

FORM TP 2023020



TEST CODE 01234020

JANUARY 2023

CARIBBEAN EXAMINATIONS COUNCIL
CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION

MATHEMATICS

Paper 02 – General Proficiency

2 hours 40 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of TWO sections: I and II.
2. Section I has SEVEN questions and Section II has THREE questions.
3. Answer ALL questions.
4. Write your answers in the spaces provided in this booklet.
5. Do NOT write in the margins.
6. All working MUST be clearly shown.
7. **A list of formulae is provided on page 4 of this booklet.**
8. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
9. **If you use the extra page(s), you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**
10. **ALL diagrams in this booklet are NOT drawn to scale, unless otherwise stated.**

Required Examination Materials

Electronic calculator
Geometry set

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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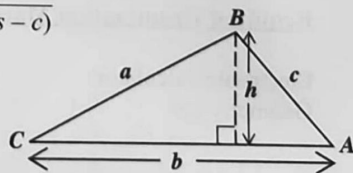
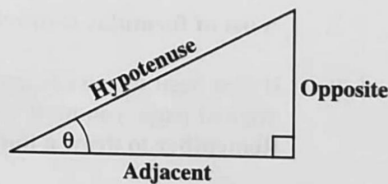


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LIST OF FORMULAE

Volume of a prism	$V = Ah$ where A is the area of a cross-section and h is the perpendicular length.
Volume of a cylinder	$V = \pi r^2 h$ where r is the radius of the base and h is the perpendicular height.
Volume of a right pyramid	$V = \frac{1}{3} Ah$ where A is the area of the base and h is the perpendicular height.
Circumference	$C = 2\pi r$ where r is the radius of the circle.
Arc length	$S = \frac{\theta}{360} \times 2\pi r$ where θ is the angle subtended by the arc, measured in degrees.
Area of a circle	$A = \pi r^2$ where r is the radius of the circle.
Area of a sector	$A = \frac{\theta}{360} \times \pi r^2$ where θ is the angle of the sector, measured in degrees.
Area of a trapezium	$A = \frac{1}{2} (a + b) h$ where a and b are the lengths of the parallel sides and h is the perpendicular distance between the parallel sides.
Roots of quadratic equations	If $ax^2 + bx + c = 0$, then $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
Trigonometric ratios	$\sin \theta = \frac{\text{length of opposite side}}{\text{length of hypotenuse}}$ $\cos \theta = \frac{\text{length of adjacent side}}{\text{length of hypotenuse}}$ $\tan \theta = \frac{\text{length of opposite side}}{\text{length of adjacent side}}$
Area of a triangle	<p>Area of $\Delta = \frac{1}{2} bh$ where b is the length of the base and h is the perpendicular height.</p> <p>Area of $\Delta ABC = \frac{1}{2} ab \sin C$</p> <p>Area of $\Delta ABC = \sqrt{s(s-a)(s-b)(s-c)}$</p> <p>where $s = \frac{a+b+c}{2}$</p>
Sine rule	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$
Cosine rule	$a^2 = b^2 + c^2 - 2bc \cos A$



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SECTION I

Answer ALL questions.

All working must be clearly shown.

1. (a) (i) By rounding each number in the expression below to **one significant figure**, estimate the value of

$$\frac{\sqrt{108}}{19.72 + 5.296}$$

.....
(2 marks)

- (ii) Find the EXACT value of

$$3\frac{3}{8} \div \left(\frac{5}{12} + \frac{1}{3}\right)$$

Give your answer as a mixed number in its **simplest** form.

.....
(3 marks)

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- (b) Due to the COVID-19 pandemic, the number of available seats in a hall was reduced from 125 to 93. Calculate the percentage decrease in the number of available seats.

.....
(2 marks)

- (c) Mica invests a certain amount of money in a bank that pays compound interest at a rate of 2.5% per annum. At the end of 2 years, the value of her investment is \$7 564.50.

Calculate the amount Mica invests.

$$\left(\begin{array}{l} \text{Compound interest: } A = P \left(1 + \frac{r}{100} \right)^n, \text{ where, } A = \text{total amount after } n \text{ years;} \\ P = \text{principal or original value;} \\ r = \text{rate of interest per annum; } n = \text{number of years the money is invested} \end{array} \right)$$

.....
(2 marks)

Total 9 marks

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2. (a) Simplify:

(i) $(x^3)^2$

.....

(1 mark)

(ii) $y^8 \div y^{-5}$

.....

(1 mark)

(b) (i) Factorize:

a) $xy - y^2$

.....

(1 mark)

b) $x^2 - y^2$

.....

(1 mark)

(ii) Hence, simplify the expression

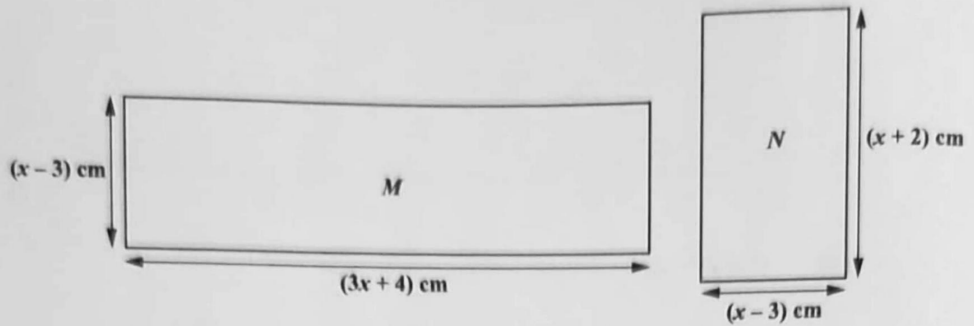
$$\frac{xy - y^2}{x^2 - y^2}$$

.....

(1 mark)



- (c) The diagram below shows 2 rectangles, M and N , with their dimensions expressed in terms of x .



Given that the difference between the areas of the two rectangles is 64 cm^2 , show that $x^2 - 2x - 35 = 0$.

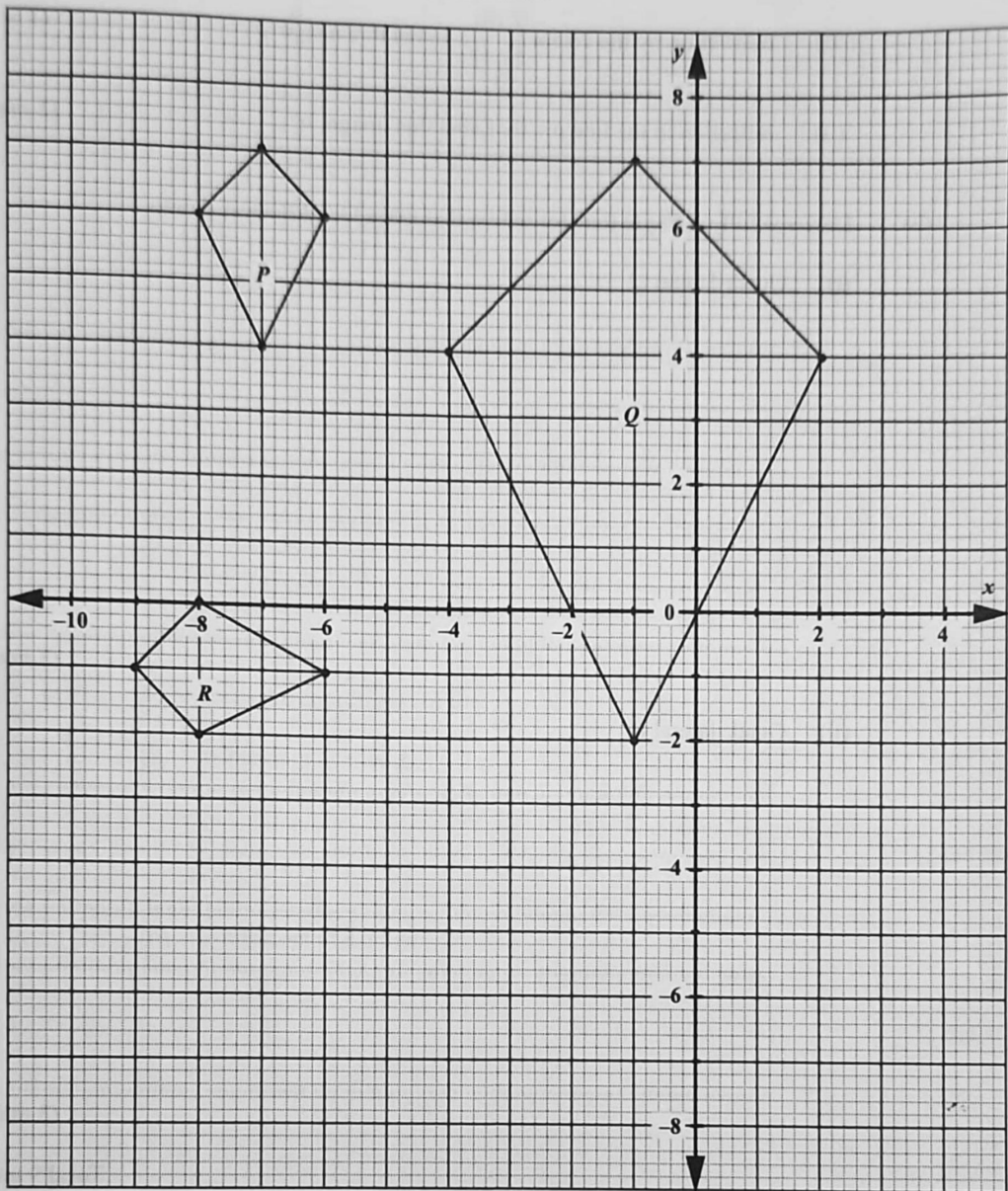
(4 marks)

Total 9 marks

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3. The following diagram shows 3 quadrilaterals, P , Q and R on a square grid. Q and R are the images of P after it underwent 2 different transformations.



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(a) On the grid on page 9, draw the image of quadrilateral P after a

(i) translation by the vector $\begin{pmatrix} 10 \\ -4 \end{pmatrix}$. Label this image P'

(1 mark)

(ii) reflection in the line $y = 0$. Label this image P'' .

(2 marks)

(b) Describe fully a **single** transformation that maps Quadrilateral P onto

(i) Quadrilateral Q

.....

.....

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.....

.....

(3 marks)

(ii) Quadrilateral R .

.....

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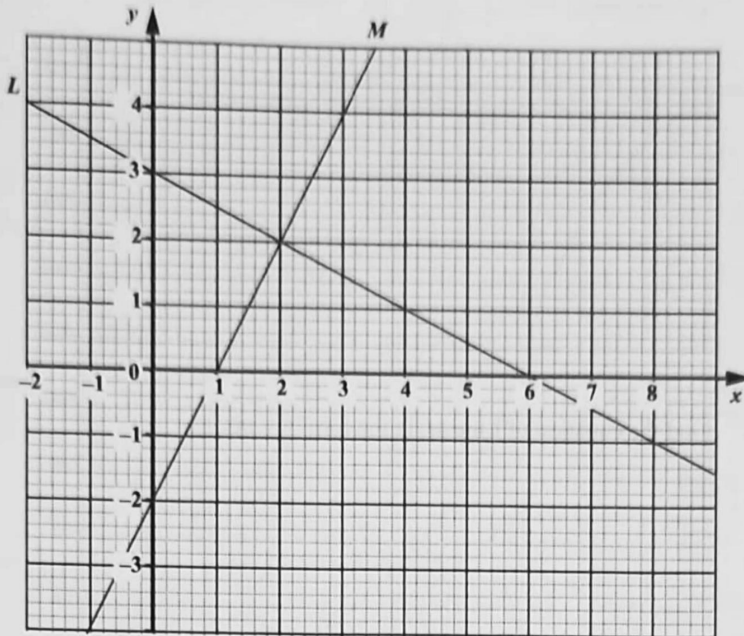
.....

(3 marks)

Total 9 marks



4. Lines L and M are drawn on the square grid below.



- (a) Write down the coordinates of the

- (i) x -intercept of Line L

..... (1 mark)

- (ii) y -intercept of Line M .

..... (1 mark)

GO ON TO THE NEXT PAGE



(b) The equation of Line L is $x + 2y - 6 = 0$. Find the value of k given that the point $(9, k)$ lies on Line L .



.....
(2 marks)

(c) Find the equation of Line M , in the form $y = mx + c$.



.....
(2 marks)

(d) Show by calculation, that Line L and Line M are perpendicular.

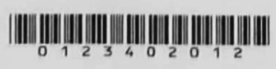
.....
(2 marks)

(e) Line L and Line M represent the graph of a pair of simultaneous equations. Using the graph on page 11, write down the solution to the pair of simultaneous equations.

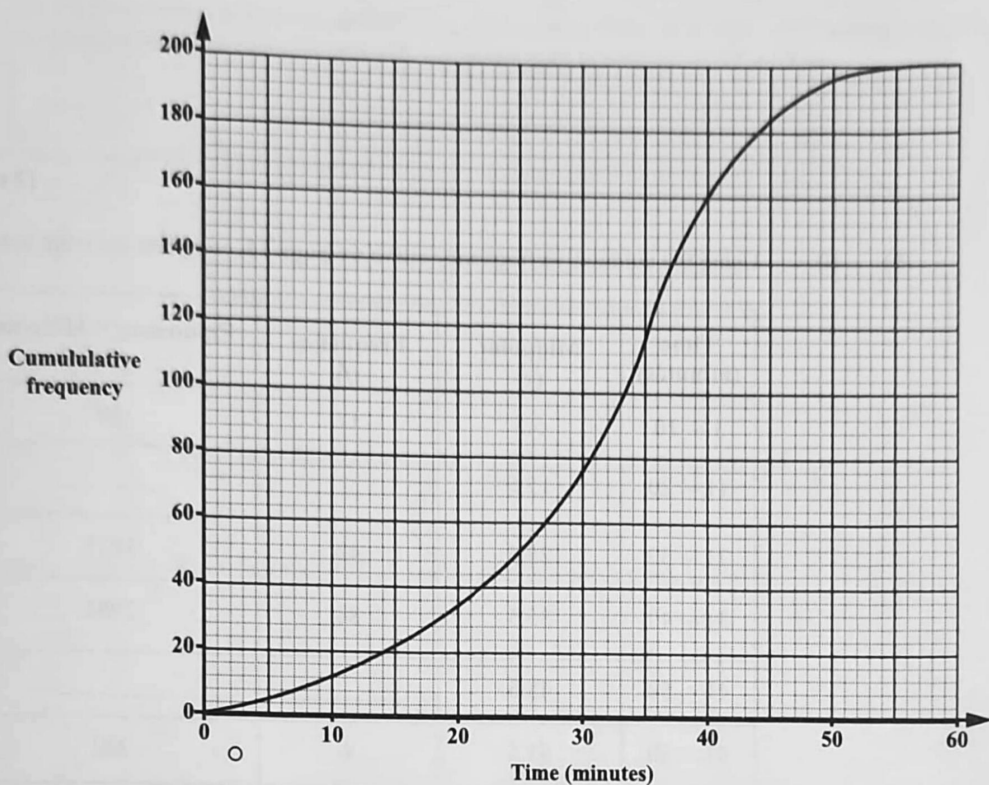
.....
(1 mark)

Total 9 marks

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5. The cumulative frequency curve below shows information about the times taken by 200 students to solve a Mathematics Olympiad problem.



- (a) Using the cumulative frequency curve shown above, find an estimate for the
- (i) number of students who took more than 50 minutes to solve the problem
-
- (ii) median time taken to solve the problem
-

(1 mark)

(1 mark)

GO ON TO THE NEXT PAGE



- (iii) probability that a student chosen at random took **at most** 28 minutes to solve the problem.

.....
(2 marks)

- (b) (i) Using the cumulative frequency curve on page 13, complete the table below.

Time (minutes)	Midpoint (x)	Frequency (f)	Frequency \times Midpoint (fx)
1 – 10	5.5	12	66
11 – 20	15.5	_____	_____
21 – 30	25.5	42	1071
31 – 40	35.5	84	2982
41 – 50	45.5	_____	_____
51 – 60	55.5	4	222

(3 marks)

- (ii) Use the information in the completed table above to calculate an estimate of the average time taken by the students to solve the problem.

.....
(2 marks)

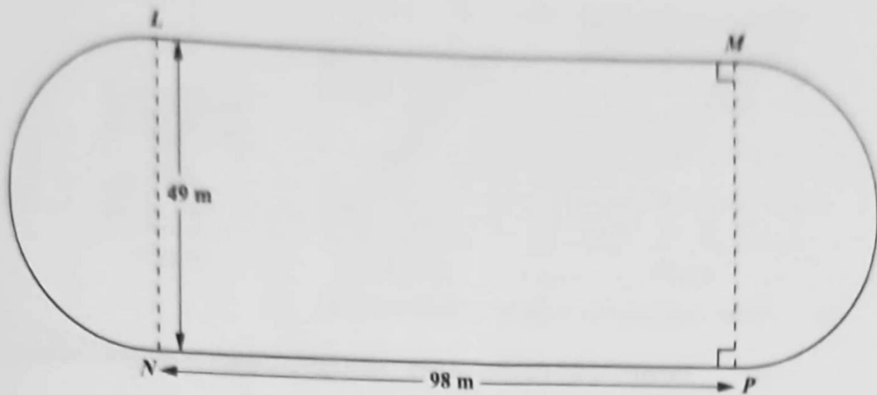
Total 9 marks

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6. In this question, use $\pi = \frac{22}{7}$.

The diagram below shows a scaled drawing of a running track. It consists of a rectangle and two semicircles with diameters LN and MP . $LN = MP = 49$ m and $LM = NP = 98$ m.



- (a) (i) Show that the TOTAL length of the running track is 350 m.

.....
(2 marks)

GO ON TO THE NEXT PAGE



- (ii) Nathan walks at a constant rate of 1.4 m/s. Calculate the time it will take him to walk 7 laps around the track.

.....
(2 marks)

- (b) Tafari runs one lap of the track in 68 seconds.

- (i) Determine the number of laps Tafari can complete in one hour, running at the same speed.

.....
(2 marks)

- (ii) Nathan completes running one lap of the track every 72 seconds. Tafari and Nathan start running at the same time from point *L* on the track. Each completed a number of laps of the track. Calculate the LEAST number of laps that each will complete before they are both at point *L* again at the same time.

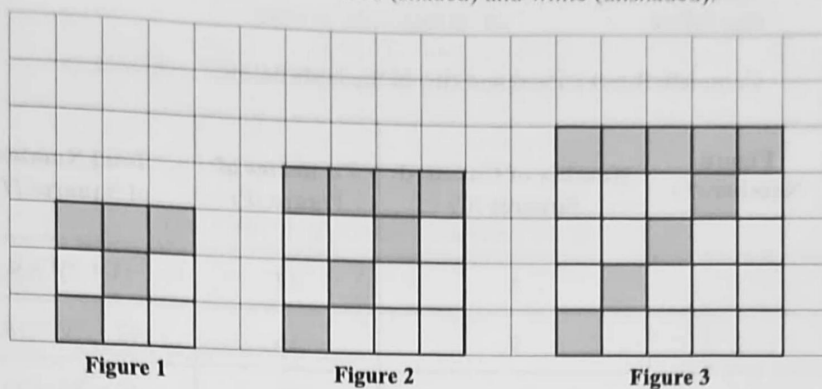
Tafari completes laps and Nathan completes laps.
(3 marks)

Total 9 marks

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7. The grid below shows the first 3 figures in a sequence. Each figure is made using a set of small squares of unit length that are **both** coloured (shaded) and white (unshaded).



- (a) In the space provided below, draw Figure 4 of the sequence.

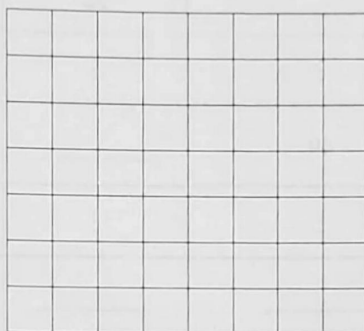


Figure 4

(2 marks)

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- (b) The number of coloured squares, C , the total number of squares, T and the perimeter of the figure, P , follow a pattern. Study the patterns in the table below and answer the questions that follow.

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

Figure Number (F)	Number of Coloured Squares (C)	Perimeter of Figure (P)	Total Number of Squares (T)	
1	5	12	$(1 + 2)^2 = 9$	
2	7	16	$(2 + 2)^2 = 16$	
3	9	20	$(3 + 2)^2 = 25$	
\vdots	\vdots	\vdots	\vdots	
(i) 11	_____	52	_____	(2 marks)
\vdots	\vdots	\vdots	\vdots	
(ii) _____	49	_____	$(23 + 2)^2 = 625$	(2 marks)
\vdots	\vdots	\vdots	\vdots	
(iii) n	_____	_____	_____	(3 marks)

- (c) How many **white squares** are in Figure 11.

.....
(1 mark)

Total 10 marks

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SECTION II

Answer ALL questions.

ALGEBRA, RELATIONS, FUNCTIONS AND GRAPHS

8. The functions f , g and h are defined as follows:

$$f(x) = 4x - 1, g(x) = x^2 - 5 \text{ and } h(x) = 3^x.$$

(a) Find

- (i) $g(x-2)$, in its simplest form

.....
(2 marks)

- (ii) $f^{-1}(11)$

.....
(2 marks)

- (b) Determine the value of $hh(1)$.

.....
(2 marks)

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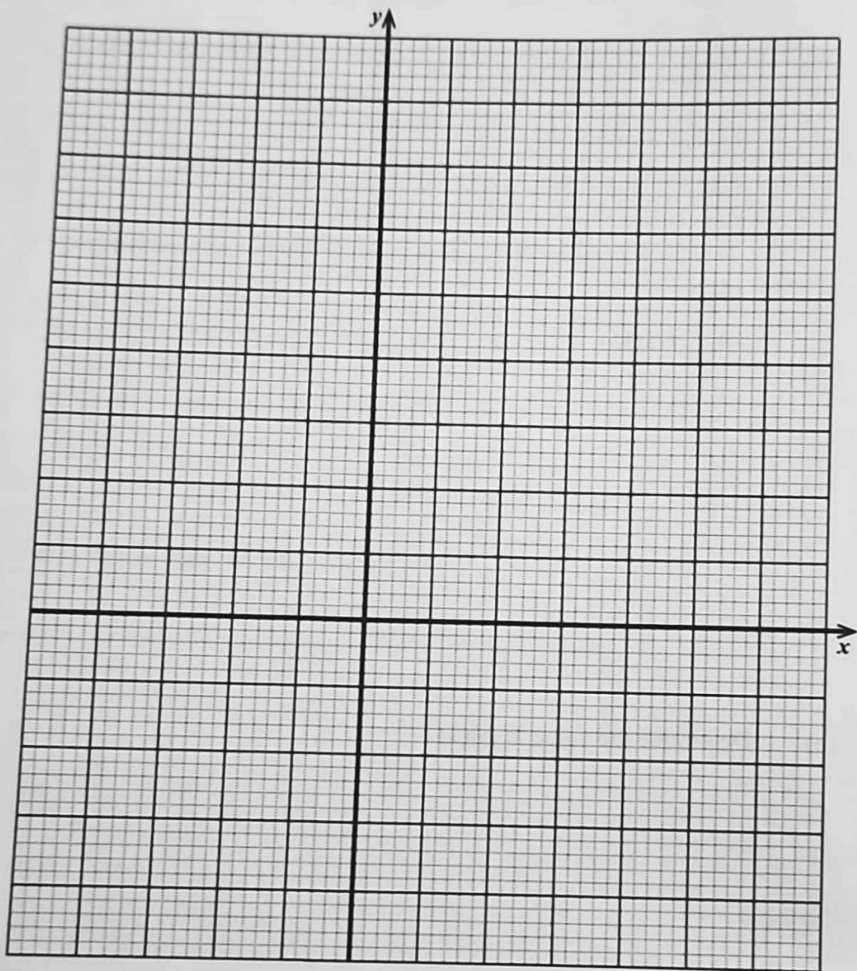
- (c) The function f is defined as follows:

$$f: x \rightarrow x^2 - x - 2.$$

Complete the table below and plot the graph for the function $f(x) = x^2 - x - 2$ on the grid that follows.

(Use a scale of 2 cm to represent 1 unit on both axes.)

x	-2	-1	0	1	2	3
$f(x)$	_____	0	_____	-2	0	4



(6 marks)

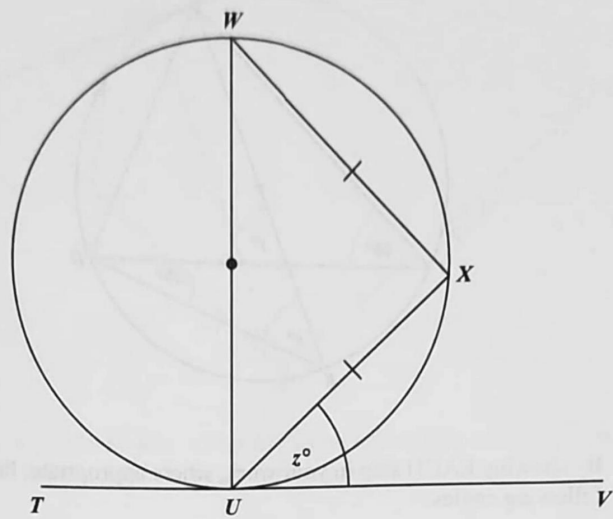
Total 12 marks

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GEOMETRY AND TRIGONOMETRY

9. (a) W, X and U are points on the circumference of a circle. TU is a tangent to the circle at U . UW is a diameter of the circle and triangle WXU is isosceles.



Using appropriate theorems, state THREE reasons that explain why the measure of Angle z is 45° .

Reason 1

.....

.....

Reason 2

.....

.....

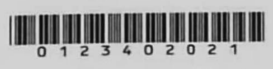
Reason 3

.....

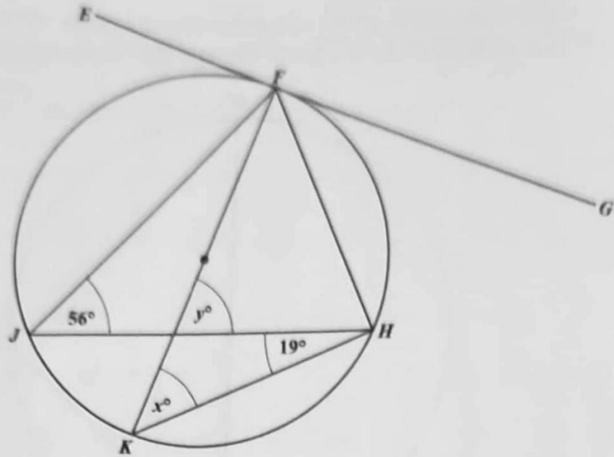
.....

(3 marks)

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- (b) The diagram below shows a circle with diameter KF . Line EFG is a tangent to the circle at F . The points F , H , K and J lie on the circumference of the circle.



By showing EACH step in your work, where appropriate, find the value for EACH of the following angles:

- (i) Angle x

.....
(1 mark)

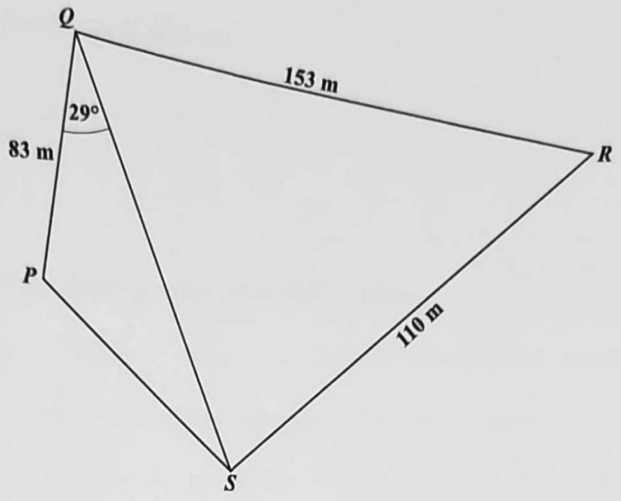
- (ii) Angle y .

.....
(2 marks)

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(c) The diagram below shows 4 points, P , Q , R and S on level ground, where pillars will be placed to mark the outline for a foundation.



(i) There is a vertical post, RT , at R . From Q , the angle of elevation of the top of the post, T , is 21° . Find the height of the post.

.....
(2 marks)

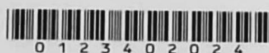
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- (ii) Given that the length QS is 135 m, calculate the perimeter of the foundation $PQRS$.

.....
(4 marks)

Total 12 marks



VECTORS AND MATRICES

10. (a) Three matrices Q , R and S are as follows:

$$Q = \begin{pmatrix} 2 & -1 \\ 4 & 3 \end{pmatrix}, \quad R = \begin{pmatrix} 1 & 6 \\ -5 & 4 \end{pmatrix}, \quad S = \begin{pmatrix} 2 & 7 \\ 4 & -1 \\ -8 & 9 \end{pmatrix}.$$

- (i) Explain why the matrix product QS is NOT possible.

.....

.....

.....

.....

(1 mark)

- (ii) State the order of the matrix product SR .

.....

.....

(1 mark)

- (iii) Calculate the matrix product QR .

.....

(2 marks)

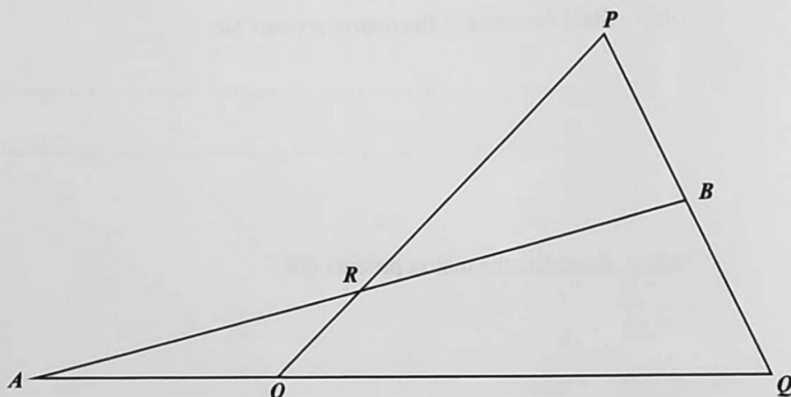
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- (b) Given that $A = \begin{pmatrix} 4 & -1 \\ -7 & x \end{pmatrix}$, determine the value of x when $|A| = 5$.

(2 marks)

- (c) In the diagram below, OPQ is a triangle. ARB and AOQ are straight lines.
 B is the midpoint of PQ .
 R is the midpoint of AB .
 $OR : RP = 1 : 3$.
 $\vec{OP} = 4\mathbf{a}$ and $\vec{OQ} = 8\mathbf{b}$.



Find, in terms of \mathbf{a} and/or \mathbf{b} , in its simplest form

- (i) \vec{PQ}

(1 mark)

GO ON TO THE NEXT PAGE



(ii) \vec{PR}

.....
(2 marks)

(iii) \vec{RB}

.....
(3 marks)

Total 12 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.

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