/June 2021, approximately 62 465 candidates sat the Mathematics General Proficiency examination. Approximately 41 per cent of candidates earned Grades I–III. Overall, the mean score was 78.49 out of 200 marks (39.24 per cent) and the standard deviation 28.99. The paper catered for the varying abilities of candidates. Some candidates experienced difficulty answering questions for which they were required to use algebraic manipulations. Such candidates were unable to score full marks.

Three profiles were assessed on each paper. These profiles were Profile 1 —Knowledge, Profile 2 — Comprehension and Profile 3 — Reasoning. The mean score on each profile was as follows.

- Profile 1 — 25.13 out of 60 (41.88 per cent)
- Profile 2 — 30.26 out of 80 (37.82 per cent)
- Profile 3 — 19.34 out of 60 (32.24 per cent)

The performance of candidates on each paper is detailed in this report.

PAPER 01 — MULTIPLE CHOICE

This paper consists of 60 multiple-choice items based on the entire syllabus. Each item is worth one mark.

In May/June 2021, the mean score was 30.06 out of 60 marks (50.09 per cent). The standard deviation was 11.41. Eighty candidates (0.13 per cent of candidates) earned the maximum available score of 60 while 473 candidates (0.75 per cent of candidates) scored zero.

PAPER 02 — STRUCTURED ESSAY

Paper 02 consisted of ten compulsory structured essay questions. The paper was worth a total of 100 marks. The paper was divided into two sections which comprised the following.

- Section I comprised seven compulsory questions worth a total of 64 marks.
- Section II comprised three compulsory questions worth 12 marks each. Each question was based on one of the following topics.
  - Algebra, Relations, Functions and Graphs
  - Measurement, Trigonometry and Geometry
  - Vectors and Matrices.

The mean score was 19.55 and the standard deviation 16.90. One candidate earned full marks while 656 candidates (1.05 per cent of candidates) scored zero.

Question 1

This question tested candidates' ability to

- perform basic operations on real numbers (fractions)
- solve problems involving salaries and wages
- express a number to a given number of significant figures
- write any rational number in scientific notation
- express one quantity as a fraction or percentage of another
- solve problems involving concepts in number theory and computation.

Candidates' Performance

More than 99 per cent of candidates attempted to provide a response. The mean was 2.51 out of 9 marks (27.89 per cent) and the standard deviation 2.50. Approximately 79 per cent of candidates scored less than half the available marks. Of the 62 465 candidates taking the examination, 18 383 candidates (29.43 per cent of candidates) scored zero while 1907 candidates (3.05 per cent of candidates) scored full marks.

Areas of good performance

- In Part (b), candidates were able to calculate the pay increase.
- For Part (d), candidates were able to use a valid method to provide an answer but several candidates divided 630 by 38 instead of by 35.

Areas of weak performance

- For Part (a), many candidates were unable to answer this section correctly. Only a few candidates were able to obtain the correct answer by using the calculator effectively. Several candidates attempted to divide and subtract simultaneously by finding the lowest common multiple (LCM).

- In Part (c) (i), 366 was commonly used and the mantissa was rounded to 2.7 or 2.71 instead of 2.714. For Part (c) (ii), candidates divided the difference, 949 900, by 3 663 900 instead of by the number given for the original population, 2 714 000.

Answers

The following are the expected answers for each part of Question 1.

(a) $\frac{9}{14}$

(b) 102

(c) (i) a) 3 660 000 (c) (i) b) 2.714×10^6 (c) (ii) 35

(d) 54

Recommendations

Teachers should

- encourage students to use the calculator properly
- reinforce the strategies used for the different operations involving fractions
- emphasize the need to read questions carefully so that they provide a complete answer to what has been asked
- underscore the importance of checking answers to ensure that they are accurate. For example, answers written in standard form can be checked for accuracy by simply plugging the values into a calculator
- point out to students that numbers that are approximated or written in standard form should be written in numerical form and not worded form, unless stated otherwise. For example, candidates should not write 3.66 million for 3 660 000 when writing 3 663 900 to three significant figures
- accentuate the use of zeros as place value holders
- stress the importance of not rounding off numbers written in standard form
- highlight to students that percentage increase = increase ÷ original number × 100.

Question 2

This question tested candidates’ ability to

- use symbols to represent numbers
- translate between algebraic symbols and worded expression
- substitute numbers for variables in algebraic expressions
- change the subject of formulae
- solve quadratic equations algebraically
- solve worded problems.

Candidates’ Performance

The performance of candidates was unsatisfactory. The mean was 2.36 out of 9 marks (26.22 per cent) and the standard deviation 1.97. Approximately 88 per cent of candidates scored less than half the available marks. Of the 62 465 candidates taking the examination, 10 179 candidates (16.30 per cent of candidates) scored zero while 1262 candidates (2.02 per cent of candidates) scored full marks.

Areas of good performance

- Candidates performed best on Part (a) (i). Most candidates who attempted it gave the correct answer. A few candidates wrote +/− 7 which was an acceptable response.
- Most candidates who attempted Part (a) (ii) were able to correctly make *T* the subject of the formula.
- In Part (b) (i), candidates were able to give the correct expression for at least one of the ages.

Areas of weak performance

- Part (b) (ii) was poorly done by candidates. Most candidates solved the given equation instead of showing that the equation represented the information given. Some of the mistakes seen were candidates
  - — doubling the ages
  - — adding the ages
  - — multiplying the ages without increasing them by 2.
- In Part (b) (iii), even though candidates solved the given quadratic equation, they did not state Ally’s age. Instead, they gave random calculations.

Answers

The following are the expected answers for each part of Question 2.

(a) (i) 7 (a) (ii) $T = n^2$

(b) (i) $x + 5$, $2x$ (b) (ii) $(x + 2)(2x + 2) = (x + 5)^2$ (b) (iii) 7

Recommendations

Candidates require more practice in the following areas.

- Translating between algebraic equations and words
- Solving questions that require them to prove formulae/verify proofs
- Solving worded questions

Question 3

This question tested candidates' ability to

- solve geometric problems
- define the trigonometric ratios of acute angles in a right-angled triangle
- state the relationship between an object and its image
- determine and represent the location of the image of an object under a transformation.

Candidates' Performance

Most candidates attempted to answer at least one part of Question 3. However, their overall performance was unsatisfactory. The mean was 1.46 out of 9 marks (16.22 per cent) and the standard deviation 2.05. Approximately 90 per cent of candidates scored less than half the available marks. Of the 62 465 candidates taking the examination, 28 140 candidates (45.05 per cent of candidates) scored zero while 654 candidates (1.058 per cent of candidates) scored full marks. The modal mark was 0 and the median mark 1.

Areas of good performance

- Part (a) (i) was attempted by most candidates and they performed satisfactorily.

Areas of weak performance

- Some candidates made careless computational errors. These candidates made errors such as '180 − 162 = 38'.
- Some candidates gave incorrect units of measurements for the angle, for example, '28 cm'.
- Candidates did not do Part (a) (ii) well as they used the incorrect ratio. A moderate number of candidates demonstrated competence in using the correct ratio. Some common mistakes made by candidates included writing '$RQ = \frac{11}{\text{Sin}\, 62^\circ}$', '$RQ = 11 \times \sin 28$' and '$RQ = \frac{11}{\text{Cos}\, 62^\circ}$'.
- A few candidates prematurely rounded down the trigonometric values from the calculators to one decimal place, for example 0.883 was rounded to 0.8.
- Very few candidates correctly identified the equation as $y = 0$ in Part(b) (i). Some named the line as the 'x-axis' while others ignored that they were required to write an equation. Few candidates gave the equation '$y = x + 0$' or '$y = x$' as an answer.

- Part (b) (ii) was poorly done by candidates or they did not attempt it. Few candidates gave a fully correct description. Many candidates did not know the origin as they provided the answer '(0,2)'. Candidates struggled to communicate the description using the correct mathematical language. A few candidates identified the correct matrix for the transformation but did not give the description.
- Candidates performed unsatisfactorily on Part (b) (iii) and Part (b) (iv). Very few candidates showed the correct images. Many candidates translated Triangle *Y* in the wrong direction or they placed the congruent image of Triangle *X* in the incorrect position for the enlargement.

Answers

The following are the expected answers for each part of Question 3.

(a) (i) 28 (a) (ii) 9.71

(b) (i) $y = 0$

(ii) rotation: 90^0 anticlockwise about the origin

(iii) V: (−7, −1), (−1, −1), (−3, −3)

(iv) W: (0, 1), (2, 2), (3, 1)

Recommendations

Teachers should emphasize the following to students.

- Numbers from the calculator should not be rounded too early because doing so gives inaccurate results. An example of this includes sin 62 = 0.8 instead of 0.883. Teachers should also encourage students to use three decimal places when working with trigonometric values obtained from the calculator.
- When doing transformations, all images must be drawn with a ruler.
- Pay attention when labelling images.
- Spend time learning about all the possible reflection lines.
- Give full descriptions of transformations
- When doing enlargements, students should place equal emphasis on fractional scale factors. This would ensure that they are fully aware that an enlargement transformation can result in a reduction in the size of the image of the object being enlarged.

Question 4

This question tested candidates' ability to

- express the equation of a straight line in the form $y = mx + c$
- determine the gradient of a straight line
- determine the equation of a perpendicular line
- evaluate a function f(x) at a given value of x
- derive a composite function and evaluate it at a given value of x
- calculate the value of x given the image of the function.

Candidates' Performance

The performance of candidates was unsatisfactory. Even though more than 99 per cent of candidates attempted to provide an answer, 1111 (1.78 per cent of candidates) completed the entire question successfully. The mean was 1.20 out of 9 marks (13.33 per cent) and the standard deviation 1.98. Approximately 92 per cent of candidates scored less than half the available marks. Of the 62 465 candidates taking the examination, 33 131 candidates (53.04 per cent of candidates) scored zero. Zero was also the modal mark.

Areas of good performance

- For Part (a) (ii), candidates were able to state the gradient of the line they obtained in Part (a) (i).
- Candidates were successful in finding the value of f(9).

Areas of weak performance

- For Part (a) (i), candidates had difficulty transposing the equation of the line in the form $y = mx + c$.
- Candidates had difficulty finding the gradient of the line L_2 (the perpendicular gradient). However, many candidates were able to ascertain the value of c from the graph or otherwise and hence stated an equation for the perpendicular line, L_2.
- Many candidates obtained the value of $g(-3)$, however, they were unable follow through to evaluate the composite function $fg(-3)$.
- Candidates were able to equate the function in Part (b) (iii) but they had difficulty cross multiplying and hence were unable to solve the equation for x. Many candidates substituted the image of g(x) for the value of x.

Answers

The following are the expected answers for each part of Question 4.

(a) (i) $y = -0.5x + 5$	(a) (ii) -0.5	(a) (iii) $y = 2x - 5$
(b) (i) 7	(b) (ii) 5.5	(b) (iii) 5

Recommendations

Teachers should do the following with their students.

- Give students additional opportunities to practice the skill of transposing. Teachers could give students more practice in changing the subject of formulae, for example, when expressing a line in the form $y = mx + c$.
- Give students additional opportunities to practice finding the gradient of a perpendicular line and using the gradient to find the equation of the perpendicular line.
- Go through a step-by-step process for deriving a composite function and evaluating that function at a given value of x.
- Give students additional opportunities to practice solving various types of equations, especially fractional equations.

Question 5

This question tested candidates' ability to

- determine measures of central tendency
- determine the probability of a simple event
- make inferences from statistics.

Candidates' Performance

More than 99 per cent of candidates attempted to provide a response. Overall, 1210 candidates (2 per cent of candidates) scored full marks. The mean was 3.15 out of 9 marks (35 per cent) and the standard deviation 2.14. Approximately 76 per cent of candidates scored less than half the available marks. Of the 62 465 candidates taking the examination, 5498 (8.80 per cent) scored zero. The modal mark was two.

Areas of Good Performance

- Candidates understood the mode as the group/data item with the greatest frequency. Candidates who failed to obtain this mark did so because they gave the highest frequency (31) or the midpoint of the modal class (75) instead of the modal class of $70 < x \leq 80$.
- Candidates knew that calculating the mean involved addition followed by division.
- Candidates performed well on Part (b)(i). Approximately 80 per cent of candidates were able to get it correct. Candidates used logic well in order to complete the table by inserting the missing values.
- Candidates recognized that 40 students were driven to school. This implies that they were able to interpret the data presented in the table.

Areas of Weak Performance

- Candidates did not pay attention to the wording of the question in Part (a)(i) for which they were asked to give the modal class.
- Many candidates did not know that they were supposed to divide by 100. Instead, several candidates divided by 5.
- Part (a)(ii) was the least popular part. Some candidates who attempted to provide a response simply stated the median without relating it to the interval $80 < x \leq 90$. Less than one per cent of candidates gave a correct explanation.
- In Part (b) (iii), candidates disregarded that the question related to the girls only so they added the number of students who did not cycle and divided by 100.

Answers

The following are the expected answers for each part of Question 5.

(a) (i) a) $70 < x \leq 80$ (a) (i) b) 79.80

(a) (ii) median class is $80 < x \leq 90$.

(b) (i) 8, 19, 37, 52 (b) (ii) 0.4 (b) (iii) 0.65

Recommendations

Teachers should do the following.

- Allow students to practise using a frequency table. Teachers should give students a frequency table and have them create possible questions based on the table. This will cause the students to anticipate questions based on a table.
- Deconstruct the frequency table into raw data in order to emphasize the mode and the median. In frequency tables with numbers in both columns, it is easy for the students to get confused.
- Focus on literacy in mathematics. Students should be encouraged to read the question and underline key terms. This would help them understand how to approach answering questions structured like Part (a)(i) and Part (b)(iii).
- Highlight to students the fact that the values inserted in a table can be checked by calculating row totals and column totals.

Question 6

This question tested candidates' ability to

- calculate the volume and surface area of solids
- solve problems involving measurement.

Candidates' Performance

The performance of candidates was poor. Many candidates attempted to provide an answer. Approximately 82 per cent of candidates who provided a response failed to score any marks. Approximately four per cent of candidates scored more than half the available marks. The mean was 0.53 out of 9 marks (5.89 per cent) and the standard deviation 1.53.

Areas of good performance

- Most candidates were able to show that the internal capacity of the box was 8 091 000 cm^3. They did this by multiplying the correct dimensions 290cm x 180cm x 155cm. A few candidates included the process of how they derived the dimensions in their product (300 −10) x (190 −10) x (160 −5).
- Even though Part (b) was poorly done, many candidates were able to gain the mark for using the correct process of adding five areas or for finding the correct external volume.
- Most candidates who were successful recognized that to find the amount of paint needed to paint the internal surface of the trough, they had to divide the area by 280 000cm^2 and then multiply that value by 3.79.

Areas of weak performance

- Part (b) was poorly done. In calculating the surface area, many candidates did not use the correct dimensions when adding the five areas. Those who used the alternative method only found the external dimensions of the box without subtracting it from the internal dimensions.
- In Part (c), many candidates divided the volume by 280 000 instead of using this number to divide the area. Such candidates lost marks for doing so.

Answers

The following are the expected answers for each part of Question 6.

(a) 290 x 180 x 155 (b) 1 029 000 (c) 2.68

Recommendations

- Students need to be given more practice in calculating the volumes and surface areas of an object where there is some degree of thickness involved.
- Students need to be exposed to more than one method of calculating the surface area or volume of a solid where some degree of thickness is involved.

Question 7

This question tested candidates ability to

- compute terms of a sequence using a given rule
- derive an appropriate rule given the terms of a sequence.

Candidates' Performance

Candidates were familiar with this type of reasoning question and most attempted to provide an answer. Most candidates who attempted to provide an answer scored at least one mark.

Areas of good performance

- Most candidates were able to complete the fourth figure in the sequence.
- Many candidates were able to determine the number of lines (*L*) and the perimeter (*P*) in Part (i) and Part (ii).
- Candidates were able to subtract their answers in Part (iii) and were awarded at least one mark.

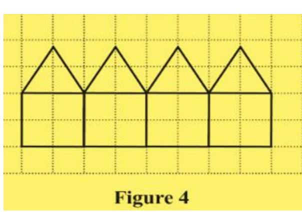
Areas of weak performance

- Many candidates were unable to do Part (a) (iii) completely. Some candidates provided answers that were either completely or partially wrong. They were unable to determine the expressions for *L* and *P* in terms of *n*. Many candidates came up with numerical values.
- For Part (c), some candidates were able express the difference between *L* and *P* as an expression in terms of *n* but either did not simplify the expression or simplified it incorrectly because they did not put the expressions in brackets.
- Also, for Part (c), some candidates misinterpreted what the question asked when it asked them for the difference between the number of lines and the perimeter of any figure. They did not attempt to find the mathematical difference; instead they attempted to describe in words what was different between *L* and *P*.

Answers

The following are the expected answers for each part of Question 7.

(a)



(b) (i) 26, 17 (b) (ii) 13, 41 (b) (iii) 5n + 1, 3n + 2

(c) 2n – 1

Recommendations

- Teachers should be encouraged to show students how to express the formula for the n^{th} term of various types of sequences as well as what patterns to look for.

Question 8

This question tested candidates' ability to

- use linear programming techniques to graphically solve problems involving two variables
- draw and use the graph of a quadratic function to identify its key features which include
  - — the maximum or minimum value of the function
  - — the equation of the axis of symmetry.

Candidates' Performance

Overall, candidates' performance was below par. Approximately nine per cent of candidates got at least half the available marks. The mean was 2.10 out of 12 marks (17.5 per cent) and the standard deviation 2.34. Of the 62 465 candidates taking the examination, 23 219 candidates (37.17 per cent of candidates) scored zero while 81 candidates (0.13 per cent of candidates) scored full marks.

Areas of good performance

- For Part (a) (ii), candidates were able to write the inequality $x \geq y$.
- In Part (b), many candidates were able to plot the coordinates. However, many of them did not draw the curve. Many candidates were also able to draw the axis of symmetry.

Areas of weak performance

- Many candidates did not draw the graphs for the inequalities and those who attempted to do so did not draw them correctly.
- In Part (b) (ii), many candidates were not able to get the minimum value. A lot of them wrote it as −4.

Answers

The following are the expected answers to each part of Question 8.

(a) (i) $60x + 80y \leq 1200$	(a) (ii) $x \geq y$	(a) (iv) 20
(b) (ii) −4.25	(b) (iii) $x = -0.5$	

Recommendations

Teachers should

- demonstrate to students the difference between the inequality signs
- expose the students to linear programming
- expose students to more graphs of linear and quadratic functions
- assist students with being able to distinguish between minimum/maximum values and equation of axis of symmetry
- emphasize to students that the x-axis is the line $y = 0$ and the y-axis is the line $x = 0$.

Question 9

This question tested candidates' ability to

- solve geometric problems using properties of circles and circle theorems
- relate objects in the physical world to geometric objects
- use the sine and cosine rules to solve problems involving triangles
- solve problems involving bearings.

Candidates' Performance

The performance of candidates was unsatisfactory. It should be noted that many candidates only attempted a few parts or did not attempt any parts at all. The mean was 0.98 out of 12 marks (8.17 per cent) and the standard deviation 2.02. Approximately 95 per cent of candidates who attempted to provide an answer scored less than half the available marks. Of the 62 465 candidates taking the examination, 42 071 candidates (67.35 per cent of candidates) scored zero while 161 candidates (0.26 per cent of candidates) scored full marks.

Areas of good performance

The following was noted for Part (a).

- Candidates were able to calculate the angle *ECD* as 68^0 correctly and give the correct reason in most cases. Very few got 74^0 using the alternate segment theorem.
- Candidates were able calculate the angle *CEG*.
- In most cases, candidates were able to calculate the angle *CGF* correctly using their angles in the cyclic quadrilateral and give the correct reason for the size of the angle.

The following was noted for Part (b).

- Some candidates were able to correctly insert the 151^0 angle (or 82^0 angle) and the 175 km distance in the diagram as requested.
- Some candidates were able to identify that the cosine rule should be used to find the length *QR* even if they were not able to get the correct answer. Most candidates got the correct length once the correct angle, *QHR*, was found.

Areas of weak performance

- For Part (a) (ii), even though candidates were able to calculate angle *CEG*, too many of them were unable to give a valid reason for the size of the angle they calculated.
- For Part (b) (i), many candidates were unable to figure out that the angle *QHR* was 82^0. There were many cases where '151^0'was inserted which indicated that the candidates did not fully understand the concept of bearings.
- In Part (b) (ii), few candidates were able to calculate the correct length, *QR,* which stemmed from the incorrect angle being used. Some candidates attempted to use Pythagoras Theorem instead of the cosine rule.
- Candidates' weakest performance was on Part (b) (iii). Few candidates were able to use the correct trigonometric ratio to calculate the length. Most candidates assumed they needed to calculate an angle and gave 29^0 as their answer. Some also attempted to use the sine rule but used it wrongly and a few candidates used the wrong trigonometric ratio.

Answers

The following are the expected answers for each part of Question 9.

(a) (i) 68	(a) (ii) 22	(a) (iii) 142
(b) (ii) 278	(b) (iii) 212	

Recommendations

Teachers should

- impress on students they should not only be able to use the circle theorems but they should also be able to give reasons based on the theorem used for the answers they obtain.
- give students more guidance on how to select the most suitable method of finding angles and lengths in triangles. They should also help students understand how to determine when trigonometric ratios should be used as opposed to the cosine or sine rules
- give students more opportunities to practice drawing diagrams and to show given bearings and calculations based on these diagrams.

Question 10

This question tested candidates' ability to

- solve problems involving matrix operations
- obtain the inverse of a nonsingular 2 x 2 matrix
- simplify expressions involving vectors
- write the position vector of a point $P(a, b)$ as OP = $\binom{a}{b}$ where O is the origin (0,0)
- determine the magnitude of a vector.

Candidates' Performance

The performance of candidates was unsatisfactory. A few candidates attempted to provide an answer but very few of these candidates gained full marks. Candidates mainly focused on the matrices aspect and often did not answer the vector portion of the question. Most candidates scored zero (40 263 or 64.46 per cent of candidates) while 176 candidates (0.28 per cent of candidates) gained full marks. The mean was 1.24 out of 12 marks (10.33 per cent) and the standard deviation 2.25. Approximately 93 per cent of candidates scored less than half the available marks.

Areas of Good Performance

- For Part (a) (i), candidates were required to calculate the product of a 2×2 matrix and a 2×3 matrix. Most candidates who attempted this part were able to gain both marks. The first mark was awarded for the procedure used and the second mark was awarded for the entries being in their correct position.
- For Part (c) (i), candidates were asked to state $\overrightarrow{CD}$ in terms of *r* and *s*. Only a few candidates attempted this part. Of those who attempted it, some were able to gain the mark for correctly stating the path from *C* to *D*. Many candidates tried to use a path other than the obvious one and as a result did not obtain the correct answer because they were not able to simplify the algebraic vector sum thus not gaining both marks. A few candidates were able to simplify the vectors and gain both marks.
- For Part (d) (i), candidates were required to write $\overrightarrow{OR}$ as a column vector. Most candidates were able to gain the mark. Candidates misjudged the scale and as such doubled the components and wrote $\begin{pmatrix} -2 \\ 8 \end{pmatrix}$. Thus, they did not earn the mark. Some candidates also used the coordinates of *R* with the origin and wrote it as the 2×2 matrix $\begin{pmatrix} 0 & -1 \\ 0 & 4 \end{pmatrix}$.

- For Part (d) (ii), candidates were asked to determine $|\overrightarrow{QR}|$. Most candidates were able to gain at least one mark for stating the correct components of $\overrightarrow{QR}$ or for calculating the magnitude of $\overrightarrow{QR}$ by following through with the components of $\overrightarrow{QR}$ calculated. A few candidates were able to gain both marks by using coordinate geometry correctly and finding the length of the line *QR*. Some candidates used the correct approach and gained both marks. Some candidates were unsure of the symbol (| |) and as such calculated the determinant of a matrix.

Areas of weak performance

- In Part (a) (ii), candidates were required to state why the matrices given in Part (a) (i) were conformable for multiplication. Even though some candidates who made an attempt were able to show that the two matrices are conformable because the column of the first matrix is equal to the row of the second, some candidates were unable to distinguish between the row and column of the two matrices.
- For Part (b), candidates were asked to determine the inverse of a 2×2 matrix. Many candidates who attempted to find the determinant did so correctly and earned that mark. Some candidates were able to gain the mark for providing the correct adjoint and determinant even though their determinants were incorrect because they used the determinant they obtained with the correct adjoint to get an inverse. However, a few candidates were unable to state the correct adjoint so they gained one mark only. Of those candidates who attempted this part, most of them were able to gain at least one mark.
- In Part (c) (i), candidates were asked to state $\overrightarrow{OE}$ in terms of *r* and *s*. In this part, candidates were required to use the value that they calculated for $\overrightarrow{CD}$. Some candidates were able to gain one mark since they followed through with the value that they calculated. But of those who were able to follow through with this value, only a few were able to gain the other mark because they were not able to able to simplify the vector algebra. A few candidates who attempted Part (c) were able to gain a maximum of four marks while most of them gained only two marks.

Answers

The following are the expected answers for each part of Question 10.

(a) (i) $\begin{pmatrix} 10 & 17 & 4 \\ -6 & -9 & 0 \end{pmatrix}$

(a) (ii) number of columns in *LHS* matrix = number of rows in *RHS* matrix

(b) $\frac{1}{2}\begin{pmatrix} -2 & -4 \\ 3 & 5 \end{pmatrix}$

(c) (i) $\frac{2}{3}s - \frac{5}{12}r$ (c) (ii) $\frac{13}{24}r + \frac{1}{3}s$

(d) (i) $\begin{pmatrix} -1 \\ 4 \end{pmatrix}$ (d) (ii) 6.32

Recommendations

- Teachers need to put more emphasis on teaching students about vector algebra.
- Teachers need to spend more time teaching and showing students how to calculate the magnitude of a vector.

PAPER 031 — SCHOOL BASED ASSESSMENT

Paper 031 is an in-school project which is marked by teachers in accordance with CXC guidelines. The aim of the project is to assist students with acquiring knowledge, skills and attitudes that are critical to the subject.

Recommendations

- Project title — Students should use a title that is clear and that relates to a real-world problem for which a solution can be obtained.
  - Example of an unclear title: Preference of teenagers at KFC.
  - Example of a clear title: An investigation into whether motorists obeyed the speed limit within the school zone during school hours. This title is clear and it relates to a real-world problem.
- Method of data collection — students should reference the sample size and mention what type of sample it is (random, etc.). They should also include the raw data in the project so that the information and calculations can be verified.
- Mathematical concepts — Students should show how averages, etc. are calculated rather than just writing down the values.
- Analysis — Students can calculate percentages and compare these values.
- Conclusion — The Conclusion should answer the Aim of the project. If the title of the project was 'To Find the Price of a Burger at the School Canteen', in the conclusion, the price of the burger should be stated (the price of the burger is $12.00). Saying how the burger tasted and how long you had to wait for the burger was not the aim of the project and therefore students will not be awarded marks for including such comments.

PAPER 032 — ALTERNATIVE TO THE SCHOOL-BASED ASSESSMENT (SBA)

This paper is an alternative to Paper 031 and is taken by private candidates. The paper comprises two compulsory questions. The topics tested may be taken from any section or a combination of sections of the syllabus.

The paper was worth a total of 20 marks, which is then scaled to 40 marks. The mean score was 7.12 (or 17.79 per cent) and the standard deviation 7.13. In May/June 2021, four candidates (0.15 per cent of candidates) earned the maximum available score while 428 of them (16.40 per cent of candidates) scored zero.

Question 1

This question tested candidates' ability to

- calculate the area of the vertical section of a hexagonal bar of gold
- calculate the mass of a bar of gold when given its density and volume
- calculate the volume of a hexagonal prism
- calculate the surface area of a hexagonal prism
- find the radius of a sphere when information is given about the volume of the sphere.

Candidates' Performance

Candidates performed poorly. Overall, of the 2610 candidates who wrote the examination, 27 candidates (1.03 per cent of candidates) scored full marks. On the other hand, 1154 (44.21 per cent of candidates) scored zero. The overall mean score was 1.45 out of 10 marks.

Areas of good performance

- This question was answered by more than 95 per cent of candidates (sample size = 100).
- For Part (a) (i), many candidates were able to input the right dimensions to calculate area of vertical section of the hexagonal gold bar.
- Using the area calculated in Part (a) (i), many candidates were able to calculate the volume of the gold bar using the formula $V = A \times L$
- Some candidates were able to use information about density and volume to calculate the mass of the bar.

Areas of weak performances

- Many candidates were not able to calculate the total surface area of the gold bar using the information provided.
- While some candidates were able to calculate the mass of gold bar in grams, some were not able to convert that measurement to the nearest kilogram.

- Making *r* the subject to find the radius when given the volume of a sphere proved challenging for many candidates.
- Some candidates did not read the question carefully and therefore missed the salient information presented.
- Some candidates were unfamiliar with some of the concepts assessed.

Answers

The following are the expected answers for each part of Question 1.

(a) (i)166.28 (a) (ii) 2860.02 (a) iii) 55 (a) (iv) 1158.16

(b) 2.50

Recommendations

Candidates should

- know the correct mode to put their calculators
- understand problem solving strategies so that they can read and understand the questions
- be familiar with every aspect of the syllabus.

Question 2

This question tested candidates' ability to

- determine the intercept of a graph of a linear function
- determine the gradient of a straight line
- determine the equation of a straight line
- solve problems involving equality of matrices.

Candidates' Performance

Overall, this question proved to be challenging for most candidates but candidates answered it better than they did Question 1. Of the 2610 candidates who attempted to provide an answer, 645 candidates (24.71 per cent of candidates) scored zero while 10 candidates (0.38 per cent) gained full marks. The mean was 2.11 out of 10 marks (21.1 per cent) and the standard deviation 2.17. Approximately 9 per cent of candidates scored more than half the available marks.

Areas of good performance

- Candidates were able to read the graph correctly and the responses fell within the expected range (2200 to 2300) when they were asked how far above the ground is the skydiver after 25 seconds.
- Some candidates demonstrated understanding of the concept of finding the slope from the graph and were logically able to explain the concept.
- Part (b) was easily done by candidates as they were able to find the values of *x* and *y* in the matrix question whether through equation method, trial and error, check or otherwise.

Areas of weak performances

- Calculating the slope of the line *BC* and providing an explanation of what the value means was challenging for candidates.
- Some candidates did not know what the negative gradient meant.

Answers

The following are the expected answers for each part of Question 2.

(a) (i) 2250 (a) (ii) −50 (a) (iii) 70 (a) (iv)

(b) $x = 8$, $y = 1$

Recommendations

Teachers should

- let students practise reading values from graphs that lie between the square units
- emphasize the sign of slope when teaching students about the gradient of a line. Students were able to calculate the gradient of the line using given points. However, they need to be able to explain the answers they obtain when they do calculations related to speed-time and distance-

time graphs. Therefore, it is recommended that teachers highlight to students the need to be able to provide such explanations and encourage students to practise problems relating to this area.

GENERAL RECOMMENDATIONS

Students need to

- read the instruction section at the front of the booklet carefully
- read the questions thoroughly to understand what is required of them
- write down all necessary working especially when questions ask them to show
- make use of the list of formulae given on page 4 of the examination booklet.

Teachers need to remind and encourage students to

- answer the questions that are asked of them
- follow the instructions given always
- realize when solutions make no sense and therefore check their working for obvious mistakes. For example, obtaining a negative answer for the volume of an object or for the number of people
- show all necessary working especially for questions where they must show or verify a result.

Teachers need to emphasize the use of correct mathematical terminologies (for example, *transpose, reflection, rotation, expand, factorize*, etc.) in their teaching so that students would not encounter some of these terms for the first time in the examination and hence would be unable to answer the questions correctly.