



EXAMINATIONS COUNCIL OF ZAMBIA

Examination for School Certificate Ordinary Level



Mathematics

4024/2

Paper 2

Monday

15 NOVEMBER 2021

Additional materials:

Answer Booklet
Silent Electronic Calculator (non programmable)
Geometrical instruments
Graph paper (3 sheets)
Plain paper (1 sheet)

Time: 2 hours 30 minutes

Marks: 100

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Instructions to Candidates

- 1 Write the **centre number** and your **examination number** on **every page** of the separate **Answer Booklet** provided.
- 2 Write your answers and working in the separate **Answer Booklet** provided.
- 3 If you use more than one Answer Booklet, fasten the Answer Booklets together.
- 4 Omission of essential working will result in loss of marks.
- 5 There are **twelve** questions in this paper.

(i) Section A

Answer **all** questions.

(ii) Section B

Answer any **four** questions.

- 6 **Silent non programmable Calculators may be used.**

Information for Candidates

- 1 The number of marks is given in brackets [] at the end of each question or part question.
- 2 If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
- 3 Cell phones are **not allowed** in the examination room.

Mathematical Formulae

1 ALGEBRA

Quadratic Equation

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

2 SERIES

Geometric Progression

$$S_n = \frac{a(1-r^n)}{1-r}, (r < 1)$$

$$S_n = \frac{a(r^n - 1)}{r - 1}, (r > 1)$$

$$S_{\infty} = \frac{a}{1-r} \text{ for } |r| < 1$$

3 TRIGONOMETRY

Formula for ΔABC

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

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

$$\Delta = \frac{1}{2} bc \sin A$$

4 STATISTICS

Mean and standard deviation

Ungrouped data

$$\text{Mean } (\bar{x}) = \frac{\sum x}{n}, \text{SD} = \sqrt{\left\{ \frac{\sum (x - \bar{x})^2}{n} \right\}} = \sqrt{\left\{ \frac{\sum x^2}{n} - (\bar{x})^2 \right\}}$$

Grouped data

$$\text{Mean } (\bar{x}) = \frac{\sum fx}{\sum f}, \text{SD} = \sqrt{\left\{ \frac{\sum f(x - \bar{x})^2}{\sum f} \right\}} = \sqrt{\left\{ \frac{\sum fx^2}{\sum f} - (\bar{x})^2 \right\}}$$

Section A (52 Marks)

Answer all questions in this section

1 (a) Simplify $\frac{a-12}{a^2-144}$. [2]

- (b) A box contains 3 black and 2 white marbles of the same size. A marble is taken out at random from the box and not replaced. A second marble is then drawn. Calculate the probability that both marbles are
- (i) white, [2]
- (ii) of different colours. [3]

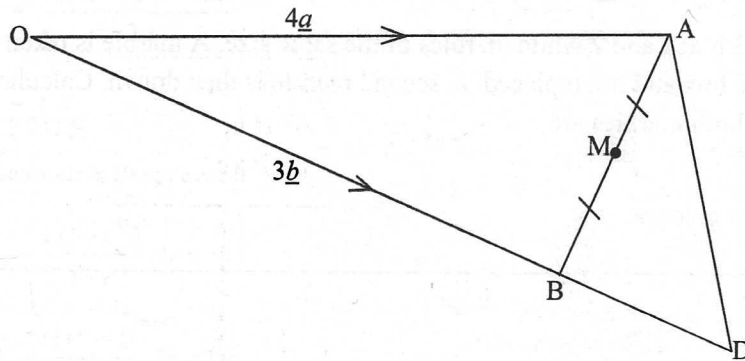
2 (a) Evaluate $\int_{-1}^1 (1-4x+3x^2) dx$. [3]

- (b) At a certain secondary school, all the learners in Grade twelve take at least one of the following optional subjects: French (F), Home Economics (HE) and Geography (G). 20 learners take French only, 25 learners take Home Economics only and 22 learners take Geography only. Furthermore, 9 learners take French and Geography, 12 learners take French and Home Economics, 15 learners take Geography and Home Economics and 4 learners take all the three subjects.
- (i) Illustrate this information in a Venn diagram. [2]
- (ii) How many Grade twelve learners
- (a) are at this school, [1]
- (b) take Home Economics and Geography but not French, [1]
- (c) take two optional subjects only? [1]

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- 3 (a) The second and the fifth terms of a geometric progression are 16 and 2 respectively. Find
- (i) the common ratio and first term, [3]
- (ii) the 12th term, [2]
- (iii) the sum of the first 10 terms. [2]
- (b) Express $\frac{5}{1-x} - \frac{3}{x-2}$ as a single fraction in its lowest terms. [3]

- 4 (a) Solve the equation $2x^2 - 13x + 14 = 0$, giving your answers correct to 2 decimal places. [5]
- (b) In the diagram below, $\vec{OA} = 4\vec{a}$, $\vec{OB} = 3\vec{b}$, M is the midpoint of AB and $OB = 3BD$.

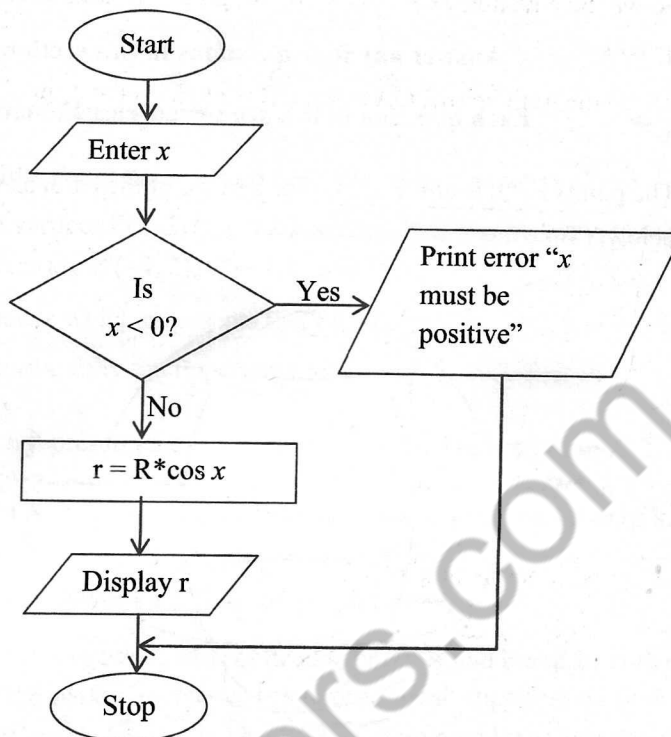


Express in terms of \vec{a} and/or \vec{b}

- (i) \vec{AB} , [1]
- (ii) \vec{OM} , [1]
- (iii) \vec{AD} , [1]
- (iv) \vec{MD} . [2]

-
- 5 (a) Given that matrix $P = \begin{pmatrix} 1 & 2 \\ 2 & -x \end{pmatrix}$,
- (i) find the value of x for which the determinant of P is -3 , [2]
- (ii) hence, find the inverse of P . [2]

(b) Study the flowchart below.



Write a pseudocode corresponding to the flowchart programme.

[5]

6 Answer the whole of this question on a sheet of plain paper.

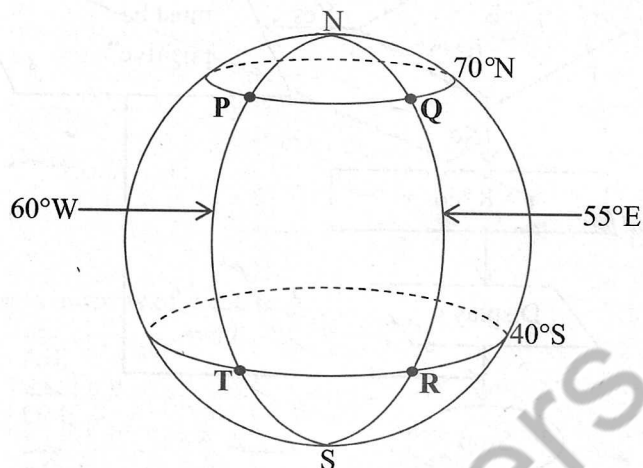
- (a) (i) Construct triangle ABC in which $AB = 6\text{cm}$, $BC = 9\text{cm}$ and $AC = 5\text{cm}$. [1]
- (ii) Measure and write the size of angle ABC. [1]
- (b) Within the triangle ABC, draw the locus of points which are
- (i) equidistant from A and C, [1]
- (ii) 3cm from A, [1]
- (iii) equidistant from AC and BC. [2]
- (c) A point P, within triangle ABC, is such that it is less than or equal to 3cm from A, nearer to BC than AC and closer to A than to C. Indicate clearly by shading, the region in which P must lie. [2]

Section B [48 marks]

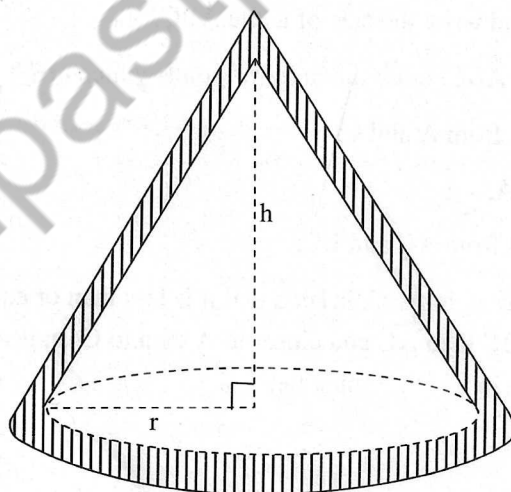
Answer any four questions in this section.

Each question in this section carries 12 marks.

- 7 (a) The points P, Q, R and T are on the surface of the earth as shown in the diagram below. (Take $\pi = 3.142$ and $R = 3\,437\text{nm}$)



- (i) Determine the difference in longitudes between points Q and R. [2]
 - (ii) Find the length of the circle of latitude 40°S in nautical miles. [2]
 - (iii) Calculate the distance TR in nautical miles. [2]
- (b) The diagram below shows a cone. The shaded part is the thickness of the cone. The internal volume is $34\,650\text{cm}^3$. The internal base area is $3\,850\text{cm}^2$. [Take $\pi = 3.142$]



- (i) Calculate the internal height (h) and radius (r). [4]
- (ii) Given that the cone is 0.7cm thick, calculate the external volume of the cone. [2]

- 8 (a) A point C is mapped onto a point C'(-2, 3) by a single transformation whose matrix is $\begin{pmatrix} 1 & -2 \\ 0 & 1 \end{pmatrix}$.
- (i) Find the coordinates of the point C. [2]
- (ii) Describe fully the transformation represented by the matrix above. [3]
- (b) Triangle PQR with vertices P(2, 2), Q(2, 0) and R(0, 1) is mapped onto triangle P'Q'R' whose vertices are P'(-4, 2), Q'(-4, 0) and R'(0, 1).
- (i) Find the matrix which represents this transformation. [3]
- (ii) Hence, describe fully the transformation. [3]
- (c) F is a transformation represented by the matrix $\begin{pmatrix} k & 0 \\ 0 & k \end{pmatrix}$. The images of A(2, 2) and B(-2, 4) under F are A'(5, 5) and B'(-5, 10) respectively. Find the value of k. [1]

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9 Answer the whole of this question on a sheet of graph paper.

A traditional drinks dealer stocks two brands of drinks, brand A and brand B, both of which are produced in bottles of the same size. He wishes to order fresh supplies and finds that he has room for up to 900 bottles. He knows that brand A is more popular and so decides to order at least twice as many bottles of brand A as brand B. He wishes, however, to have at least 100 bottles of brand B and not more than 700 bottles of brand A.

- (a) Let x be the number of bottles of brand A and y the number of bottles of brand B. Write four inequalities to represent the information above. [4]
- (b) Using a scale of 2cm to represent 100 bottles on each axis, draw x and y axes for $0 \leq x \leq 900$ and $0 \leq y \leq 900$ respectively and shade the unwanted region to indicate clearly the region where the solution of the inequalities lie. [4]
- (c) Given that the profit on a bottle of brand A is K3.00 and on a bottle of brand B is K2.00, find
- (i) the number of bottles of each brand that gives maximum profit, [2]
- (ii) the maximum profit. [2]

- 10 The table below shows the heights of trees in a plantation.

| | | | | | | | |
|-------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Height (cm) | $0 < x \leq 10$ | $10 < x \leq 20$ | $20 < x \leq 30$ | $30 < x \leq 40$ | $40 < x \leq 50$ | $50 < x \leq 60$ | $60 < x \leq 70$ |
| Frequency | 30 | 70 | 200 | 200 | 160 | 30 | 10 |

- (a) Calculate the standard deviation. [6]

- (b) Answer this part of the question on a sheet of graph paper.

- (i) Using the table above, copy and complete the relative cumulative frequency table below.

| | | | | | | | | |
|-------------------------------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Height (cm) | ≤ 0 | ≤ 10 | ≤ 20 | ≤ 30 | ≤ 40 | ≤ 50 | ≤ 60 | ≤ 70 |
| Cumulative frequency | 0 | 30 | 100 | 300 | 500 | 660 | 690 | 700 |
| Relative cumulative frequency | 0.00 | 0.04 | 0.14 | 0.43 | | | | 1.00 |

- (ii) Using a scale of 2cm to represent 10 units on the x-axis for $0 \leq x \leq 70$ and 2cm to represent 0.1 units on the y-axis for $0.00 \leq y \leq 1.00$, draw a smooth relative cumulative frequency curve. [1]
- (iii) Showing your method clearly, use your graph to estimate the 80th percentile. [3]

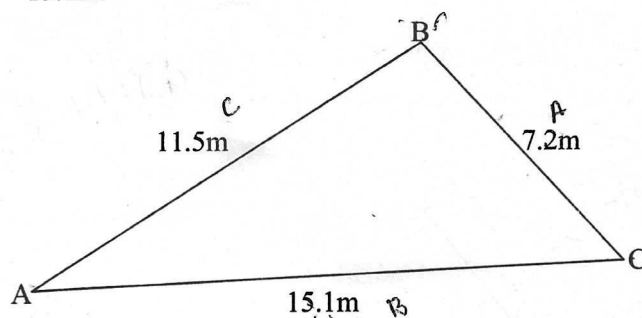
- 11 (a) Answer this part of the question on a sheet of graph paper.

The values of x and y are connected by the equation $y = x(x^2 - 4)$. Some corresponding values of x and y are given in the table below.

| | | | | | | | |
|-----|-----|-----|----|---|----|---|----|
| x | -3 | -2 | -1 | 0 | 1 | 2 | 3 |
| y | -15 | r | 3 | 0 | -3 | 0 | 15 |

- (i) Calculate the value of r . [1]
- (ii) Using a scale of 2cm to represent 1 unit on the x-axis for $-3 \leq x \leq 3$ and 2cm to represent 10 units on the y-axis for $-20 \leq y \leq 20$, draw the graph of $y = x(x^2 - 4)$. [3]
- (iii) Use your graph to solve the equations
- (a) $x(x^2 - 4) = 0$, [2]
- (b) $x(x^2 - 4) = 2$. [3]
- (b) Find the equation of the normal to the curve $y = x^2 - x + 4$ at the point $(-1, 6)$. [3]

- 12 (a) The diagram below shows triangle ABC in which $AB = 11.5\text{m}$, $BC = 7.2\text{m}$ and $AC = 15.1\text{m}$.



Calculate

- (i) angle ABC, [5]
 - (ii) the area of triangle ABC, [2]
 - (iii) the shortest distance from B to AC. [2]
- (b) Solve the equation $15\tan\theta = 14$ for $180^\circ \leq \theta \leq 270^\circ$. [1]
- (c) Simplify $\frac{39x^3}{28y^4} \div \frac{65x^5}{56y^5}$. [2]

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