EXAMINATIONS COUNCIL OF ZAMBIA

Examination for School Certificate Ordinary Level

Mathematics
Paper 2

4024/2

2020

Time: 2 hours 30 minutes

Marks: 100

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 **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 (12)** 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

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

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

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

3 TRIGONOMETRY

Formula for $\triangle$ ABC

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

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

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

4 STATISTICS

Mean and standard deviation

Ungrouped data

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

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)

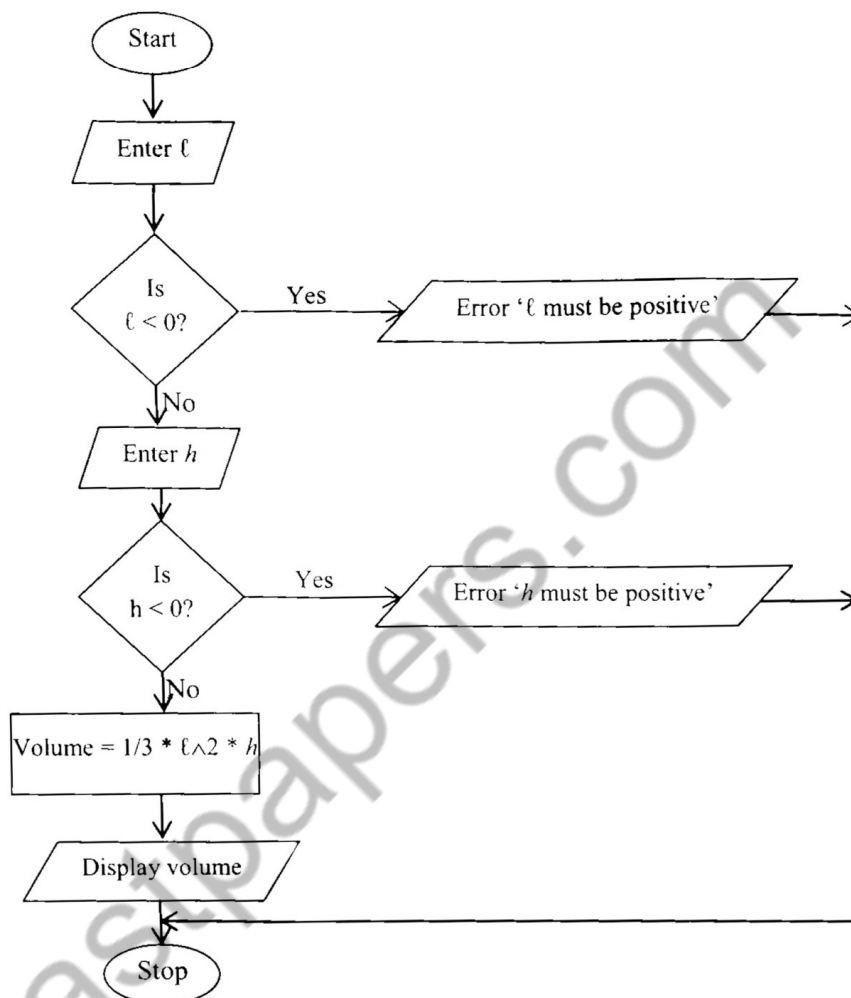**Answer all questions in this section**

1   (a)   Given that matrix A = $\begin{pmatrix} 5 & 2 \\ 2 & x \end{pmatrix}$, find the

        (i)   value of x for which A has no inverse,   [2]

        (ii)   inverse of A if $x = 1$.   [2]

   (b)   A bag contains 7 red and 3 white identical balls. Two balls are taken from the bag at random one after the other without replacement.

        (i)   Draw a tree diagram to show all the possible outcomes.   [2]

        (ii)   Find the probability of taking at least one white ball.   [3]

2   (a)   Of the 115 students who attended an end of year party, 74 took fanta, 93 took sprite, 87 took coke, 61 took fanta and sprite, 71 took sprite and coke, 60 took fanta and coke and 50 took all the three drinks.

        (i)   Illustrate this information on a Venn diagram.   [2]

        (ii)   How many students took

            (a)   none of the drinks,   [1]

            (b)   fanta and sprite but not coke,   [1]

            (c)   at least two different drinks?   [1]

   (b)   In the diagram below, AVC is a straight line, $\overrightarrow{AB} = 8p$, $\overrightarrow{AC} = 4p + 9q$, $\overrightarrow{BV} = -6p + kq$ and AM = MB.
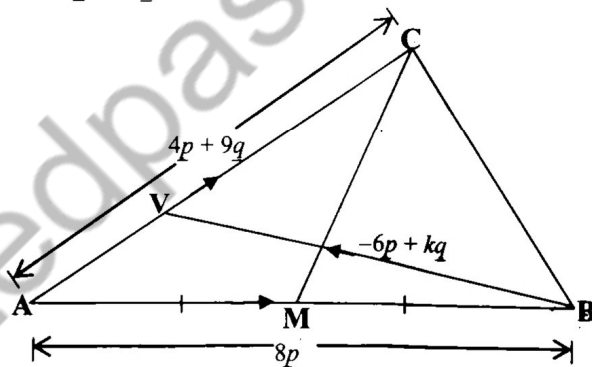
        (i)   Express in terms of p, q and/or k

            (a) $\overrightarrow{AM}$,   [1]

            (b) $\overrightarrow{AV}$.   [1]

        (ii)   Given that $\overrightarrow{AV} = h\overrightarrow{AC}$, by forming an equation involving $\underline{p}$, $\underline{q}$, h and k or otherwise, find the numerical values of h and k.   [3]

3   **(a)**   Solve the equation $x^2 - x - 19 = 0$, giving your answers correct to 2 decimal places.

                                                              [5]

        (b)   Study the flow chart below.

```
                          Start

                          Enter ℓ

                          Is
                          ℓ < 0?        ──Yes──►   Error 'ℓ must be positive'

                          │No

                          Enter h

                          Is
                          h < 0?        ──Yes──►   Error 'h must be positive'

                          │No

                    Volume = 1/3 * ℓ∧2 * h

                       Display volume

                          Stop
```

Write a pseudo code corresponding to the flow chart programme above.   [5]

---

4   **(a)**   Construct a quadrilateral PQRS in which PQ = 8cm, angle QPS = angle PQR = 120°, PS = 6cm and QR = 5cm.   [1]

        (b)   Measure and write the length of RS.   [1]

        (c)   Within the quadrilateral PQRS, draw the locus of points which are

               (i)   4.5cm from Q,   [1]

               (ii)   equidistant from P and Q,   [1]

               (iii)   equidistant from QR and RS.   [2]

        (d)   A point T, within the quadrilateral PQRS, is such that it is less than or equal to 4.5cm from Q, nearer to Q than P and nearer to RS than QR. Indicate, by shading, the region in which T must lie.   [2]

---

5 **(a)** Simplify $\dfrac{2-18p^2}{3p+1}$. [2]
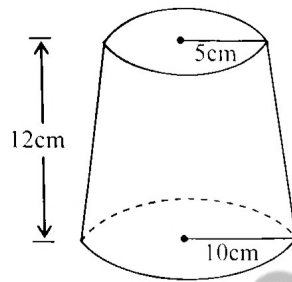
(b) The first three terms of a geometric progression are: $m - 2$, $m + 1$ and $m + 7$. Find

    (i) the value of m, [3]

    (ii) the common ratio, [2]

    (iii) the sum of the first 6 terms. [2]

---

6 The figure below is a frustum of a cone. The base radius and top radius are 10cm and 5cm respectively, while the height is 12cm. (Take π as 3.142)

Calculate its volume. [6]

[Turn over

Section B [48 marks]

### Answer any four questions in this section.

Each question in this section carries 12 marks.

7 **(a)** The values of x and y are connected by the equation $y = x^3 + 4x^2 + x - 5$ as shown in the table below.

x	−4	−3	−2	−1	0	1	2
y	−9	1	1	−3	−5	1	p

   (i) Calculate the value of p. [1]

   (ii) Using a scale of 2cm to represent 1 unit on the x-axis and 2cm to represent 5 units on the y-axis for $-4 \le x \le 2$ and $-10 \le y \le 25$, draw the graph of $y = x^3 + 4x^2 + x - 5$. [3]

   (iii) Use your graph to find the solutions of the equations

   (a) $x^3 + 4x^2 + x - 5 = 0$, [2]

   (b) $x^3 + 4x^2 + x - 5 = 2x + 4$. [3]

(b) Express $\dfrac{4}{2x-1} - \dfrac{1}{3x+2}$ as single fraction in its lowest terms. [3]

---

8 **(a)** P, Q, R and T are points on the surface of the earth as shown in the diagram below. (Take π as 3.142 and R = 3437nm)
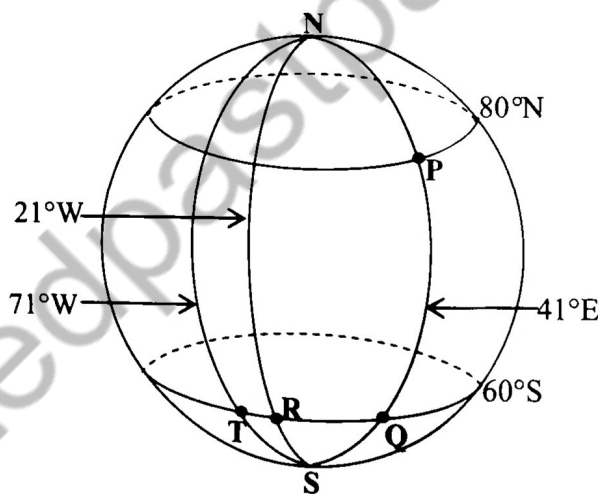
   (i) Find the difference in longitude between points Q and R. [2]

   (ii) Calculate the distance, in nautical miles, of
   (a) PQ, [2]
   (b) RT. [2]

(b) A curve has gradient $x^2 - 4x + 3$. Find the equation of this curve if it passes through the point (3, −1). [3]

(c) Find the equation of the normal to the curve $y = x^3 - 2x^2 - 4x + 1$ at the point (−1, 2). [3]

9   The table below shows the distribution of lengths of plots in a certain locality.

Length of plot (m)	$1 \leq x \leq 5$	$6 \leq x \leq 10$	$11 \leq x \leq 15$	$16 \leq x \leq 20$	$21 \leq x < 25$	$26 \leq x < 30$	$31 \leq x \leq 35$
Frequency	0	2	11	44	31	8	4

(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 cumulative frequency table below.

Length of plot (m)	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30	≤ 35
Frequency	0	2	13				100

[1]

   (ii)   Using a scale of 2cm to represent 5 units on the horizontal axis and 2cm to represent 10 units on the vertical axis, draw a smooth cumulative frequency curve.

[3]

   (iii)   Showing your method clearly, use your graph to estimate the interquartile range.

[2]

---

10   (a)   Three villages A, B and C are joined by straight roads as shown in the diagram below.
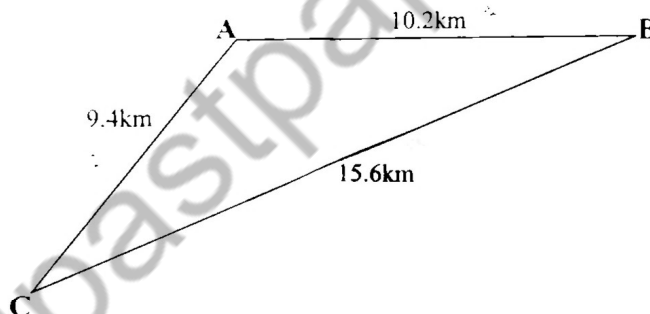
Given that AB = 10.2km, BC = 15.6km and AC = 9.4km, calculate

   (i)   angle BAC to the nearest whole number,   [5]

   (ii)   the area of triangle ABC,   [2]

   (iii)   the shortest distance from A to BC.   [2]

(b)   Solve the equation $2\cos\theta = 1$ for $0° \leq \theta \leq 180°$.   [1]

(c)   Simplify $\dfrac{3x^2y}{8xy^3} \div \dfrac{9x^3}{4y^4}$.   [2]

11   Study the diagram below to answer the questions that follow.
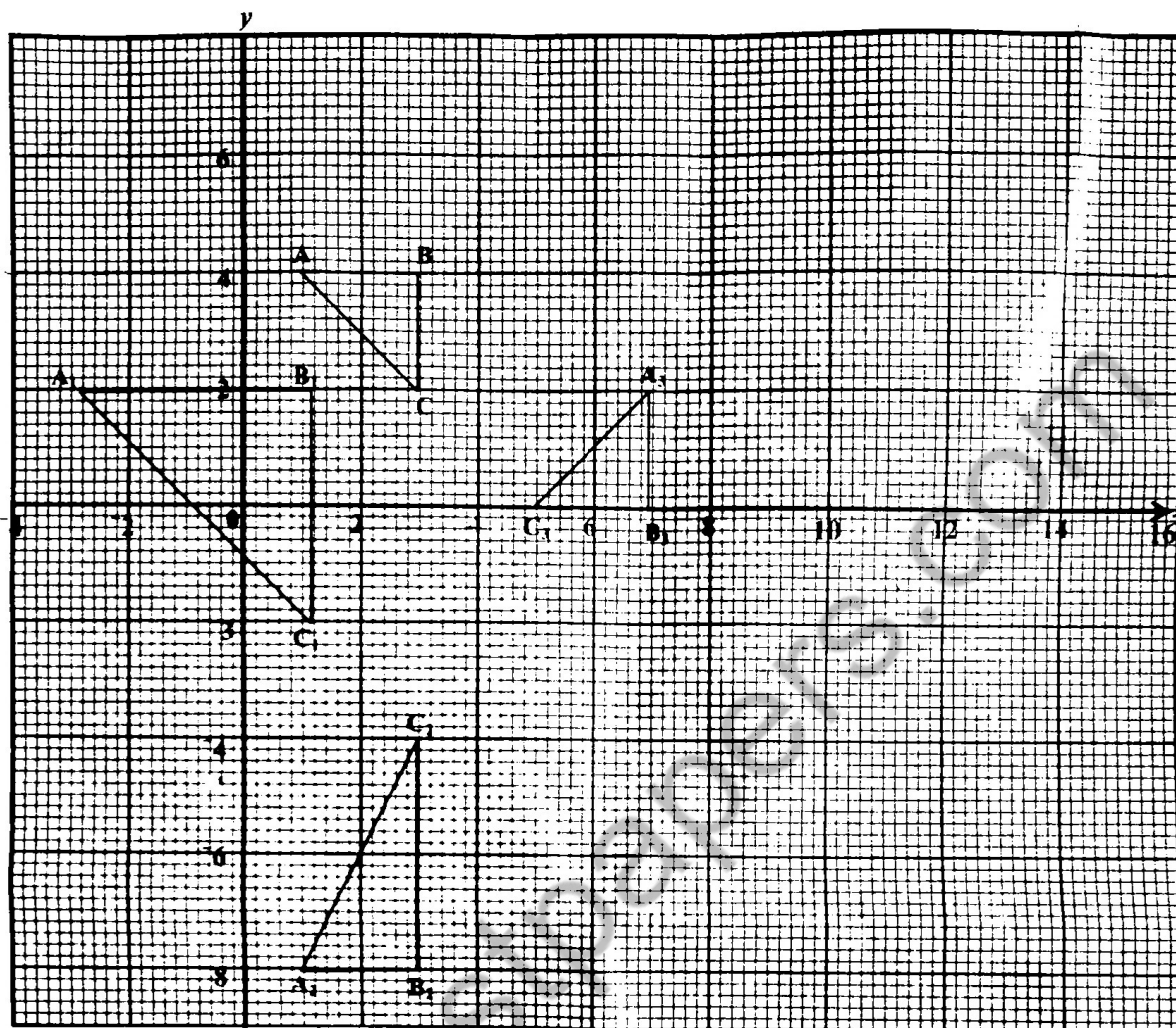
(a)   Triangle ABC is mapped onto triangle $A_1B_1C_1$ by an enlargement. Find its centre and scale factor.   [2]

(b)   Triangle ABC is mapped onto triangle $A_2B_2C_2$ by a single transformation. Find

    (i)   the matrix representing this transformation,   [2]

    (ii)   the area scale factor of the transformation.   [2]

(c)   Triangle ABC is mapped onto triangle $A_3B_3C_3$ by a single transformation. Describe fully this transformation.   [3]

(d)   The matrix $\begin{pmatrix} 1 & 3 \\ 0 & 1 \end{pmatrix}$, maps triangle ABC onto triangle $A_4B_4C_4$ (not on the diagram).

    Find the coordinates of A_4, B_4 and C_4.   [3]

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

A carpenter intends to manufacture at least 10 tables and at least 20 chairs. Each table requires 4 hours of assembling and 2 hours of varnishing. Each chair requires 3 hours of assembling and 1 hour of varnishing. There are 240 hours available for assembling and 100 hours for varnishing.

(a) Given that x represents the number of tables and y the number of chairs, write four inequalities which represent these conditions. [4]

(b) Using a scale of 2cm to represent 10 pieces of furniture on each axis, draw the x and y axes for $0 \leq x \leq 70$ and $0 \leq y \leq 100$ respectively and shade the unwanted region to show clearly the region where the solution of the inequalities lie. [4]

(c) Each table sold yields a profit of K300.00 while each chair sold yields a profit of K250.00. Find the best combination of the number of tables and chairs to gain the maximum profit. [2]

(d) Calculate this estimate of the maximum profit. [2]