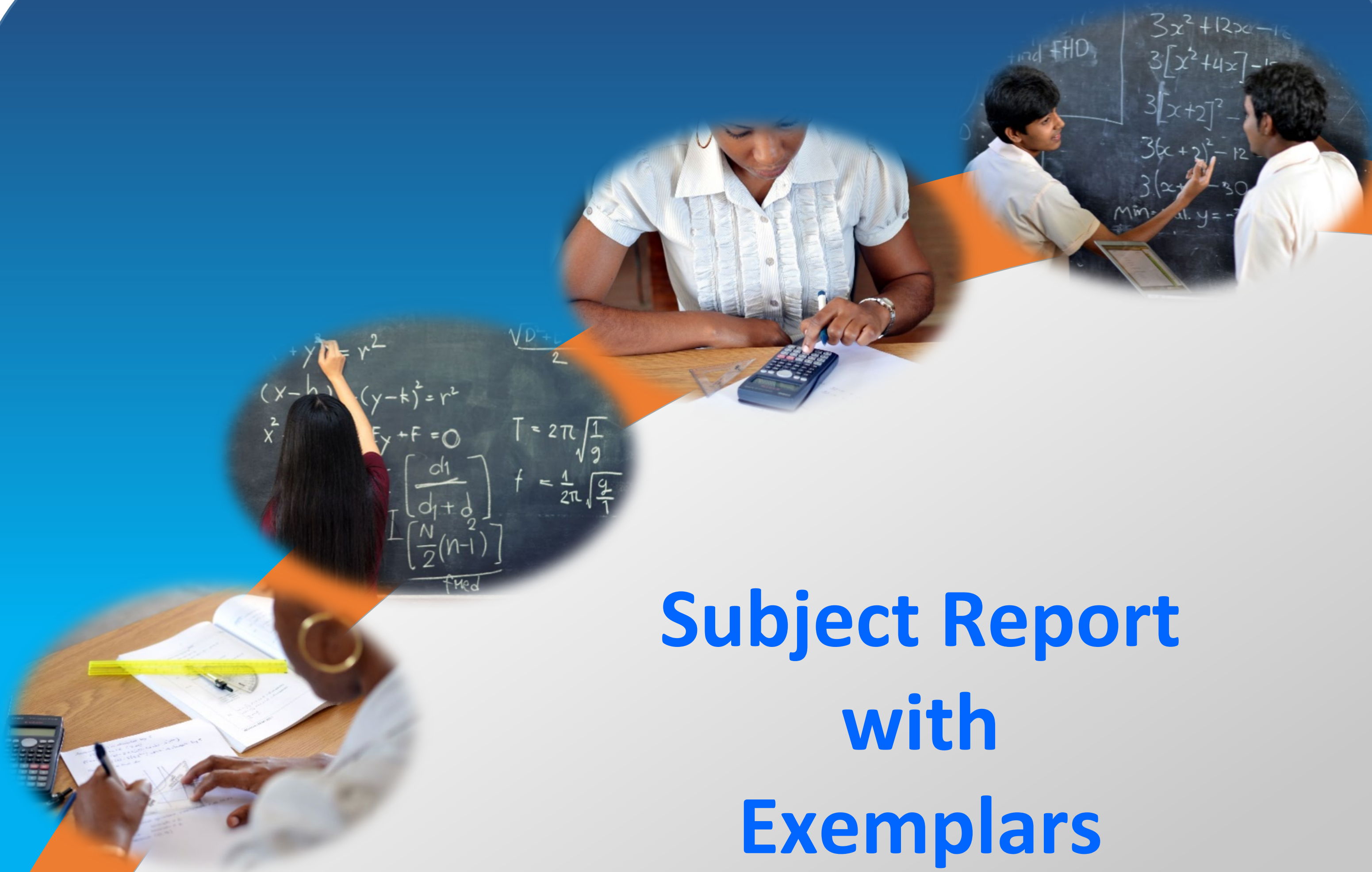
CARIBBEAN EXAMINATIONS COUNCIL

CSEC® MATHEMATICS



Subject Report with Exemplars

May/June 2024

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2024

MATHEMATICS
GENERAL PROFICIENCY

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INTRODUCTION

This guide has been compiled using candidates’ responses to the 2024 May/June CSEC Mathematics examination. The CSEC Mathematics examination is offered in January and May/June each year. In May/June 2024, approximately 70 861 candidates sat the examination.

Overall, the mean score was 76.71 out of 200 marks and the standard deviation was 30.82. The examination catered to the varying abilities of candidates.

The aim of this report is to outline how candidates performed in the 2024 May/June examination. The report is expected to be viewed as a helpful and constructive means of supporting teachers and students in the learning process.

The 2024 examination consisted of four papers.

- Paper 01 — Multiple choice
- Paper 02 — Structured answer
- Paper 031 — School-based Assessment (SBA)
- Paper 032 — Alternative to the SBA

The performance of candidates on Paper 01, Paper 02 and Paper 032 is detailed in this report. In addition, the mark scheme for the examination is included for your reference in the Appendix.

PAPER 01 — MULTIPLE CHOICE

Paper 01 consisted of 60 multiple–choice items. The paper was designed to test candidates' knowledge and understanding of the syllabus content. The items were taken from all sections of the syllabus.

In 2024, the mean score was 30.55 out of 60 marks or 50.91 per cent. The standard deviation was 11.26. One hundred and eighty-eight candidates (0.26 per cent of candidates) earned the maximum available score of 60. Fourteen candidates (0.02 per cent of candidates) scored zero.

PAPER 02 — STRUCTURED ESSAY

Paper 02 consisted of two sections which comprised structured and/or problem-solving questions. Section I comprised seven compulsory questions which were worth a total of 64 marks. Section II comprised three compulsory questions based on the following topics.

- Algebra, and Relations, Functions and Graphs
- Measurement, Geometry and Trigonometry
- Vectors and Matrices

There was one question per topic.

Each question in this section was worth 12 marks. The mean score was 17.10 out of 100 marks and the standard deviation was 18.55. Four candidates earned the maximum available score of 100 while 2315 candidates (3.19 per cent of candidates) scored zero.

Question 1

This question was based on Section 1: Number Theory and Computation and Section 2: Consumer Arithmetic. It tested candidates' ability to

- order a set of real numbers
- evaluate numerical expressions using any of the four basic operations on real numbers
- perform basic functions using a calculator
- express a value to a given number of significant figures and decimal places
- write a number in scientific notation
- compare quantities
- calculate any fraction or percentage of a given quantity
- solve consumer-related problems on measures and money.

Candidates' Performance

Of the candidates who attempted this question, 3779 candidates (5.21 per cent of candidates) earned the maximum available mark. The following was also noted.

- Most candidates scored between zero and two marks out of a total of nine marks.
- Approximately 36 251 candidates (50 per cent of candidates) earned two marks at most.
- The mean mark was 3.20 out of 9.
- In relation to the other questions on the examination, the performance of candidates was satisfactory.
- Candidates did not attempt some parts.

Candidate's Response to Part (a) (i)

(a) (i) Calculate the value of $\sqrt{(7.1)^2 + (2.9)^2}$, giving your answer correct to

a) 2 significant figures

$\sqrt{(7.1)^2 + (2.9)^2}$

$= \sqrt{50.41 + 8.41}$

$= \sqrt{58.82}$

$= 7.7$

(1 mark)

b) 2 decimal places.

7.669

$= 7.67$

(1 mark)

Examiner's Comments

The candidate performed well.

Candidate's Response to Part (a) (ii)

(ii) Write the following quantities in ascending order.

$\frac{12}{25}$, 0.46, 47%

0.48 0.47

0.46 < 47% < $\frac{12}{25}$

(1 mark)

Examiner's Comments

The candidate answered correctly.

Candidate's Response to Part (b)

(b) Mahendra and Jaya shared \$7 224 in the ratio 7:5. How much MORE money does Mahendra receive than Jaya?

$$M = \frac{7}{12} \times \frac{7224}{1} = 4214$$

$$J = \frac{5}{12} \times \frac{7224}{1} = 3010$$

$$1204$$

= \$ 1204 ....

(2 marks)

Examiner's Comments

Many candidates were able to calculate how much money both Mehendra and Jaya received. However, numerous candidates forgot to subtract the amount Jaya received from the amount that Mahendra received to arrive at the correct answer.

Candidate's Response to Part (c) (i)

(c) The present population of Portmouth is 550 000. It is expected that this population will increase by 42% by the year 2030.

(i) Write the number 550 000 in standard form.

5.50000

$= 5.50 \times 10^5$

(1 mark)

Examiner's Comments
Generally, candidates performed well. However, many candidates wrote 550 000 in words instead of in standard form.

Candidate's Response to Part (c) (ii)

(ii) Calculate the expected population of Portmouth in 2030.

$\frac{42}{100} \times \frac{550000}{1} = 2.31 \times 10^5$

$= 231000$

550000 + 231000

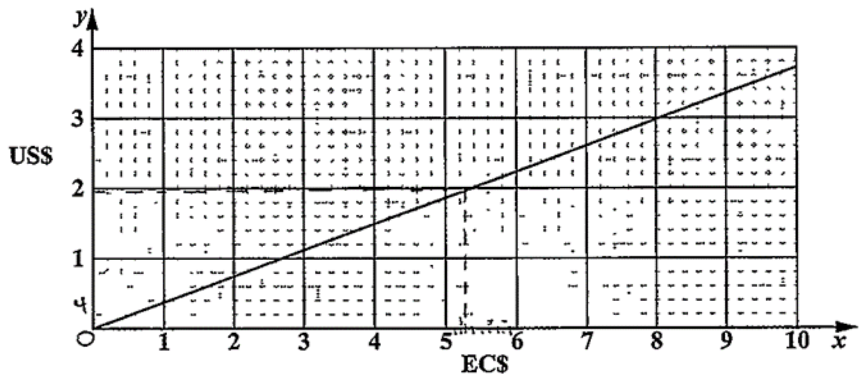
Population increase 781 000

(1 mark)

Examiner's Comments
Many candidates found 42 per cent of 550 000. However, they did not add their answer to 550 000 to arrive at the total for the expected population of Portmouth in 2030.

Candidate's Response to Part (d) (i)

(d) The graph below can be used to convert between United States dollars (US$) and Eastern Caribbean dollars (EC$).



Using the graph,

(i) convert US$2 to EC$.

~~= EC$ 2.00~~ = EC$ ~~5.90~~ 5.30

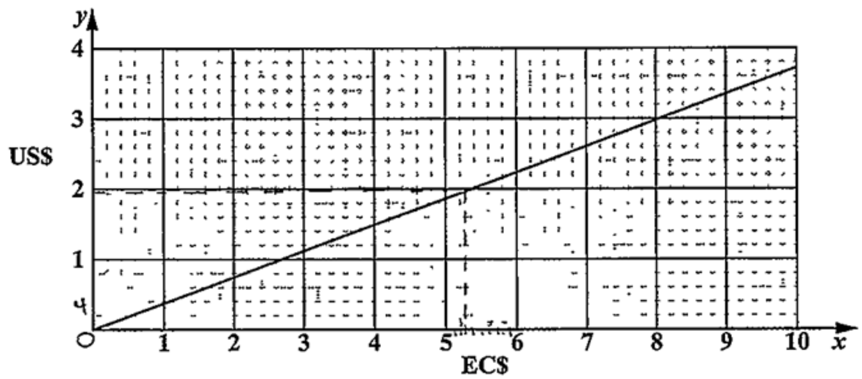
(1 mark)

Examiner's Comments

Some candidates interpreted the graph incorrectly. Other candidates did not attempt this part.

Candidate's Response to Part (d) (ii)

(d) The graph below can be used to convert between United States dollars (US$) and Eastern Caribbean dollars (EC$).



Using the graph,

(ii) convert EC$70 to US$.

$ 1 EC to sUS$ = $ 0.40

70 x 0.40 = $28.

~~US$ 28.00~~ = US$ 28.00

(1 mark)

Examiner's Comments

Many candidates did not attempt this part. However, some candidates were able to gain full marks.

Recommendations

Teachers should

- emphasize to students that they need to read questions carefully so that they provide a complete and correct answer to each question
- teach students thoroughly, using examples, about scientific notation/standard form and the other areas in algebra that help students to cement their understanding of the concept
- encourage students to use calculators properly

- present stimulus materials in a variety of formats for students to analyse and use to solve problems in consumer arithmetic.

Question 2

This question was based on Section 6: Algebra. It examined candidates' ability to

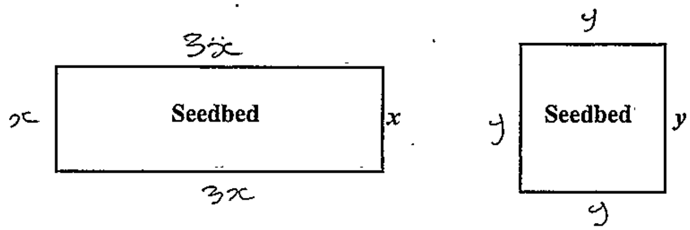
- translate algebraic symbols into worded expressions and vice versa
- simplify algebraic expressions using the four basic operations
- change the subject of formulas
- solve quadratic equations algebraically
- solve worded problems based on the application of algebra.

Candidates' performance

Almost all candidates attempted this question. Overall, the performance of candidates was extremely poor. Five hundred and sixty-two candidates (0.77 per cent of the candidates) earned the maximum available mark while 59 248 (81.63 per cent of candidates) scored zero. The mean mark was 0.56 out of 9 (6.2 per cent).

Candidate's Response to Part (a)

Laura needs to put mesh around **two** seedbeds to protect her seedlings. **Altogether**, she uses 60 m of mesh. One of the seedbeds is a rectangle and the other is a square, as shown in the diagram below.



The width of the rectangular seedbed is x metres. The length of the rectangular seedbed is 3 times its width. The length of a side of the square seedbed is y metres.

(a) Using the information given above, derive a simplified expression for y in terms of x.

total mesh = perimeter of rectangle + perimeter of square

$$60 = 8x + 4y$$

$$4y = 60 - 8x$$

$$y = \frac{60}{4} - \frac{8x}{4}$$

$$y = 15 - 2x$$

....

(2 marks)

Examiner's Comments

Most candidates were able to correctly identify the perimeter of the rectangle and the perimeter of the square. Hence, they derived the correct answer.

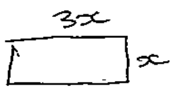
Candidate's Response to Part (b) (i)

(b) The area of the rectangular seedbed is **equal** to the area of the square seedbed.

(i) Use this information and your answer in (a) to write down a quadratic equation, in terms of x, and show that it simplifies to

$$x^2 - 60x + 225 = 0.$$

~~Perimeter~~ $y = 15 - 2x$



area $= 3x \times x$

$= 3x^2$

Area $= y^2$

$3x^2 = y^2$

$3x^2 = (15 - 2x)^2$

$3x^2 = (15 - 2x)(15 - 2x)$

$3x^2 = 225 - 30x - 30x + 4x^2$

$0 = 225 - 60x + x^2$

$\therefore x^2 - 60x + 225 = 0$ Hence shown

(2 marks)

Examiner's Comments

Numerous candidates correctly equated the areas for both shapes. However, most candidates made algebraic errors moving forward. Candidates were not able to expand and simplify the brackets to prove the quadratic equations.

Candidate's Response to Part (b) (ii)

(ii) Solve the equation $x^2 - 60x + 225 = 0$ using the quadratic formula.

$a = 1$
$b = -60$
$c = 225$

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

$$= \frac{60 \pm \sqrt{(-60)^2 - 4(1)(225)}}{2(1)}$$

$$= \frac{60 \pm \sqrt{2700}}{2}$$

$\sqrt{3600 - 900}$
$= \sqrt{2700}$
$=$

$$x = \frac{60 + \sqrt{2700}}{2}$$
$= 55.98$ (to 2 dp)
⇐ unreasonable answer

or

$$x = \frac{60 - \sqrt{2700}}{2}$$
$= 4.02$ (to 2 dp)

$\therefore\ x = 4.02$ m (to 2 dp)

(3 marks)

Examiner's Comments

Most candidates failed to correctly use the quadratic formula to solve the equation. Some candidates used the factorization method although the question specified that candidates should use the quadratic formula.

Candidate's Response to Part (b) (iii)

(iii) Calculate the TOTAL area of the **two** seedbeds.

Area of ▭ $= 3x^2$
$= 3(4.02)^2$
$= 48.4812$

Area of □ $= y^2$
$= (15 - 2x)^2$
$= (15 - 2 \times 4.02)^2$
$= 48.4416$

Total area = A. of ▭ + A. of □
= 48 (to nearest whole) + 48 (to nearest whole) = 96 m²

(2 marks)

Examiner's Comments

Most candidates were not able to find the correct area; numerous candidates substituted incorrect values for *x*.

Recommendations

- Candidates require more practice in the following areas.
  - Using the formula method to solve quadratic equations
  - Rearranging equations to make a particular variable the subject or expressing one variable in terms of the other
  - Solving worded problems involving equations/quadratic equations
- It may be useful for teachers to teach students the derivation of the quadratic formula which may provide more meaning to students when manipulating quadratic equations.

Question 3

This question was based on Section 8: Geometry and Trigonometry. It tested candidates' ability to

- use a trigonometric ratio (sine) to solve the length of a missing side when given a right-angled triangle
- use Pythagoras' theorem to find the missing length of the hypotenuse
- find the value of a missing angle in a given diagram, using the properties of an isosceles triangle and the properties of parallel lines
- describe a transformation as a reflection given its image and object
- state the equation of a mirror line
- draw an image after a translation given the object and the translation vector.

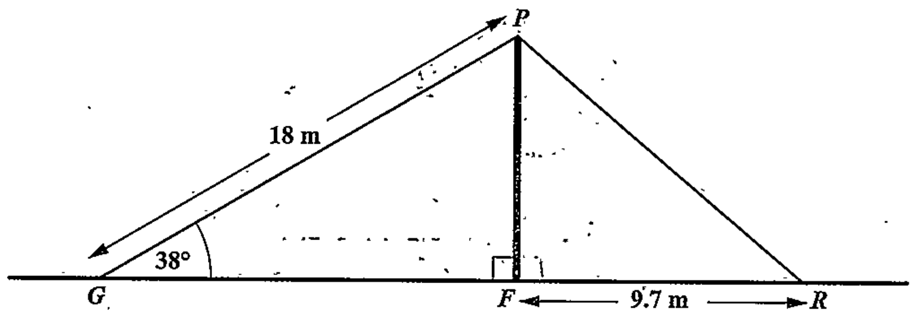
Most candidates attempted this question. Generally, candidates performed unsatisfactorily. They omitted the entire question or parts thereof. Approximately 19 per cent of candidates scored four or more marks out of a total of nine marks. The mean score was 1.60 out of nine marks.

Only 1796 candidates (2.47 per cent of candidates) scored full marks while 38 811 (53.47 per cent of candidates) scored zero. Most candidates scored 0 or 1 mark.

Candidate's Response to Part (a) (i)

(a) A vertical flagpole, *FP*, stands on horizontal ground and is held by two ropes, *PG* and *PR*, as shown in the diagram below.

$PG = 18$ m, $FR = 9.7$ m and angle $FGP = 38°$.



(i) Calculate the height of the flagpole, *FP*.

$\sin\theta = \frac{opp}{hyp}$

$\sin 38 = \frac{FP}{18}$

$18 \sin 38 = FP$

$FP = 11.08$ m (to 2 d.p.)

$FP = 11.08$ m (to 2 d.p.)

(2 marks)

Examiner's Comments

Candidates did Part (a) (i) satisfactorily. Most candidates applied the sine ratio correctly to find the length of *PF*.

Some candidates used alternative methods such as calculating the value of angle *PGF* and using the sine rule or cosine rule to calculate *PF*.

Candidate's Response to Part (a) (ii)

(ii) Find PR, the length of one of the pieces of rope used to hold the flagpole.

~~GF =~~ GF:

$\tan\theta = \frac{opp}{adj}$

$\tan 38 = \frac{11.08}{GF}$

$GF = \frac{11.08}{\tan 38}$

$= 14.18\text{m (2d.p.)}$

$GR = 14.18 + 9.7$

$= 23.88\text{m}$

USING COSINE RULE:

$a^2 = b^2 + c^2 - 2bc\cos A$

$PR^2 = 18^2 + 23.88^2 - 2(18)(23.88)\cos 38$

$PR = \sqrt{894.2544 - 2(18)(23.88)\cos 38}$

$= 14.72\text{m (to 2d.p.)}$

$PR = 14.72\text{m (to 2d.p.)}$

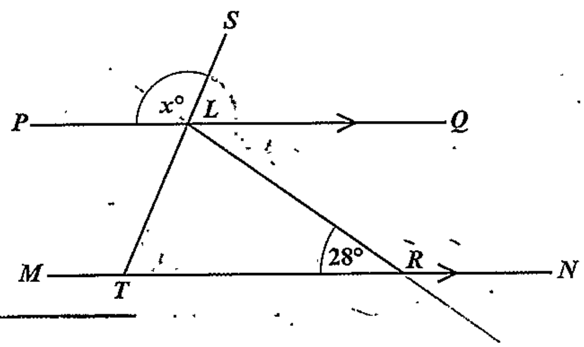
(2 marks)

Examiner's Comments

Part (a) (ii) was satisfactorily done as candidates correctly substituted the values into Pythagoras' theorem. In many cases, candidates correctly used the answer from Part (a) (i) to complete the follow-up computation. In addition, candidates correctly applied alternate methods like the cosine rule. A few students incorrectly applied Pythagoras' theorem by subtracting instead of adding.

Candidate's Response to Part (b)

(b) In the diagram below, *PQ* is parallel to *MN*, *LRT* is an isosceles triangle and *SLT* is a straight line.



Find the value of x.

~~(∠LTR = 28° – base angles in an isoceles triangle are equal)~~

~~(remaining angle△ = 124° – all angles in a triangle add up to 180°)~~

~~(∠QLR = 28° – alternate interior angles)~~

~~(∴ x = 124 + 28~~

~~(= 152° – vertically opposite angles are equal)~~

$\angle RTL = \frac{180-28}{2} = 76°$ – base angles in an isosceles triangle are equal

$\therefore \angle RLT = 76°$

$\angle QLR = 28°$ – alternate interior angles are equal

$\therefore x = 76 + 28 = 104°$ – vertically opposite angles are equal

~~x = 152°~~ $x = 104°$

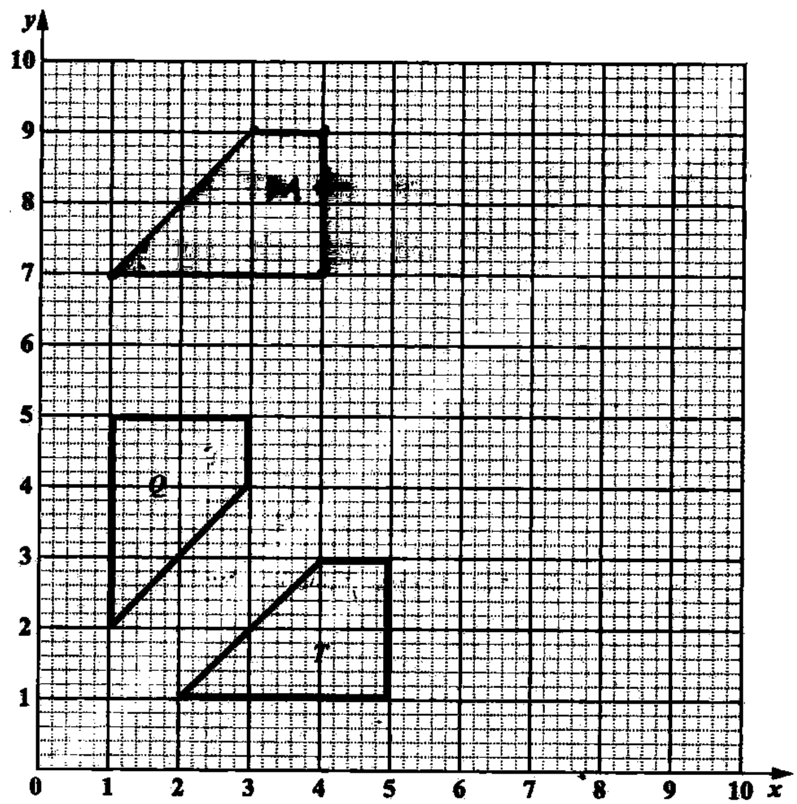
(2 marks)

Examiner's Comments

Overall, candidates performed satisfactorily. A few candidates correctly calculated the base angles of the isosceles triangle but did not find *x*. Common incorrect responses included '152°' (180° – 28°) and '124°' [180° – (28° x 2)]. Candidates failed to identify the base of the isosceles correctly. Many candidates did not provide an answer.

Candidate's Response to Part (c) (i)

(c) **The diagram below shows a shape, *T*, and its image, *Q*, after a transformation.**



(i) **Describe fully the single transformation that maps Shape *T* onto Shape *Q*.**

Shape T ~~was~~ undergoes a reflection in ~~the~~ the line y=x.

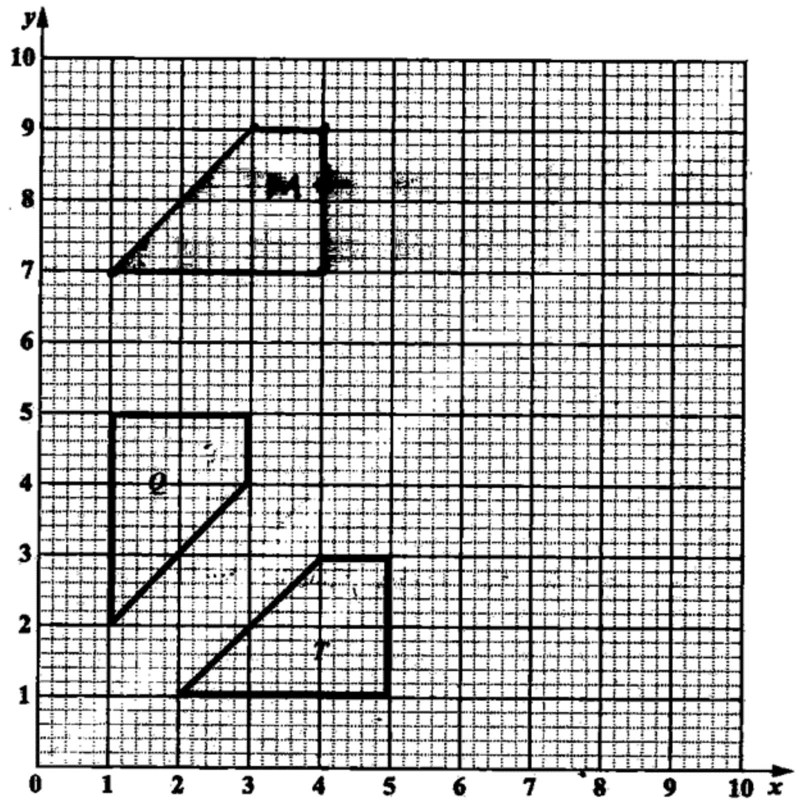
Examiner's Comments

Part (c) (i) was attempted by many candidates. They were able to identify the transformation as a reflection. However, most candidates could not state the correct equation of the mirror line which was *Y = X*. Some candidates drew the mirror line on the graph or gave the points which it passed through but they did not name it.

Many candidates used the incorrect mathematical terminology such as 'flip' or 'mirrored' for the term. *reflection*.

Candidate's Response to Part (c) (ii)

(c) The diagram below shows a shape, *T*, and its image, *Q*, after a transformation.



(ii) On the diagram above, draw the image of Shape *T* after it undergoes a translation by the vector $\begin{pmatrix} -1 \\ 6 \end{pmatrix}$. Label this image *M*. **(1 mark)**

Examiner's Comments
Many candidates positioned the image of the shape *T* on the graph incorrectly. In some cases, the image had a different area or shape.

Common Errors

The following are common errors that candidates made on each part.

- Part (a) (i): Candidates used the incorrect trigonometric ratio (cosine) to find the missing sides of *FP*.
- Part (a) (ii): Candidates applied Pythagoras' theorem incorrectly to find the missing side *PR*.

- Part (b): Candidates incorrectly applied the properties of an isosceles triangle, parallel lines and a transversal to find the value of the angle *x* in the given diagram.
- Part (c): Candidates were unable to name the mirror line as Y = X even though a few candidates plotted the points of the line or named the points which the line passed through.

Recommendations

Teachers should

- encourage students to use correct mathematical terminology
- provide students with ample practice questions for which they must use trigonometric ratios and apply Pythagoras' theorem
- provide students with practice in translating objects and finding the mirror line when the object and image are given under a reflection. Bolstering their knowledge of the concepts of symmetry and displacement will assist students in correcting their errors.

Question 4

This question was based on Section 7: Relations, Functions and Graphs. The question tested candidates' ability to

- determine the length of a straight line using the co-ordinates of two points on a line
- determine the gradient of a straight line
- determine the equation of a straight line using the co-ordinates of two points on the line
- evaluate a function $f\ (x)$ and $g\ (x)$ at a given value of x, expressing the answer in its simplest form.

Candidates' performance

Overall, the performance of candidates was below average. Candidates mainly did Part (a). One thousand three hundred and ninety-three candidates (1.92 per cent of candidates) were able to score full marks while most candidates (44 787 candidates or 61.71 per cent of candidates) scored zero. The mean mark was 1.20 out of nine marks.

Candidate's Response to Part (a) (i) and Part (a) (ii) — Sample 1

(a) A rectangle, *PQRS*, has a diagonal, *PR*, where *P* is the point (–3, 10) and *R* is the point (4, –4).

(i) Calculate the length of the line *PR*.

$$\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$
$$=\sqrt{(-3-4)^2+(10+4)^2}$$
$$=\sqrt{(-7)^2+(14)^2}$$
$$\approx 15.65 \text{ units}$$

15.65 units

(2 marks)

(ii) Determine the equation of the line *PR*.

$$m=\frac{y_2-y_1}{x_2-x_1}$$
$$=\frac{10+4}{-3-4}=\frac{14}{-7}=-2$$

$$y-10=-2(x+3)$$
$$y-10=-2x-6$$
$$y=-2x+4$$

$y=-2x+4$

(3 marks)

Examiner's Comments

Areas of good performance

Generally, candidates were able to find the gradient of the line *PR* and were able to recall the general equation of a straight line (y=mx+c).

Candidate's Response to Part (a) (i) and Part (a) (ii) — Sample 2

4. (a) A rectangle, $PQRS$, has a diagonal, PR, where P is the point $(-3, 10)$ and R is the point $(4, -4)$.

x_2 y_2

(i) Calculate the length of the line PR.

Length $= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

~~$\sqrt{(4-3)^2 + (-4+10)^2}$~~

$\sqrt{(4-3)^2 + (-4-10)^2}$

$\sqrt{(1)^2 + (-14)^2} = \sqrt{1 + 196} = \sqrt{197} = 14.04$ units

14.04 units (taken to 2 decimal points)

(2 marks)

(ii) Determine the equation of the line PR.

gradient $= \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{-4-10}{4-3} = \frac{-14}{1} = -14$

Equation of a line =

$y - y_1 = m(x - x_1)$

$y - 10 = -14(x - 3)$

$y = -14x + 42 + 10$

$y = -14x + 52$

$\therefore y = -14x + 52$

(3 marks)

Examiner's Comments

Areas of weak performance

- Many candidates were unable to recall the formula used to find the length of a line using two coordinates on the line. Hence, they were unable to find the length of the line *PR.*
- Many candidates were unable to find the value of *c* (y-intercept) and therefore unable to deduce the equation of the line *PR*.

Candidate's Response to Part (b) (i) — Sample 1

(b) Two functions, *f* and *g*, are defined as follows.

$$f(x) = 3x + 1 \text{ and } g(x) = x^2.$$

Find, in its simplest form, an expression for

(i) $f(x-2)$

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

$= 3x-6+1$

$= 3x-5$

$f(x-2) = 3x-5$ ....

(2 marks)

Examiner's Comments

Areas of good performance

Several candidates were able to substitute their *f*(x−2) into the f(x) function.

Candidate's Response to Part (b) (i) — Sample 2

(b) Two functions, f and g, are defined as follows.

$$f(x) = 3x + 1 \text{ and } g(x) = x^2.$$

Find, in its simplest form, an expression for

(i) $f(x - 2)$

$f(x) = 3x+1$

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

$f(x-2) = 3x - 6 + 1$

$f(x-2) = 3x - 5$

$f(x-2) = 3x - 5$

(2 marks)

Examiner's Comments
Areas of weak performance
Candidates encountered difficulty in expanding and simplifying after substituting f(x−2) and g(x+2)+10.

Candidate's Response to Part (b) (ii)

(ii) $g(3x + 2) + 10.$

$$g(3x+2) = (3x+2)^2$$
$$= (3x+2)(3x+2)$$
$$= (9x^2 + 6x + 6x + 4)$$
$$= (9x^2 + 12x + 4)$$
$$(9x^2 + 12x + 4) + 10$$
$$= 9x^2 + 12x + 14$$

$g(3x+2)+10 = 9x^2 + 12x + 14$ ....

(2 marks)

Examiner's Comments
Several candidates were able to substitute their g(3x+2)+10 into the g(x) function.

Recommendations

Candidates should practise

- similar questions and use the formulas relevant to co-ordinate geometry, including the equation of a line. Such formulas can be used to
  - — find the length of a line using the two co-ordinates on the line
  - — find the gradient of a line using the two co-ordinates on the line
- substitution in algebra as it relates to evaluating a function at a given value for x
- expansion and simplification of algebraic expressions which consist of brackets
- expanding brackets involving multiplying every term inside the bracket by the term on the outside and then collecting like terms with the aim of removing the set of brackets.

Question 5

This question was based on Section 5: Statistics. It tested candidates' ability to

- determine measures of central tendency for raw, ungrouped and grouped data
- analyse statistical diagrams
- determine the proportion or percentage of a sample above or below a given value from raw data, a table or a cumulative frequency curve
- determine experimental and theoretical probabilities of simple events.

This question was attempted by at least 95 per cent of candidates. The responses varied from excellent to very poor. Two hundred and eighty-three candidates (0.39 per cent of candidates) were able to attain full marks. Approximately 42 205 candidates (58 per cent of candidates) got zero marks. The mean mark was 0.88 out of nine marks (9.8 per cent).

Candidate's Response to Part (a) (i) (a)

(a) Mr Morgan administered a spelling test to his class. The table below shows the number of words out of 10 that each student spelt correctly.

Number of Words	5	6	7	8	9	10
Frequency	8	4	2	2	3	4

(i) For the data set shown above, state the

a) mode

Sample 1

~~8 and 2~~ 8, 4 & 2

(1 mark)

Sample 2

The mode is equal to = 8

(1 mark)

Examiner's Comments

Overall, candidates did not perform well. Many candidates did not know what was meant by mode and some candidates stated the modal frequency instead of the mode. In Sample 1, the candidate did not know what the mode was and in Sample 2, the candidate stated the modal frequency.

Candidate's Response to Part (a) (i) (b)

b) median.

Sample 1

2, 2, 3, 4, 4, (5, 6) 7, 8, 8, 9, 10

5.5

Sample 2

median= 5 ....

(1 mark)

Examiner's Comments
Candidates recognized that the median value was the middle item (the twelfth item). However, many candidates had difficulty identifying which item was the twelfth. Some students confused the meanings of mode, median and mean. In Sample 1, the candidate knew that the median is the middle value. In Sample 2, the candidate stated the mode instead of the median.

Candidate's Response to Part (a) (ii)

(ii) Calculate the mean number of words spelt correctly.

Sample 1: Candidate found $\sum f$ only

~~5+6+7~~ 8+4+2+2+3+4

=23

23 words were spelt correctly.

Sample 2: Candidate found $\sum fx$ only

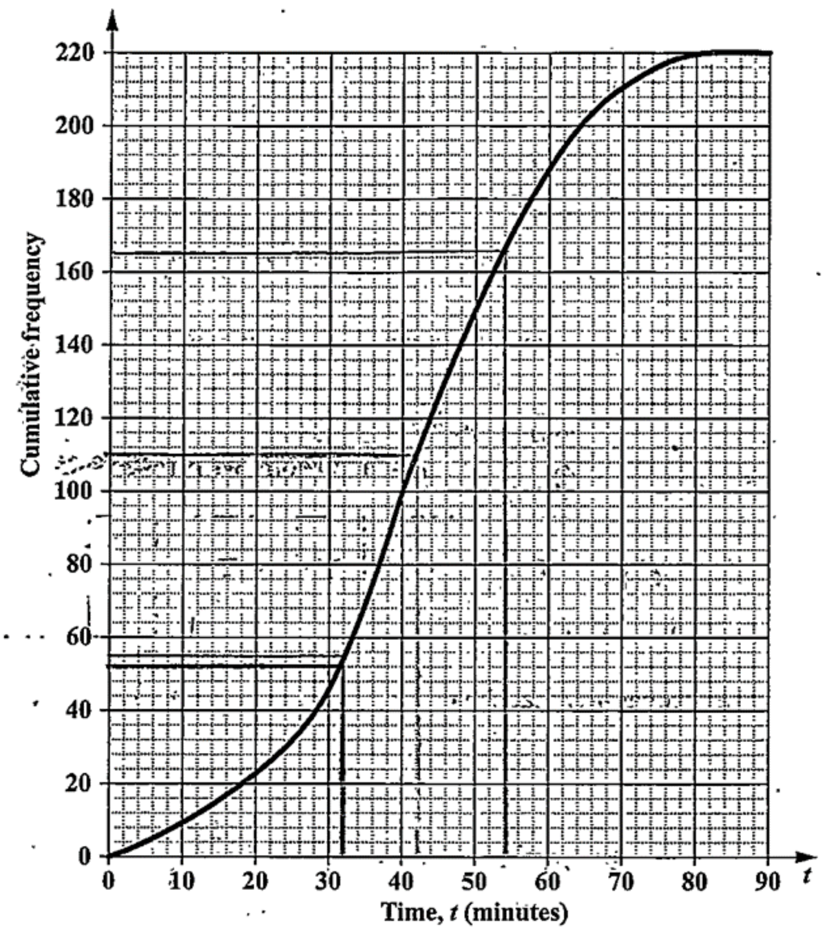
40+24+14+16+27+40 = 161

161 words

Examiner's Comments
Overall, candidates were able to solve some parts. Some candidates were able to find ∑fx while others were able to find ∑f. Only about 15 per cent of candidates were able to find both to arrive at the correct answer.

Candidate's Response to Part (b) (i)

(b) The attendance officer at a particular school recorded the time, t, in minutes, taken by each student in a group to travel to school. The data collected is shown on the cumulative frequency curve below.



Using the cumulative frequency curve, find an estimate of

(i) the number of students who took at MOST 32 minutes to travel to school

52 Students

(1 mark)

Examiner's Comments

More than 50 per cent of candidates were able to provide a correct answer.

Candidate's Response to Part (b) (ii)

(ii) the inter-quartile range.

Sample 1

$Q_3 - Q_1$

$Q_1 = 0 \times \frac{1}{4} = 0$

$220 \times \frac{3}{4} = 165$

$160 - 0 = 160$ units

(2 marks)

Sample 2

$Q_3 = \frac{3}{4}(n+1) = \frac{3}{4}(220+1) = 166$

$Q_1 = \frac{1}{4}(n+1) = \frac{1}{4}(220+1) = 55$

Inter-quartile range $= Q_3 - Q_1 = 166 - 55 = 111$

(2 marks)

Examiner's Comments

In Part (b) (ii), candidates knew the formula for the interquartile range but they had difficulty finding Q_1 and Q_3. A common error made by candidates was not identifying the 55^{th} and 165^{th} items. Instead, they used 55 as the first quartile and 165 as the third quartile. There were a few candidates who found the semi-interquartile range. In Sample 1, the candidate knew the formula used to find the interquartile range. In Sample 2, the candidate did not find the 166^{th} and 55^{th} data items.

Candidate's Response to Part (c)

(c) The letters in the word "POSITIVITY" are each written on separate cards and placed in a bag. Dacia picks 2 of these cards, at random, **with replacement**.

P	O	S	I	T	I	V	I	T	Y

Find the probability that she picks the letter "I" then the letter "V".

Sample 1 (The candidate found the individual probabilities but added.)

$$\frac{3}{10} + \frac{1}{10} = \frac{4}{10}\,\frac{2}{5}$$

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

Sample 2 (The candidate did not use replacement.)

Probability of I $= \frac{3}{10}$

Probability of V $= \frac{1}{9}$

Sample 3 (The candidate found probability for I separately from the probability of V.)

$\frac{3}{10}$ for I $\frac{1}{10}$ for V

Sample 4 (The candidate subtracted the probabilities.)

I $= \frac{3}{10}$ T $= \frac{2}{10}$

$\frac{3}{10} - \frac{2}{10} = \frac{1}{10}$

Examiner's Comments

Less than one per cent of candidates successfully answered Part (c). Many candidates were not familiar with independent events in relation to probability. Most candidates simply found the probability of getting I and the probability of getting V. Some candidates added the probabilities while others subtracted. A few candidates sampled without replacement.

Recommendations

Teachers should

- provide ample opportunities for students to practise finding and interpreting the probabilities of various events
- provide a wider variety of practice examples for which students are required to draw, read and interpret information from graphs
- provide more opportunities for students to experiment and explore graphical activities using a variety of scales, inclusive of scales requiring accurate reading of decimals
- discuss with students the interpretative concepts associated with graphs. Examples include concepts such as standard deviation which is a tool used to appreciate the dispersion of scores about the mean of a particular distribution.

Question 6

This question was based on Section 4: Measurement. It tested candidates’ ability to

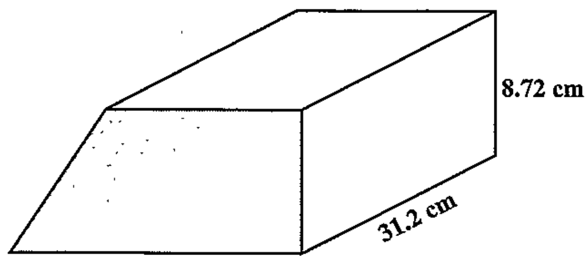
- convert units of length, mass, area, volume and capacity
- calculate the surface area of solids
- calculate the volume of solids
- solve problems involving measurement.

This question was attempted by most candidates. Generally, candidates’ performance was below average. Most candidates (approximately 76 per cent) scored zero. Six hundred and sixty-four candidates (0.91 per cent) scored full marks. Overall, the mean mark was 0.91 out of 9 marks.

Candidate's Response to Part (a) (i)

[In this question, take $\pi = \frac{22}{7}$.]

(a) The diagram below shows a gold bar in the shape of a trapezoidal prism. Its volume is 2 886 cm³. The length and height of the prism are indicated on the diagram.



(i) Calculate the area of the **shaded** cross-section of the trapezoidal prism.

$4 \times 31.2 = 2886$ $\quad V = A \times L$

$A = \frac{2886}{31.2}$

$= 92.5$

....

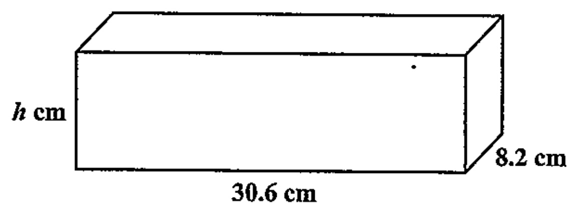
(1 mark)

Examiner's Comments

Candidates performed fairly well. They used the formula V=Ah and deduced that $A = \frac{V}{h}$. However, some candidates provided $A = \frac{2886}{8.72} = 331 \text{ cm}^2$.

Candidate's Response to Part (a) (ii)

(ii) The cuboid-shaped gold bar shown below has the same volume as the trapezoidal prism-shaped gold bar displayed at (a).



Calculate the height, h, of the cuboid-shaped gold bar.

$30.6 \times 8.2 \times h = 2886$

$250.92h = 2886$

$h = \frac{2886}{250.92}$

$h = 11.5$ cm

Examiner's Comments

This part was well done by most candidates. They scored at least three marks. However, many candidates gave 8.72 or 8.2 as their answer.

Candidate's Response to Part (b) (i) — Sample 1

(b) The trapezoidal gold bar is melted down and **all** the gold is used to make SIX identical spheres.

Calculate, for EACH sphere of gold, its

(i) radius

[The volume, V, of a sphere with radius, r is $V = \frac{4}{3}\pi r^3$.]

$$2886 \text{ cm}^3 = \frac{4}{3} \times \frac{22}{7} r^3$$

$$\frac{2886 \text{ cm}^3}{\frac{88}{21}} = r^3$$

$$688.7 = r^3$$

$$\sqrt[3]{688.7} = r$$

$$r \doteq 8.83$$

Candidate's Response to Part (b) (i) — Sample 2

(b) The trapezoidal gold bar is melted down and **all** the gold is used to make SIX identical spheres.

Calculate, for EACH sphere of gold, its

(i) radius

[The volume, V, of a sphere with radius, r is $V = \frac{4}{3}\pi r^3$.]

Find r $\frac{V}{6} = \frac{4}{3}\pi r^3$

$\frac{2886}{6} = \frac{4}{3} \times \frac{22}{7} r^3$

$481 = \frac{4}{3} \times \frac{22}{7}$

$\frac{481}{1} \times \frac{3}{4} \times \frac{7}{22} = r^3$

$\sqrt{\frac{10101}{88}} = \sqrt{r^3}$

$\sqrt{\frac{10101}{88}} = r$

$10.71 = r$

∴ Each sphere of gold is $= 10.71\ cm^3$

Examiner's Comments

Most candidates did not divide the total volume 2886 by 6 to find the volume of one sphere and as a result obtained the answer 8.83. Some candidates then divided the figure obtained by 6. In addition, many candidates who remembered to divide by 6 first either could not make the radius of the sphere the subject of the formula or did not know how to use the cube root button on the calculator and therefore they found the square root instead. Such candidates gave 10.71 as their answer.

Candidate's Response to Part (b) (ii)

(ii) surface area

[The surface area, A, of a sphere with radius r, $A = 4\pi r^2$.]

$A = \frac{4}{1} \times \frac{22}{7} \times (10.71)^2$

Surface Area = 1441.99 cm^2

Examiner's Comments
Most candidates who obtained an answer for the radius successfully substituted the value obtained into the formula for the surface area of the sphere. However, a few candidates forgot to square the radius because they had the square on the unit ($4\pi \times 8.83cm^2$ was given).

Candidate's Response to Part (b) (iii) — Sample 1

(iii) mass, **to the nearest kilogram**, given that the density of gold is 19.3 g/cm³.

$\left[\text{Density} = \frac{\text{mass}}{\text{volume}}\right]$

$\frac{19.3}{1} = \frac{\text{mass}}{2886}$

mass = 19.3 × 2886

= 55699.8g

= 55.6998kg to the nearest Kilogram

55.6998 Kg

(2 marks)

Candidate's Response to Part (b) (iii) — Sample 2

(iii) mass, **to the nearest kilogram,** given that the density of gold is 19.3 g/cm³.

$$\left[\text{Density} = \frac{\text{mass}}{\text{volume}}\right]$$

mass = Density x volume = 9283.3g

Examiner's Comments

Part (b) (iii) was not done well by most candidates. They either found the mass of the original block of gold or did not divide their product by 1000 to convert to kilograms. Candidates often provided the following figures.

- 9283
- 9.283
- 55 699
- 55.699

Very few candidates rounded their answer to the nearest whole number

Recommendations

- Candidates need to be given more practice in solving problems which involve finding the volume of prisms and spheres.
- Candidates need to be given more practice in transposing formulas.
- Candidates need to be given more exposure to the relationship between the area of a cross section of a solid and its volume.
- Candidates need to examine the instructions of questions to determine the requirements for solving the question.
- Candidates should be allowed to practise more questions in which they must transpose formulas where powers are involved

Question 7

Question 7 is the investigation question. It is based on any combination of objectives in the syllabus. In 2024, it tested candidates' ability to

- compute terms of a sequence, given a rule
- derive an appropriate rule, given the terms of a sequence
- determine the perimeter of a plane shape.

Candidates' performance

Candidates seemed to be familiar with this type of reasoning question. Most candidates (approximately 60 percent) earned scores between four and ten marks. The mean mark was 4.21 out of ten.

Candidate's Response to Part (a)

The diagram below shows the first four diagrams in a sequence of regular hexagons. Each regular hexagon is made using sticks of unit length.

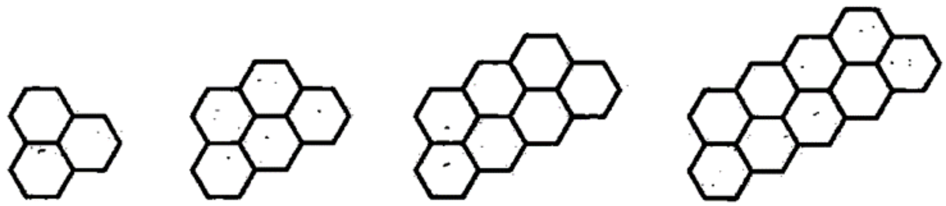
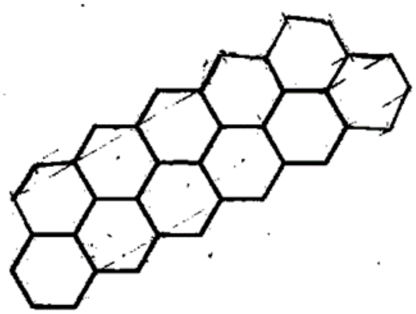


Diagram 1 Diagram 2 Diagram 3 Diagram 4

(a) Complete the diagram below to represent Diagram 5 in the sequence of regular hexagons.



(2 marks)

Examiner's Comments

Many candidates were unable to complete Diagram 5 of the sequence accurately.

Candidate's Response to Part (b) (i) to (iii)

(b) The number of regular hexagons, H, the number of sticks, S, and the perimeter of each figure, P, follow a pattern. The values for H, S and P, for the first 4 diagrams are shown in the table below. Study the pattern of numbers in each row of the table and answer the questions that follow.

Complete the rows marked (i), (ii) and (iii) in the table below.

	Diagram Number (D)	Number of Hexagons (H)	Number of Sticks (S)	Perimeter (P)	
	1	3	15	12	
	2	5	23	16	
	3	7	31	20	
	4	9	39	24	
(i)	5	11	47	28	**(2 marks)**
	⋮	⋮	⋮	⋮	
(ii)	23	47	191	100	**(2 marks)**
	⋮	⋮	⋮	⋮	
(iii)	n	2n+1	8n+7	4·n+8	**(3 marks)**

Examiner's Comments

Candidates performed well on Part (b) (i). They were able to determine H and S, given D and P.

In Part (b) (ii), candidates were also able to determine D and P, given H and S. Some candidates misinterpreted the table, thinking that after n = 5, the values increased by 1 in each subsequent row. They either ignored the ellipsis between rows or they did not know what the ellipsis signified. Hence, they took n = 7 and used this incorrect value to provide an answer.

Part (b) (iii) was done correctly by the minority of candidates. Most candidates were unable to determine the correct expression in terms of n for H, S and P. They put a numerical value, rather than an expression in the n row.

Candidate's Response to Part (c)

(c) Skyla says that she can make one of these figures with a perimeter of EXACTLY 1 005. Explain why she is **incorrect**.

She is incorrect because ~~she will~~ no whole number gives a perimeter of exactly 1005.

i.e. $4n+8=1005$

$4n = 1005-8$

$n = \frac{997}{4} = 249.25$

(1 mark)

Examiner's Comments

Most candidates were unable to explain why Skyla was incorrect accurately.

Recommendations

Teachers should

- give students practice in how to obtain expressions for the n^{th} term of linear and quadratic sequences and devise methods to assist students in this process (look for common differences and how this affects the expression for the n^{th} term etc.)
- give students practice in how to complete subsequent figures in a sequence by observing patterns between figures and determining how each new figure is formed using the previous figure.

Question 8

This question was based on Section 7: Relations, Functions and Graphs. It tested candidates' ability to

- evaluate a function at a given value of x
- apply the relationship between a function and its inverse to evaluate the inverse function at a given value of x
- derive the composition of two functions
- sketch the graph of a quadratic function and identify the turning point and the roots of the function
- draw the tangent to the curve at a given point
- determine the gradient of a straight line given the graph of the line
- determine the equation of a straight line

Candidates' Performance

Generally, candidates performed poorly. Many candidates attempted Part (a) (i) and Part (a) (ii) only. Most candidates were only able to evaluate g(2) correctly. Overall, the mean score on was 1.61 out of 12 marks (13.42 per cent). Three hundred and seventy-two candidates (0.51 per cent of candidates) scored full marks while 31 659 (43.62 per cent) scored zero.

Candidate's Response to Part (a) (i) (a) and Part (a) (i) (b)

(a) The functions f and g are defined as follows.

$$f(x) = \frac{2x-1}{3} \text{ and } g(x) = 5 - x^2.$$

(i) Determine the value of

a) $g(2)$

$g(2) = 5 - 2^2$

$= 5 - 4$

$g(2) = 1$

$g(2) = 1$

(1 mark)

b) $f^{-1}(3)$.

$f^{-1}(3)$

Let $y = \frac{2x-1}{3}$

$x = \frac{2y-1}{3}$

$3x = 2y - 1$

$3x + 1 = 2y$

$y = \frac{3x+1}{2}$

$f^{-1}(x) = \frac{3x+1}{2}$

$\therefore f^{-1}(3) = \frac{3(3)+1}{2}$

$f^{-1}(3) = \frac{10}{2}$

$= 5$

$f^{-1}(3) = 5$

(2 marks)

Examiner's Comments

Candidates were able to successfully evaluate g(2). They were familiar with the general algorithm to obtain the inverse of a function.

Candidate's Response to Part (a) (ii)

(ii) Derive an expression, in its simplest form, for $fg(x)$.

$$fg(x) = \frac{2(5-x^2)-1}{3} \qquad -2x^2+9$$

$$= \frac{10-2x^2-1}{3}$$

$$= \frac{(9-2x^2)}{3}$$

$$fg(x) = \frac{(9-2x^2)}{3}$$

(2 marks)

For graph
sub $x=-1$

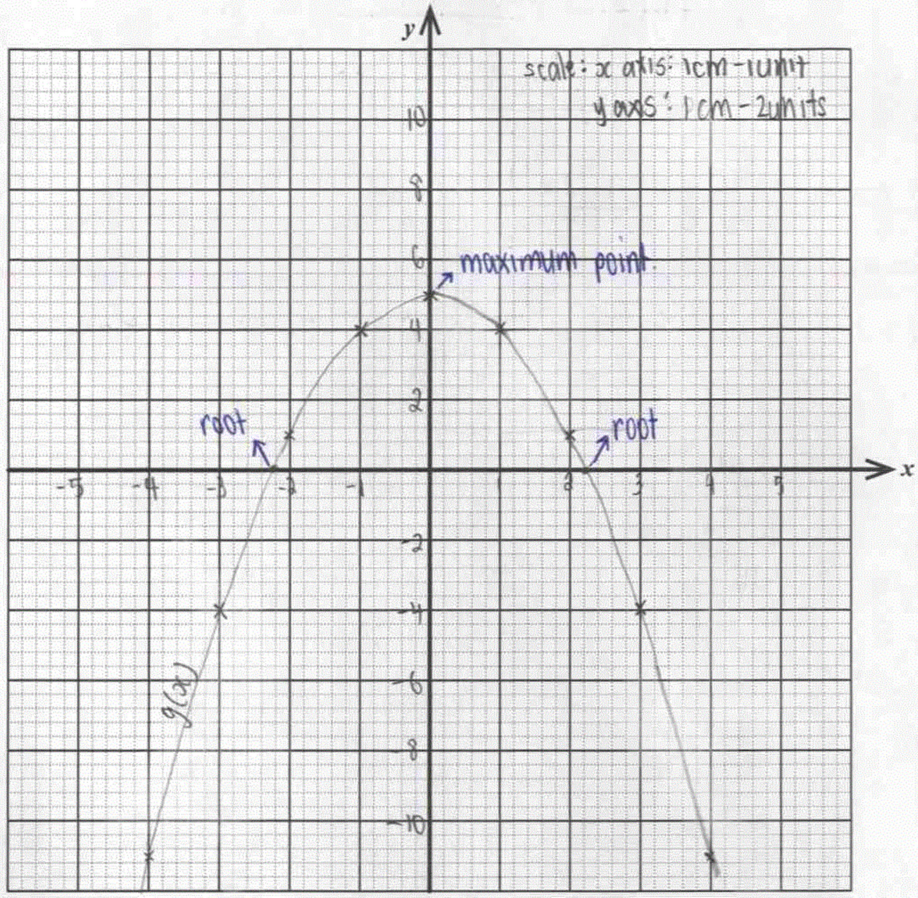
$y=$

Examiner's Comments

Candidates had difficulty obtaining fg(x).

Candidate's Response to Part (a) (iii)

(iii) Sketch the graph of the function $g(x)$ in the space provided below. On your sketch, indicate the maximum/minimum point and the roots of the function.



(3 marks)

$g(x) = 5 - x^2$

let $y = 5 - x^2$

sub x as 1

$(1,4)$ $y = 5 - 1$
$= 4$

sub x as 2

$y = 5 - (2)^2$
$= 5 - 4$

$(2,1)$ $y = 1$

sub x as -3

$y = 5 - (-3)^2$

$y = 5 - 9$
$= -4$

sub x as 5

$y = 5 - (5)^2$
$= 5 - 25$

$y = -20$

$(5, -20)$

sub x as 0

$y = 5 - 0^2$

$y = 5$

sub $y = 0$

$0 = 5 - x^2$

sub $x = -1$

$y = 5 - (-1)^2$
$= 5 - 1$
$= 4$

x as -2

$y = 5 - (-2)^2$
$= 5 - 4$
$= 1$

$x^2 = 5$

x as 0

$y = 5 - 0^2$

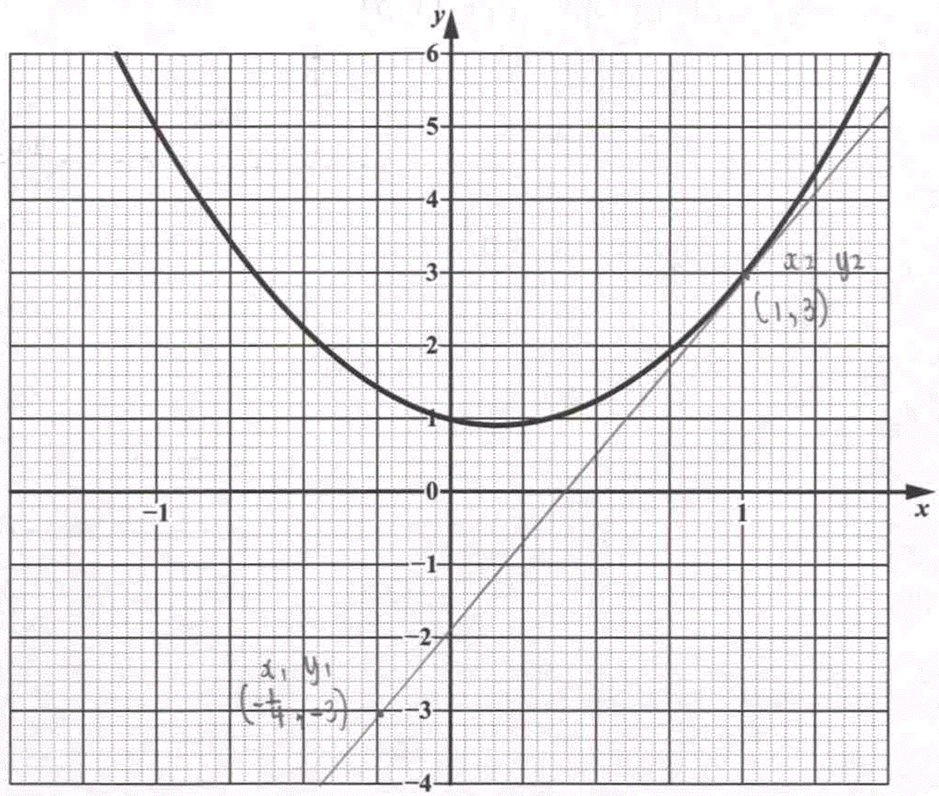
$y = 5$ $(0, 5)$

Examiner's Comments

Candidates who attempted to sketch the graph of the curve sketched the graph as a maximum curve and correctly identified the roots and value of the maximum point.

Candidate's Response to Part (b) (i)

(b) The graph below shows a quadratic function.



(i) On the grid above, draw the tangent to the curve at $x = 1$. **(1 mark)**

Examiner's Comments

Candidates had difficulty determining the direction in which the tangent should be drawn. However, they were aware that the tangent was a straight line which touched the curve at one point.

Candidate's Response to Part (b) (ii)

(ii) Use the tangent drawn to estimate the gradient of the curve at $x = 1$.

use tangent and find gradient.

$m = \frac{\Delta y}{\Delta x} \rightarrow \frac{y_2 - y_1}{x_2 - x_1} = \frac{3-(-3)}{1-(-1/4)} = \frac{6}{5/4}$

$= 4.8$

at $x=1$ m of the curve $= 4.8$ or $4\frac{4}{5}$

(2 marks)

Examiner's Comments Candidates who attempted to find the gradient were familiar with the formula used to do so.

Candidate's Response to Part (b) (iii)

(iii) Write down the equation of the tangent in the form $y = mx + c$.

using the point (1,3)

$y = mx + c$

$3 = 4\frac{4}{5}x + c \rightarrow 3 = \frac{24}{5} + c$

$3 = 24/5 + c$, $c = 3 - 24/5$

$c = -1.8$

$y = 4\frac{4}{5}x - 1\frac{4}{5}$

(1 mark)

Examiner's Comments Candidates who did not use the graph to determine the intercept were able to use the formula $y = mx + c$ to calculate the intercept.

Recommendations

Teachers should

- ensure that students are familiar with using different scales when drawing graphs
- help students recognize that the slope of the tangent should follow the direction of the curve. This means that if the tangent is being drawn at a point on the curve where the curve is sloping upward, left to right, the tangent should also be drawn in this direction
- help students appreciate the relationship between the gradient of the curve at a point and the gradient of the tangent at that point.

Question 9

This question was based on Section 8: Geometry and Trigonometry. It tested candidates' ability to

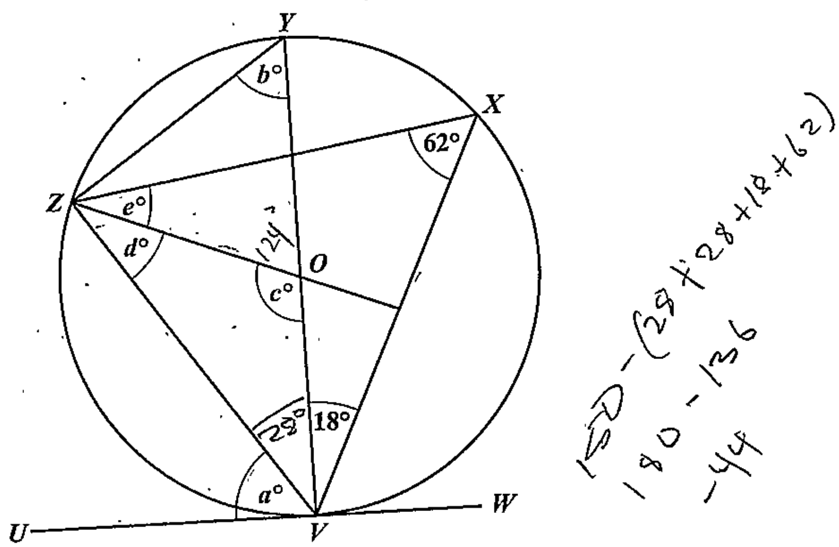
- solve geometric problems using circle theorems and the properties of circles
- relate objects in the physical world to geometric objects
- use the sine and cosine rules to solve problems involving triangles
- solve problems involving bearings.

Candidates' performance

Almost all candidates attempted this question. Three hundred and ninety-four candidates (0.54 per cent of candidates) obtained full marks while 46 201 (63.65 per cent of candidates) scored zero. The mean score was 1.53 out of 12 marks.

Candidate's Response to Part (a) (i) — Sample 1

(a) V, X, Y and Z lie on the circumference of the circle shown below, centre O, with diameter VY. UW is a tangent to the circle at V. Angle $VXZ = 62°$ and Angle $XVY = 18°$.



(i) State a theorem that justifies the values of EACH of the following angles.

a) Angle $b = 62°$

Angles in the same segment of a circle subtended by a common cord are equal.

(1 mark)

b) Angle $c = 124°$

Angle at the centre of the circle is ~~twice~~ twice the ang subtended by the circumference.

(1 mark)

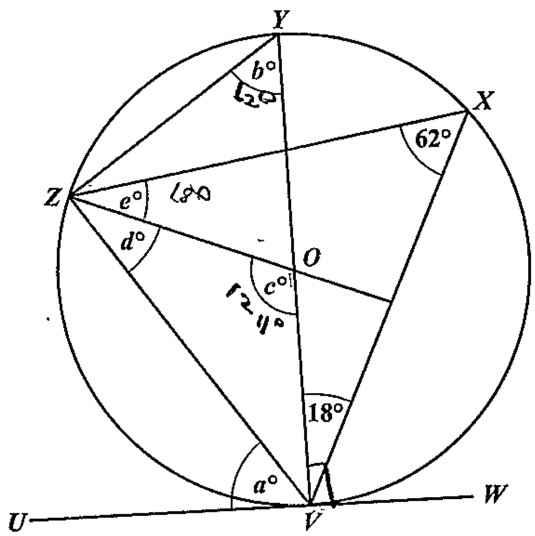
Examiner's Comments

Areas of good performance

- Candidates were able to find the value of angle *d* (28°).
- Candidates were able to recall the following theorems.
  - — The angle which an arc of a circle subtends at the centre of a circle is twice the angle it subtends at any point on the remaining part of the circumference.
  - — A tangent of a circle is perpendicular to the radius/diameter of that circle at the point of contact.
- Part (a) was attempted by less than 50 per cent of candidates. However, most of them got it entirely or partially correct.
- Candidates performed better on Part (b).
- Many candidates correctly used the cosine rule to find the length of *s*.
- Many candidates were able to find the bearings.

Candidate's Response to Part (a) (i) — Sample 2

(a) V, X, Y and Z lie on the circumference of the circle shown below, centre O, with diameter VY. UW is a tangent to the circle at V. Angle $VXZ = 62°$ and Angle $XVY = 18°$.



(i) State a theorem that justifies the values of EACH of the following angles.

a) Angle $b = 62°$

The two angles on top of the bunny ears are equivalent

(1 mark)

b) Angle $c = 124°$

Because the angle on the bottom of a tangent is always double the angle at the top

(1 mark)

c) Angle $OVW = 90°$

It's a right angle due to the straight line coming from outside the circle.

(1 mark)

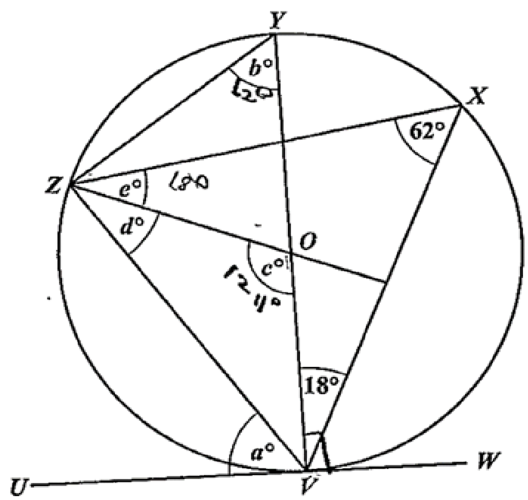
Examiner's Comments

Areas of weak performance

Many candidates were not familiar with the circle theorems. While many candidates may have had an idea of what the theorem stated, they were unable to express it.

Candidate's Response to Part (a) (ii)

(a) V, X, Y and Z lie on the circumference of the circle shown below, centre O, with diameter VY. UW is a tangent to the circle at V. Angle $VXZ = 62°$ and Angle $XVY = 18°$.



(ii) Find the values of Angles a, d and e. Show ALL working where appropriate.

$\angle a =$

36°

$\angle d =$

62°

$\angle e =$

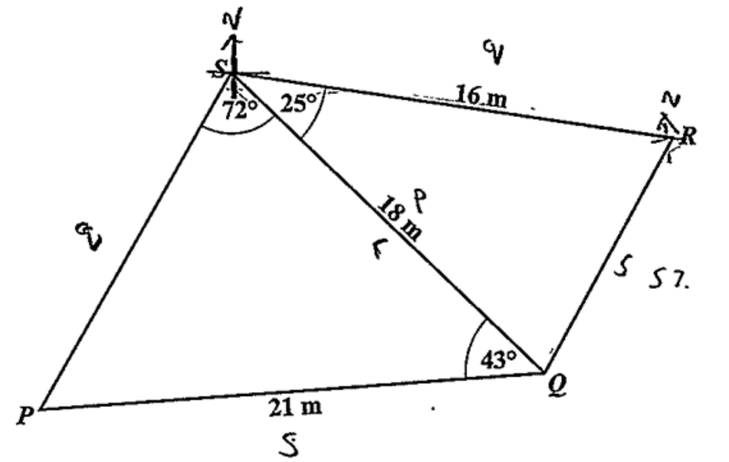
18°

(3 marks)

Examiner's Comments
Many candidates were unable to calculate the required angles.

Candidate's Response to Part (b) (i)

(b) The diagram below shows a quadrilateral *PQRS* formed by joining two triangles, *PQS* and *QRS*.



(i) Calculate the length of *QR*.

$a^2 = b^2 + c^2 - 2bc \cos A$

$a^2 = 18^2 - 16^2 - 2(18)(16) \cos 25$

$a^2 = 58.$ to 1 d.p.

$\sqrt{a} = \sqrt{58}$

$a = 7.6$

7.6 m ....

(3 marks)

Examiner's Comments

A few candidates were unable to recognize that they should use the cosine rule to calculate the length of *s*. Many candidates recognized the need to use the cosine rule but they were unable to compute accurately after they substituted the values into the rule correctly.

Candidate's Response to Part (b) (ii)

(ii) The bearing of P from S is 205°. Determine the bearing of

a) R from S

72
\+ 25
97

205
− 97
108

108°
(1 mark)

b) S from P.

360
− 205
155

155°
(2 marks)

Examiner's Comments

Some candidates could not find the bearings. There were also candidates who could calculate the answer for one part but not the other.

Recommendations

Teachers should ensure that students

- fully understand the circle properties and circle theorems in order to apply them correctly
- are aware that when they are asked to give a reason for their calculation, they should not rewrite the working. It must be emphasized that the reason they provide must be based on the theorem used
- can correctly determine when to use the various trigonometrical ratios and rules. It is recommended that candidates be given more practice in real-life scenarios that involve calculations with the sine rule, cosine rule and bearings.

Question 10

This question was based on Section 9: Vectors and Matrices. It tested candidates' ability to

- simplify expressions involving vectors
- write the position vector of a point $P(a, b)$ as $\overrightarrow{OP} = \begin{pmatrix} a \\ b \end{pmatrix}$ where O is the origin (0,0)
- determine the magnitude of a vector
- use vectors to solve problems in geometry
- solve problems involving matrix operations
- evaluate the determinant of a 2 x 2 matrix
- obtain the inverse of a non-singular 2 x 2 matrix.

Candidates' performance

The performance of candidates was unsatisfactory. Overall, only 476 candidates (0.66 per cent of candidates) gained full marks and 47 371 candidates (65.27 per cent of candidates) scored zero. The mean score was 1.40 out of 12 marks.

Candidate's Response to Part (a)

(a) The determinant of the matrix $\begin{bmatrix} 6 & 2v \\ -5 & -v \end{bmatrix}$ is 24.

Calculate the value of v.

$ad - bc = 24$

$-6v - (-10v) = 24$

$4v = 24$

$v = 6$

$v = 6$ ....

(2 marks)

Examiner's Comments

Candidates did fairly well. Most candidates who attempted this part were able to find the determinant and obtain the value of *v*.

Candidate's Response to Part (b) (i)

(b) The matrices L and M are defined as follows.

$$L = \begin{bmatrix} 9 & 5 \\ 3 & 2 \end{bmatrix}, \quad M = \begin{bmatrix} 2 \\ -4 \end{bmatrix}.$$

Evaluate EACH of the following.

(i) The matrix product LM

$$\begin{bmatrix} 9 & 5 \\ 3 & 2 \end{bmatrix}\begin{bmatrix} 2 \\ -4 \end{bmatrix} = \begin{bmatrix} 9 \times 2 + 5 \times -4 \\ 3 \times 2 + 2 \times -4 \end{bmatrix}$$

$$= \begin{bmatrix} 18 - 20 \\ 6 - 8 \end{bmatrix}$$

$$= \begin{bmatrix} -2 \\ -2 \end{bmatrix}$$

Examiner's Comments

Most candidates who attempted this question obtained the correct answer. However, a few candidates left their answer as the 2×2 matrix, $\begin{pmatrix} 18 & -20 \\ 6 & -8 \end{pmatrix}$, or said that the product could not be done because the matrices were not conformable for multiplication.

Candidate's Response to Part (b) (ii)

(ii) L^{-1}, the inverse of L

$$L^{-1} = \frac{1}{\text{determinant}}\begin{bmatrix} 2 & -5 \\ -3 & 9 \end{bmatrix}$$

$$= \frac{1}{24}\begin{bmatrix} 2 & -5 \\ -3 & 9 \end{bmatrix}$$

$$= \begin{bmatrix} \frac{1}{12} & \frac{-5}{24} \\ \frac{-1}{8} & \frac{3}{8} \end{bmatrix}$$

Consider: $M = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$

$\text{adj } M = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$

$M^{-1} = \frac{1}{\text{determinant}} \times \text{adj } M$

Examiner's Comments

A few candidates gained both marks but most candidates gained only one mark since they either had the incorrect determinant or the incorrect adjoint.

Candidate's Response to Part (c)

(c) $\overrightarrow{PQ} = \begin{pmatrix} 5 \\ -4 \end{pmatrix}$.

If P is the point $(-2, 3)$, determine the coordinates of Q.

$$\begin{bmatrix} 5 \\ -4 \end{bmatrix} - \begin{bmatrix} -2 \\ 3 \end{bmatrix} = \begin{bmatrix} 7 \\ -7 \end{bmatrix}$$

$$\begin{bmatrix} -2 \\ 3 \end{bmatrix} + \begin{bmatrix} 7 \\ -7 \end{bmatrix} = \begin{bmatrix} 5 \\ -4 \end{bmatrix}$$

$$Q = \begin{bmatrix} 7 \\ -7 \end{bmatrix}$$

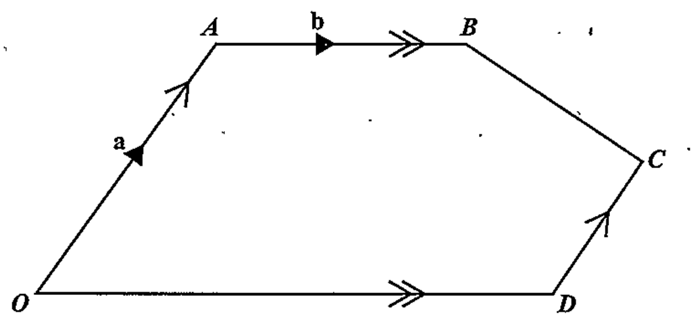
Examiner's Comments

Obtaining the coordinates of the point *Q*, given the vector *PQ* and the point *P*, proved to be challenging for most candidates. They did not know the vector equation *OQ = OP + PQ* and instead used the equation 'OQ = PQ − OP', thereby obtaining the coordinate of Q as '(7, −7)' instead of *(3, −1).*

Candidate's Response to Part (d) (i)

(d) In the pentagon *OABCD*, *OA* is parallel to *DC* and *AB* is parallel to *OD*.

$OD = 2AB$ and $OA = 2DC$. $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{AB} = \mathbf{b}$.



Find, in terms of **a** and **b**, in its simplest form,

(i) $\overrightarrow{AD}$

$\overrightarrow{AD} = \overrightarrow{AO} + \overrightarrow{OD}$

$= -a + 2b$

$\overrightarrow{AD} = -a + 2b$

(1 mark

Examiner's Comments

This part was the done well by most of the candidates who attempted the question.

Candidate's Response to Part (d) (ii)

(ii) $\overrightarrow{BC}$.

$\overrightarrow{BC} = \overrightarrow{BA} + \overrightarrow{AO} + \overrightarrow{OD} + \overrightarrow{DC}$

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

$= b + \frac{a}{2} - a$

$\overrightarrow{BC} = b - \frac{a}{2}$

(2 marks)

> **Examiner's Comments**
>
> Part d (ii) proved to be challenging for candidates, even for those who had a correct route. The simplification of an algebraic expression involving negatives was problematic for candidates.

Candidate's Response to Part (d) (iii)

(iii) State the conclusion about $|\overrightarrow{AD}|$ and $|\overrightarrow{BC}|$ that can be drawn from your responses in (i) and (ii).

$|\overrightarrow{AD}|$ is twice the size of $|\overrightarrow{BC}|$ since the vector $\overrightarrow{AD}$ is $\overrightarrow{BC}$ multiplied by 2.

(1 mark)

> **Examiner's Comments**
>
> Many candidates either indicated that the vectors were parallel or collinear in some cases, even though the question asked about the relationship between the lengths of the two vectors.

Recommendations

- Teachers need to include more sessions on matrix multiplication in their teaching. They should focus on matrix multiplication where there is one matrix followed by another.
- Teachers need to spend more time showing students how vectors can be used to solve problems in geometry.
- Teachers should give students additional work on vector algebra.

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

Paper 032 or Alternative to the School-Based Assessment (SBA) is an alternative to Paper 031 and it is intended to be 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.

Overall, the mean score was 11.26 out of 40 marks (28.16 per cent) and the standard was deviation 6.97. In 2024, no candidate earned the maximum available score of 40; however, 147 candidates (or 4.02 per cent of candidates) scored zero.

Question 1

This question was based on a combination of objectives from two sections of the syllabus, Number Theory and Computation, and Statistics. It tested candidates' ability to

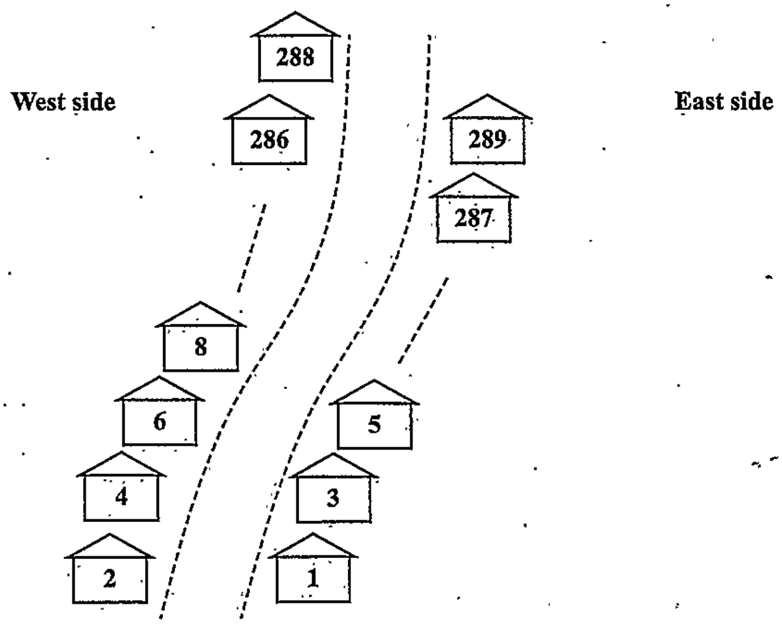
- distinguish among sets of numbers
- compute terms of a sequence given a rule
- derive an appropriate rule given the terms of a sequence
- construct statistical diagrams.

Candidates' performance

Candidates performed satisfactorily. Of the 3648 candidates who wrote the examination, only five candidates (0.14 per cent of candidates) scored full marks. Two hundred and eighty-four candidates (7.79 per cent of candidates) scored zero. The mean score was 3.60 out of a possible ten marks.

Candidate's Response to Part (a)

Along a road, there are 289 houses numbered 1 to 289. Some of these houses are shown on the diagram below. The houses on the western side of the road have even numbers and the houses on the eastern side have odd numbers.



(a) Circle the house number(s) in the list below that is/are on the eastern side of the road.

50 (87) 126 178 (189) 252

(1 mark)

Examiner's Comments
Most candidates were able to identify that the odd numbered houses were on the eastern side of the road and hence they circled the two odd numbers from the given list.

Candidate's Response to Part (b)

(b) Determine the number of houses on the western side of the road.

~~total houses =~~ ~~280~~

total # of houses = multiples of 2 under 289

total # of houses = 288 ÷ 2

total # of houses = 144

There are 144 houses on the west side

(2 marks)

Examiner's Comments

Candidates were able to find the number of houses on the western side of the road. The most common method used by candidates was dividing 288 by 2 which gave the answer *144*. Alternate methods which were used by candidates included the following.

- Manually listing of the houses on the western side in groups or otherwise and then adding
- Finding the number of houses on the eastern side to deduce the total number of houses on the western side

Less than 50 percent of candidates divided 289 by 2 and arrived at 144.5. They expressed their answer as 144.5 and in some cases 145.

Candidate's Response to Part (c)

(c) On the western side, how many houses are there **between** the house numbered 166 and the house numbered 184?

~~$\frac{184-166}{2}$ = ans~~

1 2 3 4 5 6 7 8

166, 168, 170, 172, 174, 176, 178, 180, 182, 1

There are 8 houses between the house numbered 166 and 184

(1 mark)

Examiner's Comments

Candidates' performance on Part (c) was fair. They had to find how many houses were between the house numbered 166 and the house numbered 184. Some candidates made a list of the houses between 166 and 184 on the relevant side of the street and then they counted the number of house numbers they wrote. A common error made by candidates was subtracting 166 from 184 and giving the answer as '18'.

Candidate's Response to Part (d)

(d) Which of the houses from 1 to 100 have numbers that are **both** a multiple of 29 **and** a composite number?

multiples of 29 under 100 = {29, 58, 87}
composite multiples of 29 under 100 = {58, 87}

House number 58 and house number 87

(1 mark)

Examiner's Comments

Part (d) was challenging for candidates and as such their performance was average. Most candidates were able to list the multiples of 29. However, they were unable to write down, from the list, the house numbers that were both a multiple of 29 and a composite number.

Candidate's Response to Part (e) (i)

(e) Hosea delivers a pamphlet to some of the houses on the eastern side of the road. He starts at House number 1 and then delivers to **every other** house, in order.

(i) An expression, in terms of n, for the house number of the nth house to which Hosea delivers pamphlets is given as $4n + k$. Determine the value of k.

4n + k
4(1) + k = 1
4 + k = 1

~~k = 4~~
k = 1 − 4
k = −3

(1 mark)

Examiner's Comments

This part was difficult for most candidates and as such their performance was weak. Candidates were required to find the value of *K* from an expression, in terms of n, for the n^{th} house (4n + k). Very few students were able to solve the problem. Many candidates did not attempt this part.

Alternate solutions

- Note 2nd house = 5
  4(2) + k = 5 , 8+ k = 5 and k = 5 – 8 which produced the answer of k = −3

- Or 1st house = 1
  4n + k = 4(1) + k = 1 and K = 1−4 = −3

Candidate's Response to Part (e) (ii)

(ii) Determine the house number of the 50th house to which he delivers a pamphlet.

$4(50)+k=n$

$200+k=n$

$200+-3=n$

$200-3=n$

$n=197$

house number 197

(1 mark)

Examiner's Comments

This part followed on from Part (e) (i). It was also poorly done by candidates. They were required to substitute for the 50th house into the formula 4n−3 to get the correct response. Many candidates did not attempt this part.

Candidate's Response to Part (f) (i)

(f) **There have been 36 complaints about the garbage collection service along the roadside.**

The complaints are as follows.

- **The price for the service is too high.**
- **The garbage collectors do not do clean work.**
- **The garbage truck does not operate on schedule.**

(i) **Complete the table below.**

Complaint	**Frequency**	**Pie Chart Sector Angle**
Price	15	150°
Untidy work	9	90°
Off schedule	12	120°

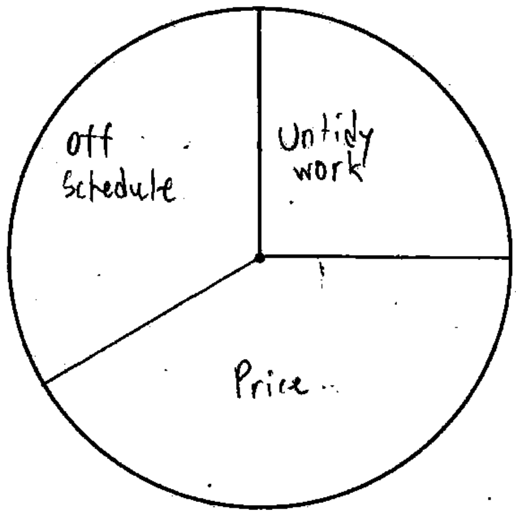
(1 mark)

Examiner's Comments

Most candidates did well in calculating the sector angles from the table given.

Candidate's Response to Part (f) (ii)

(ii) Complete the pie chart below to show the information in the table.



(2 marks)

Examiner's Comments
The candidates who performed well correctly drew the pie chart from the sector angles calculated within the parameters of +/− 1 0. However, some candidates' pie charts fell outside of the required parameters. Such candidates' pie charts showed +/− 2 0.

Recommendations

Teachers need to emphasize the types of numbers and identify patterns in their lessons. Students should practice techniques that will help them to write the rule for deriving the n^{th} term of a sequence. Also, students need much more practice in how to construct statistical diagrams, especially the pie chart.

Question 2

This question was based on a combination of objectives from two sections of the syllabus, namely, Measurement and Geometry, and Trigonometry. It tested candidates' ability to

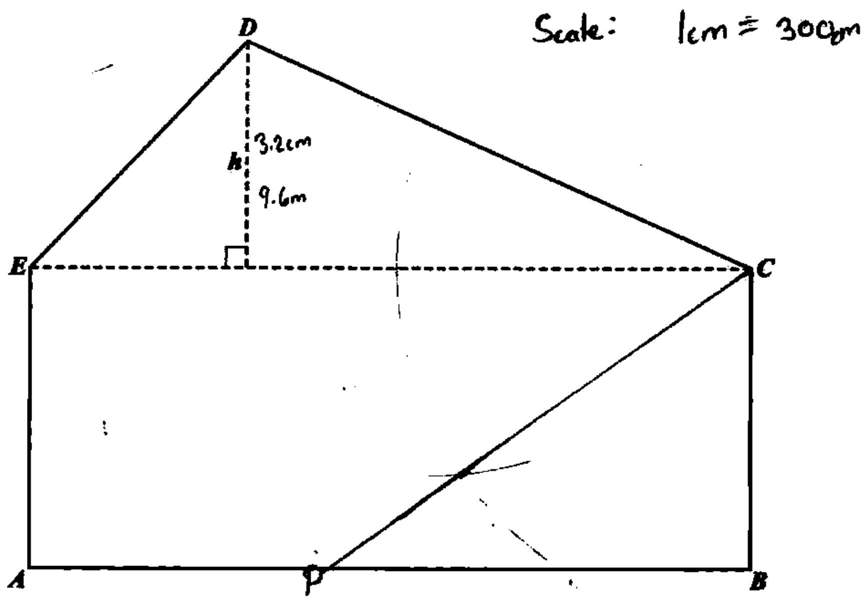
- draw and measure angles and line segments accurately using appropriate instruments
- construct lines, angles and polygons using appropriate instruments
- determine the perimeter of a plane shape
- calculate the area of polygons and circles
- use scales and scale drawings to determine distances and areas.

Candidates' performance

Overall, candidates performed unsatisfactorily. Of the 3648 candidates taking the examination, only one candidate scored full marks. Nine hundred and fifteen candidates (25.08 per cent of candidates) scored zero. The overall mean score was 2.03 out of 10 marks.

Candidate's Response to Part (a)

The scale drawing below shows a playfield, *ABCDE*. In the drawing, 1 cm represents 3 m.



(a) **Measure the height, *h*, and determine the actual distance, in metres.**

h = 3.2cm

actual h = 3.2 × 300

= 960 cm

= 9.6m

h = 9.6m

(1 mark)

Examiner's Comments

Most candidates used their rulers to measure and state the perpendicular height of the triangle accurately. Then they multiplied by 3 to get the correct answer. However, some candidates did not understand the concept of scale drawing and so they left their answers at 3.1cm or within the given range of 3cm–3.2cm. Some candidates also did not follow the instructions and gave answers relating to 100 cm: 1m

Candidate's Response to Part (b)

(b) **The section *CDE* of the playfield is a children's playground and must be completely covered with a grass mat to ensure the children's safety.**

Calculate the amount of material, *in square metres*, that is needed to cover the section *CDE*.

distance of EC = 10 cm
actual = 10 × 300
= 3000 cm
= 30 m

area of CDE = $\frac{1}{2}$ (base × height)
= $\frac{1}{2}$ (30[redacted] × 9.6)
= 144 m^2

....144 m^2..

(3 marks)

Examiner's Comments

Candidates did well on Part (b). They recognized that the area of the triangle needed to be found and as such used the formula *A = ½ x bh*. Some candidates also used alternate solutions. These included the following.

- Using the trigonometrical formula A = ½ abSinC.
- Splitting triangle CDE into two triangles. This was the most attempted method. However, only some candidates who used this method derived the correct answer.
- Using 10 cm in the formula A =1/2bh instead of the conversion of 30m in calculations.

Candidate's Response to Part (c) (i)

(c) There is a circular pool in the playfield. The pool has a diameter of 36 m.

Calculate, as represented on the scale drawing,

(i) the circumference of the pool

(Use $\pi = \frac{22}{7}$.)

radius = 36 ÷ 2 = 18

~~diameter~~

circumference = $2 \times \frac{22}{7} \times 18$

= 113 (3sig. fig)

113m (3sig. fig)

(2 marks)

Examiner's Comments

This part was challenging for candidates. Many of them used the correct radius or diameter in the formula for circumference of the pool and got one mark out of two. However, some candidates did not produce the correct answer as they did not divide by 3 as required and left their answer as 113.14m instead of 37.7cm. This indicated that such candidates had a weak understanding of scale drawing.

Candidate's Response to Part (c) (ii)

(ii) the area of the pool.

area $= \frac{22}{7} \times 18^2$

$= 1018.3$ (1d.p)

1018.3m^2 (1d.p) = 1020 m^2 (3 sig. fig)

(2 marks)

Examiner's Comments

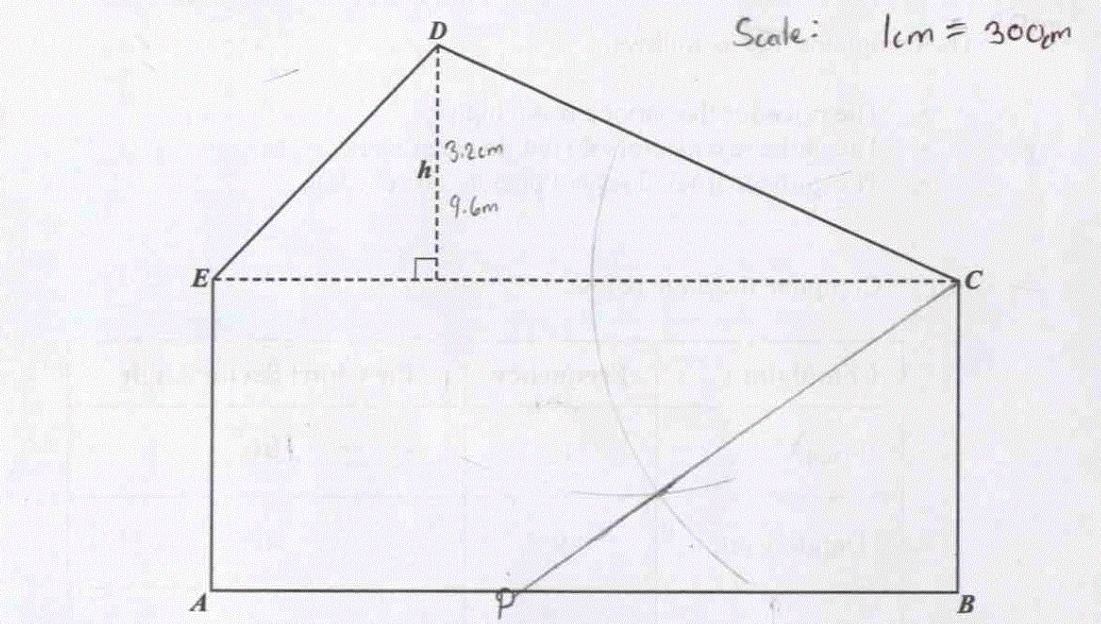
This part was also challenging for candidates. Many of them used the correct radius in the formula for the area of the pool and they were awarded a mark. However, some candidates divided by 3 instead of 9 while others just left answers at 1018.3m^2, hence arriving at the wrong answer. These incorrect answers indicated that these candidates had a weak understanding of scale drawing.

Candidate's Response to Part (d)

(d) A straight path, CP, crosses AB at P. The path is equidistant from CB and CD.

Using a ruler and compasses only, construct the path on the diagram **on page 8. Show all your construction arcs.** **(2 marks)**

The scale drawing below shows a playfield, $ABCDE$. In the drawing, 1 cm represents 3 m.



Examiner's Comments
The performance of candidates on Part (b) was weak performance. They seemed to have a weak understanding of the topic, Construction. Some candidates knew that the position of *P* should be on the line *AB*; however, they did not know how to bisect an angle and as such, the *P* was out of the range.

Recommendations

Teachers should

- expose students to more real-life examples and problems related to scales and scale drawings
- provide more practice for students in construction and using geometrical instruments during instruction time. These hands-on experiences will greatly enhance students' understanding of the topic.

General Recommendations

Teachers are encouraged to remind students to

- carefully read each question so that they understand it before attempting to provide an answer
- practise using their calculators
- familiarize themselves with documents published by CXC. Such documents include the subject reports for past examinations, the syllabus as well as the specimen examination papers. Teachers should also become familiar with these documents.

It is also important for students to be exposed to the various notations and terminologies associated with the subject since seeing them for the first time in an examination can be off-putting.

APPENDIX — THE MARK SCHEME

The mark scheme for the 2024 Mathematics examination has been included for your reference.

Caveat Regarding Mark Scheme

The CXC® mark scheme is an unedited version of the guidelines used in the standardization and marking of candidates' scripts. The mark scheme represents a **sample** of the expected responses, as it cannot encompass all possible solutions or explanations. Users should consider this when interpreting the guidelines provided.

Additionally, the mark scheme may include information from various sources which have been acknowledged where possible. If any sources have been inadvertently overlooked or any material has been incorrectly acknowledged, CXC® will be pleased to correct this at the earliest opportunity.

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CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION

MATHEMATICS

PAPER 02 – GENERAL PROFICIENCY

KEY AND MARK SCHEME

MAY/JUNE 2024

MATHEMATICS

PAPER 02 – GENERAL PROFICIENCY

KEY AND MARK SCHEME

SECTION I

Question 1.

(a) (i) **Calculation:**

$\sqrt{7.1^2 + 2.9^2}$

$= \sqrt{50.41 + 8.41}$

$= \sqrt{58.82}$

$= 7.669419796$

a) correct to 2 sig. figures

$= 7.7$ **R_1 – CAO**

b) correct to 2 decimal places

$= 7.67$ **K_1 – CAO**

(ii) **Quantities in ascending order:**

$0.46 \quad 47\% \quad \frac{12}{25}$ **C_1 CAO**

Part	K	C	R	Total
(a)(i) a)			1	
(a)(i) b)	1			
(a)(ii)		1		
	1	1	1	3

(b) **How much more Mahendra received than Jaya:**

$7224 in the ratio 7 : 5

Amount extra $= \left(7224 \times \frac{7}{12}\right) - \left(7224 \times \frac{5}{12}\right)$

$= \$\ 4214 - 3010$ **C_1 – process**

$= \$1204$ **K_1 – CAO**

OR

$= 7224 \times \frac{2}{12}$ **C_1 – process**

$= \$1204$

Part	K	C	R	Total
(b) process		1		
(b) answer	1			

MATHEMATICS

PAPER 02 – GENERAL PROFICIENCY

KEY AND MARK SCHEME

Question 1 (continued)

Part	Working	K	C	R	Total
(c) (i)	**Population in standard form:** $550000 = 5.5\times10^5$ **R_1 - CAO**			1	
(ii)	**Expected population in 2030:** $= 142\%$ of 550000 $= \frac{142}{100}\times 550000$ **C_1 - finding 142%** $= 781000$		1		
		0	1	1	2
(d) (i)	**Currency conversion using graph:** - $US\$2 = EC\$5.40$ **K_1 – correct read off (± 0.10)**	1			
(ii)	**Currency conversion using graph:** $EC\$1 = US\$0.37$ $\therefore EC\$70 = US\$0.37\times 70$ $= US\$25.90$ **R_1 – CAO** OR $EC\$\,7 = US\$\,2.60$ $\therefore EC\$\,70 = US\$\,2.60\times 10 = US\$\,26$ OR $EC\$\,10 = US\$\,3.70$ $\therefore EC\$\,70 = US\$\,3.70\times 7 = US\$\,25.90$			1	
		1	0	1	2
		3	3	3	9

Specific Objectives: 1.1.2.3.; 1.1.2.9.; 1.1.2.11.; 1.1.2.12.; 1.1.2.14., 1.1.2.15., 2.1.2.9.

MATHEMATICS

PAPER 02 - GENERAL PROFICIENCY

KEY AND MARK SCHEME

Question 2.

			Profiles K	Profiles C	Profiles R	Total
(a)		**Simplified expression for y in terms of x:**				
		Length of rectangular seed bed – $3x$				
		Perimeter of rectangular seed bed – $8x$				
		Perimeter of square seed bed – $4y$				
		$\therefore 8x + 4y = 60$ **R$_1$ – equation**			1	
		$4y = 60 - 8x$				
		$y = \frac{4\ 15 - 2x}{4} = 15 - 2x$ **C$_1$ – having 8x and 4y**		1		
(b)	(i)	**Quadratic equation in x:**				
		Area of rectangle = area of square				
		$\therefore (3x \times x) = (y \times y)$ **R$_1$ – equating correct areas**				
		$3x^2 = y^2$				
		but $y = 15 - 2x$			1	
		$\therefore 3x^2 = (15 - 2x)^2$				
		$3x^2 = 225 - 60x + 4x^2$ **K$_1$ – computation**	1			
		$x^2 - 60x + 225 = 0$				
	(ii)	**Solving quadratic equation by formula:**				
		$x^2 - 60x + 225 = 0$				
		$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$				
		$x = \frac{-(-60) \pm \sqrt{(-60)^2 - 4(1)(225)}}{2(1)}$ **K$_1$ – substitution**	1			
		$x = \frac{60 \pm \sqrt{3600 - 900}}{2}$		1		
		$x = \frac{60 \pm \sqrt{2700}}{2}$ **C$_1$ – computation**				
		$\therefore x = \frac{60 + \sqrt{2700}}{2} = 56.0$				
		K$_1$ – CAO (both values)	1			
		$or\ x = \frac{60 - \sqrt{2700}}{2} = 4.02$				

Question 2 continued.

(iii) **Total area of flower beds:**

Value of y when $x = 4.02$

$y = 15 - 2(4.02)$

$y = 15 - 8.04 = 6.96$

Total area

$= 3x^2 + y^2$

$= 3(4.02)^2 + (6.96)^2$ **C_1 – any correct area FT**

$= 96.92\text{m}^2$ **K_1 – total area FT**

or

$Total\ area = 2 \times 3x^2 = 2 \times 3 \times 4.02^2 = 96.96\ m^2$

Profiles K	Profiles C	Profiles R	Total
	1		
1			
4	2	1	7
4	3	2	9

Specific Objectives: 6.1.2.2.; 6.1.2.4.; 6.1.2.13.; 6.1.2.16.; 6.1.2.17.

MATHEMATICS

PAPER 02 – GENERAL PROFICIENCY

KEY AND MARK SCHEME

Question 3.

Question	Working	K	C	R	Total
(a) (i)	**Height of the flagpole, FP:** $\sin 38^\circ = \frac{\text{Opposite}}{\text{Hypotenuse}}$ $\sin 38^\circ = \frac{\text{FP}}{18\text{ m}}$ **C_1 – substituting in the sine ratio** $FP = 18 \sin 38^\circ$ $FP = 18 \times 0.616$ $FP = 11.08\text{ m}$ **K_1 – CAO (based on sig figs used)**	1	1		
(ii)	**Length of rope, PR:** Applying Pythagoras' theorem $PR^2 = FP^2 + FR^2$ $PR^2 = (11.08)^2 + (9.7)^2$ **C_1 – substitution** $PR = \sqrt{216.8564}$ **K_1 – FT correctly** $PR = 14.73\text{ m}$	1	1		
		2	2	0	4
(b)	**Value of angle x:** $x = \angle QLR + \angle RLT$ $x = 28^\circ + \left(\frac{180^\circ - 28^\circ}{2}\right)$ **R_1 – correct $\angle RLT$ or RTL** $x = 28^\circ + 76^\circ$ $x = 104^\circ$ **C_1 – CAO** *OR* $x = 180^\circ - \left(\frac{180^\circ - 28^\circ}{2}\right)$ $x = 180^\circ - 76^\circ = 104^\circ$		1	1	

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KEY AND MARK SCHEME

Question 3.

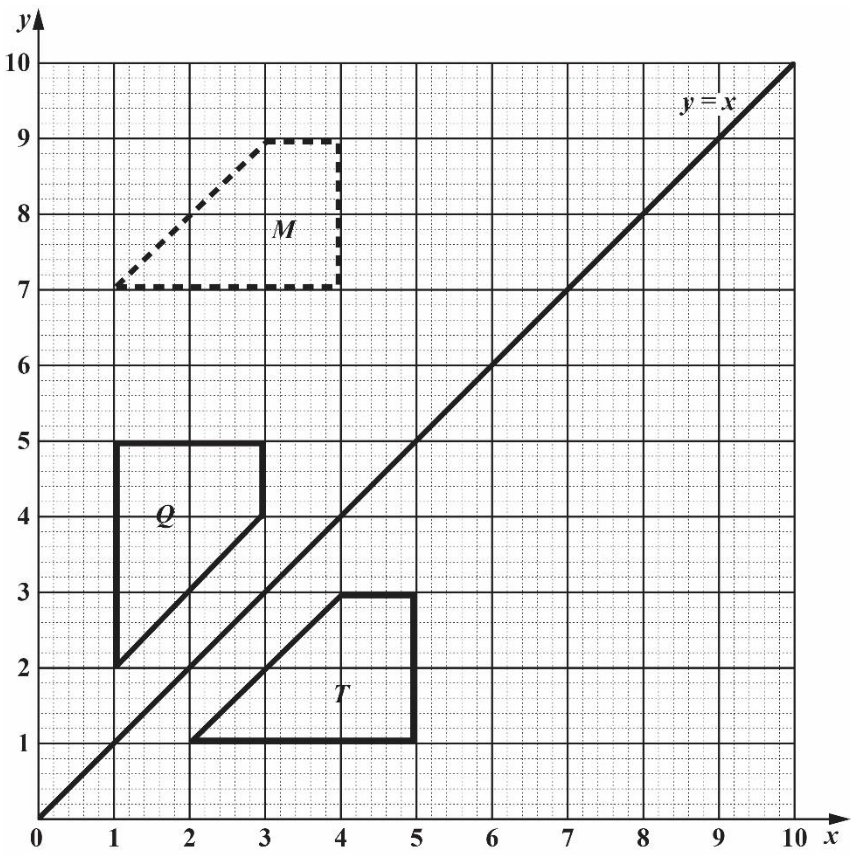
(c) (i) **Description of transformation that maps T onto Q:**

- A reflection (R_1) in the line $y = x$ (C_1).

(ii) **Translation (on graph paper):**

- **Correct position of image, M** K_1 **- CAO**

Profiles			Total
K	C	R	
	1	1	
1			
1	1	1	3
3	4	2	9



Specific objectives: 8.1.2.5.; 8.1.2.8.; 8.1.2.10.; 8.1.2.12.; 8.1.2.13.

Question 4.

Working	Marks	Profiles K	Profiles C	Profiles R	Total
(a) (i) **Length of PR:**					
$d=\sqrt{\left(x_2-x_1\right)^2+\left(y_2-y_1\right)^2}$					
$d=\sqrt{(4-(-3))^2+((-4)-10)^2}$	**C_1 – substituting**		1		
$d=\sqrt{(7)^2+(-14)^2}$					
$d=\sqrt{245}$	**K_1 – CAO**	1			
$d=15.65$ *units*					
(ii) **Equation of line PR:**					
Gradient of Line *PR*					
$m=\frac{y_2-y_1}{x_2-x_1}=\frac{-4-10}{4-(-3)}=-\frac{14}{7}=-2$	**C_1 – computation of gradient CAO**		1		
Using $m=-2$ and $(4,-4)$, then					
$y-y_1=m\left(x-x_1\right)$					
$y-(-4)=-2(x-4)$	**R_1 – correct substitution FT**			1	
$y+4=-2x+8$					
$y=-2x+4$	**K_1 – correct FT**	1			
OR					
$y=mx+c$					
$-4=-2(4)+c$					
$8-4=c$					
$4=c$					
$y=-2x+4$					
		2	**2**	**1**	**5**

Question 4 continued.

			Profiles K	Profiles C	Profiles R	Total
(b) (i)	**Evaluating functions:**					
	$f(x)=3x+1$					
	$f(x-2)=3\left(x-2\right)+1$	**C_1 – substitute correctly**		1		
	$f(x-2)=3x-6+1$					
	$f(x-2)=3x-5$	**K_1 – CAO**	1			
(ii)	**Evaluating functions:**					
	$g(3x+2)+10$					
	$=(3x+2)^2+10$	**R_1 – substitute correctly**			1	
	$=9x^2+12x+4+10$	**C_1 – expand correctly**		1		
	$=9x^2+12x+14$					
			1	2	1	4
			3	4	2	9

Specific Objectives: 7.1.2.8.; 7.1.2.9.; 7.1.2.11.; 7.1.2.19.

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KEY AND MARK SCHEME

Question 5.

Profiles			Total
K	C	R	

(a) (i) **Mode and median of the number of words spelt correctly:**

a) Highest frequency = 8

$\therefore$ Mode = 5 words — **R_1 – correct mode** (R: 1)

b) Median $= \frac{23 + 1}{2} = 12^{th}$ rank element

According to the table

Median = 6 words — **R_1 – correct median** (R: 1)

(ii) **Average number of words spelt correctly:**

Number of Words	5	6	7	8	9	10	**Total**
Frequency	8	4	2	2	3	4	23
$f \times x$	40	24	14	16	27	40	**161**

$$\text{Mean} = \frac{\sum fx}{n}$$

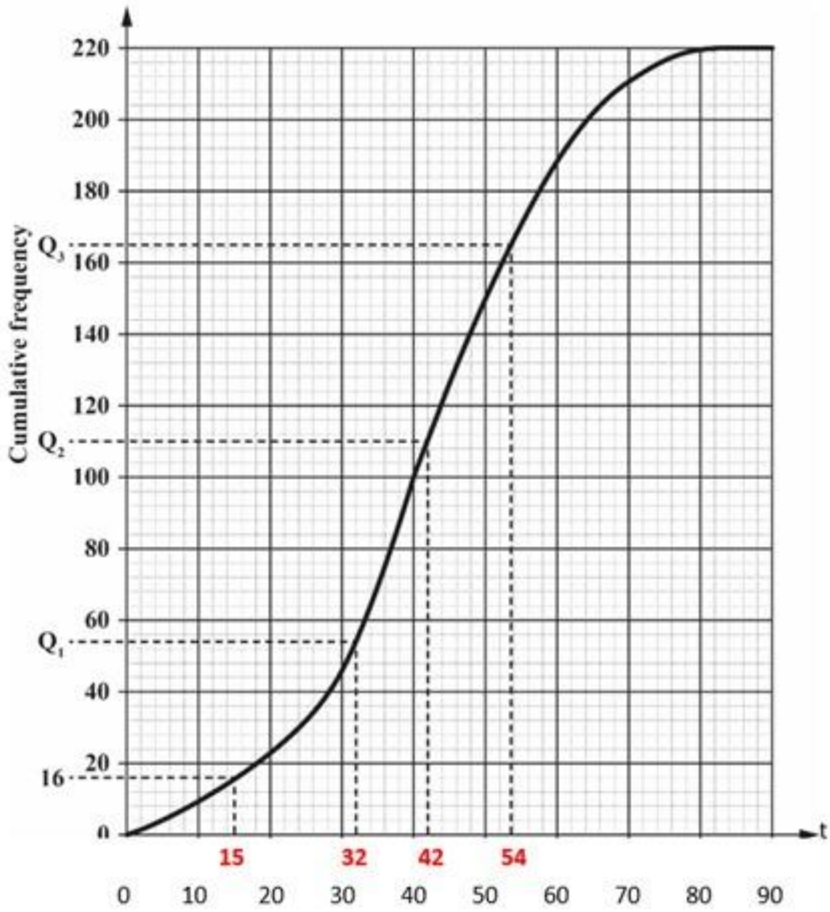
$$= \frac{161}{23}$$ **C_1 – summing fx and dividing by 23** (C: 1)

$$= 7 \text{ words}$$ **K_1 – CAO** (K: 1)

K	C	R	Total
1	1	2	4

Question 5 continued.

(b)



(i) **Number of students who took at MOST 32 minutes to travel to school:**

54 ± 2 **C_1 – CAO** (C: 1)

(ii) **The inter-quartile range:**

$$Q_3 = \frac{3}{4}n = \frac{3}{4} \times 220 = 165^{th}$$

$$Q_1 = \frac{1}{4}n = \frac{1}{4} \times 220 = 55^{th}$$

According to the graph:

$165^{th} = 54 \pm 2$ **C_1 – any correct of Q_1 or Q_3** (C: 1)

$55^{th} = 32 \pm 2$

$\therefore IQR = (54 - 32)$ minutes

$IQR = 22$ minutes **R_1 – FT subtracting (Q_3 - Q_1)** (R: 1)

Profiles			Total
K	C	R	
	1		
	1	1	
0	2	1	3

Question 5 continued.

(c) **Probability that she picks an "I" then a "V":**

$P(I \text{ followed by } V) = P(I) \times P(V)$

$= \frac{3}{10} \times \frac{1}{10}$ — **R_1 – multiplying probabilities (at least one correct)**

$= \frac{3}{100}$ — **K_1 – CAO**

$= 0.03$

Profiles K	Profiles C	Profiles R	Total
		1	
1			
2	3	4	9

Specific Objectives: 5.1.2.5., 5.1.2.10., 5.1.2.11., 5.1.2.13.

Question 6.

Working	Mark	K	C	R	Total
(a) (i) **Area of cross-section of the prism:** $V = Ah$					
$\therefore A = \frac{V}{h} = \frac{2886}{31.2}$	**C_1 – computation**		1		
$A = 92.5\ cm^2$					
(ii) **Height of cuboid:** $V = l \times w \times h$					
$\therefore 2886 = 30.6 \times 8.2 \times h$	**C_1 – substitution**		1		
$h = \frac{2886}{30.6 \times 8.2} cm$					
$h = 11.5\ cm$	**K_1 – CAO**	1			
		1	2	0	3
(b) (i) **Radius of sphere:** $V = \frac{4}{3}\pi r^3$					
$\frac{2886}{6} = 481 = \frac{4}{3}\pi r^3$	**R_1 – obtaining volume of each sphere and equating**			1	
$r = \sqrt[3]{\frac{3 \times 481}{4\left(\frac{22}{7}\right)}}$	**C_1 – make r the subject**		1		
$r = \sqrt[3]{\frac{1443}{12.566}}$					
$r = 4.86$ cm	**K_1 – CAO (based on π used)**	1			
(ii) **Surface area of sphere:** $S.A. = 4\pi r^2$					
$S.A. = 4 \times \frac{22}{7} \times (4.86)^2$	**K_1 – substitution FT**	1			
$S.A. = 296.93\ cm^2$					

Question 6 continued.

	Profiles K	Profiles C	Profiles R	Total
(b) (iii) **Mass of each sphere of gold:**				
$\text{Density} = \dfrac{\text{mass}}{\text{volume}}$				
$\text{Mass} = \text{density} \times \text{volume}$				
$\text{Mass} = 19.3\ \text{g/cm}^3 \times 481\ \text{cm}^3$ **R_1 – multiplying**			1	
$\text{Mass} = 9283.3\ \text{g}\ (\div 1000)$	1			
$\text{Mass} = 9.28\ \text{kg} = 9\ \text{kg}$ **K_1 – dividing mass by 1000**				
	3	1	2	6
	4	3	2	9

Specific Objectives: 4.1.2.1., 4.1.2.10., 4.1.2.11., 4.1.2.15.

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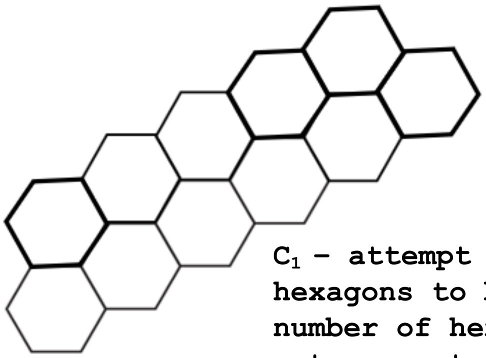
Question 7.

(a) **Completion of Diagram 5:**



C_1 – attempt made to add hexagons to both sides, but number of hexagons added not correct

K_1C_1 – all 4 hexagons added correctly

(b) **Completion of table:**

	Diagram Number (n)	Number of Hexagons (H)	Number of Sticks (S)	Perimeter (P)
	1	3	15	12
	2	5	23	16
	3	7	31	20
	4	9	39	24
(i)	5	**<u>11</u>** K_1 – CAO	**<u>47</u>** R_1 – CAO	28
	⋮	⋮	⋮	⋮
(ii)	**<u>23</u>** C_1 – CAO	47	191	**<u>100</u>** R_1 – CAO
	⋮	⋮	⋮	⋮
(iii)	n	$2n + 1$	$8n + 7$	$4n + 8$ / $4(n + 2)$
		R_1 – CAO	R_1 – CAO	R_1 – CAO

Part	Profiles K	Profiles C	Profiles R	Total
(a)	1	1		
(b)(i)	1		1	
(b)(ii)		1	1	
(b)(iii)			3	
	1	1	5	7

Question 7 continued.

	Profiles			Total
	K	C	R	
(c) **Explanation:** The perimeter 4(n + 2) will always result in an even number, irrespective of the value of n. The number 1005 is an odd number, so it is not possible to make a figure of perimeter 1005. **R_1– logical explanation**			1	
	2	2	6	10

Specific Objectives:1.1.2.16.,1.1.2.17.,4.1.2.3.

	K	C	R	Total
TOTAL SECTION I	21	22	21	64

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SECTION II

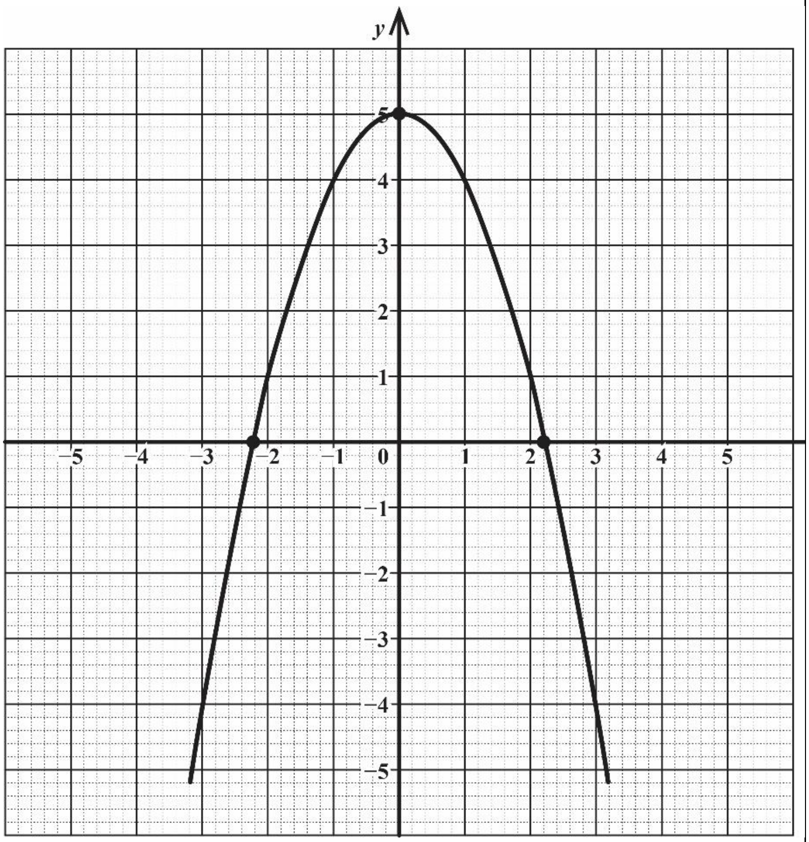
Question 8.

$$f(x)=\frac{2x-1}{3} \text{ and } g(x)=5-x^2.$$

			Profiles K	Profiles C	Profiles R	Total
(a)	(i)	**a) Evaluating function:**				
		$g(x)=5-x^2$				
		$g(2)=5-2^2$				
		$g(2)=1$ — **K_1 – CAO**	1			
		b) Evaluating function:				
		$f(x)=\frac{2x-1}{3}$				
		$y=\frac{2x-1}{3}$				
		$x=\frac{2y-1}{3}$				
		$2y-1=3x$				
		$y=\frac{3x+1}{2}$ — **C_1 – procedure – sub. 3 in his inverse/correct inverse**		1		
		$\therefore f^{-1}(3)=\frac{3(3)+1}{2}=5$ — **K_1 – CAO**	1			
		OR $3=\frac{2x-1}{3}$				
		$x=\frac{9+1}{2}=5$ — **C_1 – make x the subject of f(x) = 3**				
		$\therefore f^{-1}(3)=5$ — **K_1 – CAO**				
			2	1	0	3
	(ii)	**Composite function:**				
		$f(x)=\frac{2x-1}{3}$ and $g(x)=5-x^2$				
		$fg(x)=\frac{2(5-x^2)-1}{3}$ — **R_1 – put g into f**			1	
		$fg(x)=\frac{10-2x^2-1}{3}$				
		$fg(x)=\frac{9-2x^2}{3}$ — **C_1 – CAO**		1		
			2	2	1	5

Question 8 continued.

(iii) **Sketch of graph:**



C_1 – correct roots of the function marked off
R_1 – correct maximum point indicated
R_1 – maximum curve

Profiles			Total
K	**C**	**R**	
	1	2	

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Question 8 continued.

(b) (i) **Tangent to the quadratic function:**

On graph paper

C_1 – correct line drawn through the point (1, 3) and touching the curve at only that point

(ii) **Gradient:**

Using the points (0.5, 0.6), (1, 3) and/or (1.5, 5.4)

$m = \dfrac{y_2 - y_1}{x_2 - x_1}$ **C_1 – reading off the points and substituting FT**

$m = \dfrac{3 - 0.6}{1 - 0.5} = \dfrac{2.4}{0.5} = \dfrac{24}{5} = 4.8$ **K_1 – computation**

(allow ± one small square on each axis)

(iii) **Equation of tangent:**

Using $m = 4.8$

and $c = -1.8$

$y = mx + c$

$y = 4.8x - 1.8$ **C_1 – FT**

	Profiles K	Profiles C	Profiles R	Total
(b)(i)		1		
(b)(ii)	1	1		
(b)(iii)		1		
	1	3	0	4
	3	6	3	12

Specific Objectives: 7.1.2.9., 7.1.2.16., 7.1.2.18.; 7.1.2.19., 7.1.2.20., 7.1.2.21.

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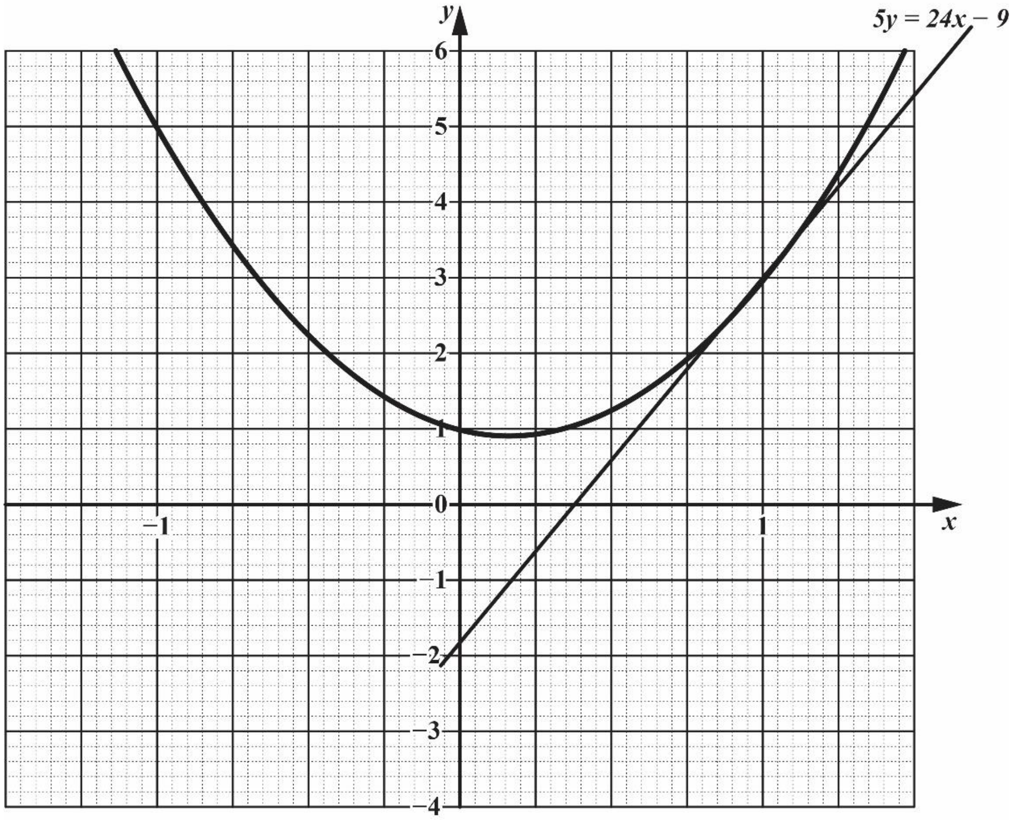
KEY AND MARK SCHEME

Question 8(b)(i).



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KEY AND MARK SCHEME

Question 9

			Profiles			Total
			K	C	R	
(a)	(i)	**Justification for the values of each angle:** **Angle b** Angles at the circumference in the same segment of a circle and subtended by the same arc/chord are equal. **Angle c** The angle which an arc of a circle subtends at the centre of a circle is twice the angle it subtends at any point on the remaining part of the circumference. **Angle OVW** A tangent of a circle is perpendicular to the radius/diameter of that circle at the point of contact. **R_3 – for each correct theorem cited, 1 mark**			3	
	(ii)	**Value of angles:** $\angle a = 62^\circ$ **K_1 – CAO** $\angle d = 90^\circ - 62^\circ = 28^\circ$ **C_1 – FT (a + d = 90)** $\angle e = 72 - 28 = 44^\circ$ **C_1 – FT (d + e = 72)**	1	1 1		
			1	2	3	6

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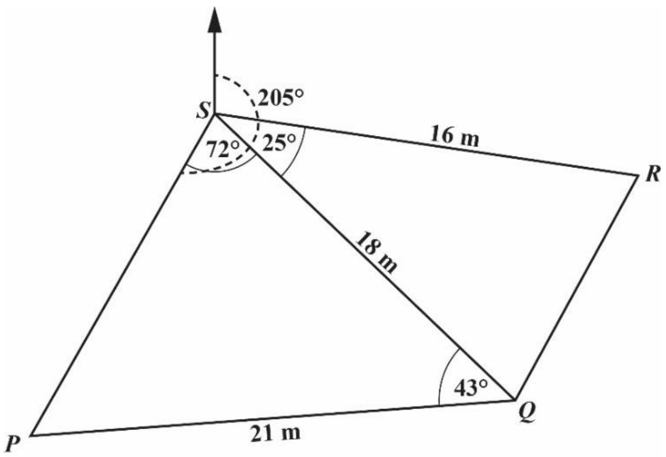
KEY AND MARK SCHEME

Question 9. continued

Working	Profiles K	Profiles C	Profiles R	Total
(b) (i) **Length of QR:** 				
Considering ΔQRS				
$s^2 = r^2 + q^2 - 2rq\cos S$ **C_1 – applying the cosine rule correctly**		1		
$s^2 = 16^2 + 18^2 - 2(16 \times 18)\cos 25^\circ$				
$s^2 = 580 - (576 \times 0.906)$				
$s = \sqrt{58.144}$ **C_1 – computation (58.144)**		1		
$s = 7.63$				
$\therefore QR = 7.63$ m **K_1 – CAO (based on sig figs used)**	1			
(ii) **a) Bearing of R from S:**				
$= 205^\circ - (72^\circ + 25^\circ)$				
$= 205^\circ - 97^\circ$				
$= 108^\circ$ **C_1 – CAO**		1		
$\therefore$ bearing of R from S is 108°				
b) Bearing of S from P:				
$= 180^\circ - (360^\circ - 205^\circ)$ **C_1 – subtracting twice**		1		
$= 180^\circ - 155^\circ$				
$= 25^\circ$ **K_1 – CAO**	1			
$\therefore$ bearing of S from P is 025°				
	2	4	0	6
	3	6	3	12

Specific Objectives: 8.1.2.6., 8.1.2.14., 8.1.2.16., 8.1.2.17.

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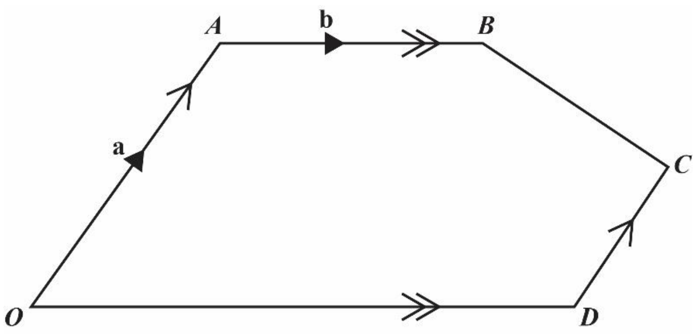
KEY AND MARK SCHEME

Question 10

		Working	Mark scheme	K	C	R	Total
(a)		**Value of v:**					
		$\begin{vmatrix} 6 & 2v \\ -5 & -v \end{vmatrix} = 24$					
		$\therefore 6\times(-v)-\left[(-5)\times 2v\right]=24$	**R_1 – correct equation**			1	
		$-6v+10v=24$					
		$4v=24$					
		$v=\frac{24}{4}$					
		$v=6$	**K_1 – CAO**	1			
(b)	(i)	**Multiplying matrices:**					
		$LM=\begin{pmatrix} 9 & 5 \\ 3 & 2 \end{pmatrix}\begin{pmatrix} 2 \\ -4 \end{pmatrix}$					
		$LM=\begin{pmatrix} 9\times 2+5\times(-4) \\ 3\times 2+2(-4) \end{pmatrix}$	**C_1 – procedure**		1		
		$LM=\begin{pmatrix} 18+(-20) \\ 6+(-8) \end{pmatrix}$					
		$LM=\begin{pmatrix} -2 \\ -2 \end{pmatrix}$	**K_1 – CAO**	1			
	(ii)	**Inverse of a Matrix L:**					
		$L=\begin{pmatrix} 9 & 5 \\ 3 & 2 \end{pmatrix}$					
		$\therefore \lvert L\rvert=(9\times 2)-(5\times 3)$					
		$\lvert L\rvert=18-15=3$					
		$L^{-1}=\frac{1}{\lvert L\rvert}\times L \text{ adjoint}$	**C_1 – equation (correct determinant/adjoint)**		1		
		$L^{-1}=\frac{1}{3}\begin{pmatrix} 2 & -5 \\ -3 & 9 \end{pmatrix}$	**C_1 – CAO**		1		
		$L^{-1}=\begin{pmatrix} 2/3 & -5/3 \\ -1 & 3 \end{pmatrix}$					
				1	**3**	**0**	**4**

Question 10. continued

Part	Working	Mark scheme	K	C	R	Total
(c)	**Coordinates of Q:**					
	$\overrightarrow{PQ}=\overrightarrow{PO}+\overrightarrow{OQ}$	**C_1 – correct path (SOI)**		1		
	$\therefore\ \overrightarrow{OQ}=\overrightarrow{OP}+\overrightarrow{PQ}$					
	$\overrightarrow{OQ}=\begin{pmatrix}-2\\3\end{pmatrix}+\begin{pmatrix}5\\-4\end{pmatrix}$					
	$\overrightarrow{OQ}=\begin{pmatrix}3\\-1\end{pmatrix}$	**K_1 – CAO**	1			
	$\therefore$ coordinates of Q are $(3,-1)$					
(d)	**Vector diagram:**					
(i)	**Finding vectors:**					
	$\overrightarrow{AD}=\overrightarrow{AO}+\overrightarrow{OD}$					
	$\overrightarrow{AD}=-\mathbf{a}+2\mathbf{b}$	**C_1 – CAO**		1		
	$\overrightarrow{AD}=2\mathbf{b}-\mathbf{a}$					
(ii)	**Finding vectors:**					
	$\overrightarrow{BC}=\overrightarrow{BA}+\overrightarrow{AD}+\overrightarrow{DC}$	**R_1 – correct path (SOI)**			1	
	$\overrightarrow{BC}=-\mathrm{b}+(-\mathrm{a})+2\mathrm{b}+\frac{1}{2}\mathrm{a}$					
	$\overrightarrow{BC}=\mathrm{b}-\frac{1}{2}\mathrm{a}$	**C_1 – simplifying FT**		1		



Question 10. continued

(iii) **Conclusion about** $\overrightarrow{AD}$ and $\overrightarrow{BC}$.

$\overrightarrow{BC} = b - \frac{1}{2}a = \frac{1}{2}(2b - a) = \frac{1}{2}\overrightarrow{AD}$

$\overrightarrow{AD} = 2b - a = 2(b - \frac{1}{2}a) = 2\,\overrightarrow{BC}$

$\overrightarrow{AD} : \overrightarrow{BC} = 1 : \frac{1}{2} = 2:1$ **R_1 – logical conclusion**

$\therefore$ *AD is twice as long as BC*.

Profiles K	C	R	Total
		1	
0	2	2	4
3	6	3	12

Specific Objectives: 9.1.2.2., 9.1.2.3., 9.1.2.4., 9.1.2.6., 9.1.2.8., 9.1.2.9, 9.1.2.11.