

**THE KENYA NATIONAL EXAMINATIONS COUNCIL**  
**Kenya Certificate of Secondary Education**



**Paper 1**

**121/1**

**MATHEMATICS Alt. A**

**Nov. 2023 – 2½ hours**

Serial No.
12858251

**Name:** ..... **Index Number:** .....

**Candidate's signature:** ..... **Date:** .....

**Instructions to candidates**

- (a) Write your name and index number in the spaces provided above.
- (b) Sign and write the date of examination in the spaces provided above.
- (c) This paper consists of **two** sections: **Section I** and **Section II**.
- (d) Answer **all** the questions in **Section I** and only **five** questions from **Section II**.
- (e) **Show all the steps in your calculation, giving your answers at each stage in the spaces provided below each question.**
- (f) Marks may be given for correct working even if the answer is wrong.
- (g) **Non-programmable** silent electronic calculators and KNEC mathematical tables may be used, except where stated otherwise.
- (h) **This paper consists of 17 printed pages.**
- (i) **Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.**
- (j) **Candidates should answer the questions in English.**



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**Section I**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total

**Section II**

17	18	19	20	21	22	23	24	Total

**Grand Total**

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**SECTION I (50 marks)**

*Answer all the questions in this section in the spaces provided.*



- 1 Without using a calculator, evaluate  $\frac{-13+5-70 \div 5}{9-14 \times -3 \div 21}$  (3 marks)
- 2 Simplify the expression  $\frac{3a^2b^{-3}}{2^{-1}a^{-2}b^2}$  (2 marks)
- 3 A triangle ABC is such that AB = 11 cm, BC = 8 cm and  $\angle ABC = 53^\circ$ . Calculate the area of the triangle correct to 2 decimal places. (2 marks)

- 4 A cylindrical solid of radius 7 cm has a conical top of the same radius. The height of the cylindrical part of the solid is 17 cm. The conical top has a vertical height of 9 cm.  
Calculate the volume of the solid. (Take  $\pi = \frac{22}{7}$ ) (3 marks)



- 5 Two light bulbs are set to light after every 40 seconds and 60 seconds respectively. If they light exactly at the same time initially, calculate:  
 (a) the time, in minutes, they will take to light together again. (2 marks)  
 (b) the number of times they would light together in the first half an hour. (1 mark)

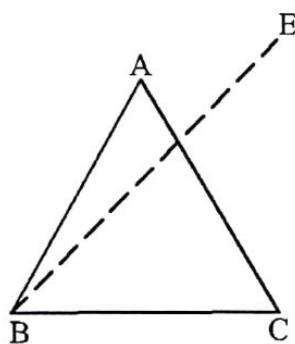


- 6 Solve the equation  $\cos 2\theta = \sin \theta$  for  $0^\circ \leq \theta \leq \frac{\pi^c}{4}$ . Leave the answer in terms of  $\pi^c$ . (3 marks)

- 7 Simplify and hence factorise the expression  $(5x - 4y)(4x + 5y) - 9xy$ . (3 marks)



- 8 From a point on top of a cliff 40 m high, two boats A and B are observed due East. The angle of depression of boat A is  $32^\circ$  and that of boat B is  $52^\circ$ . Determine the distance between the two boats, correct to 2 decimal places. (4 marks)
- 9 In the following figure, triangle ABC is a uniform cross section of a solid ABCDEF. Given that BE is one of the edges of the solid, complete the sketch showing hidden edges with broken lines. (3 marks)



- 10 A salesman sells story books and textbooks. The cost price of a story book is sh 600 while that of a textbook is sh 900. The salesman is paid a commission of 10% on the cost of any book sold. One day, the salesman sold twice as many story books as textbooks. He earned a commission of sh 8 400.

Determine the total number of story books sold.

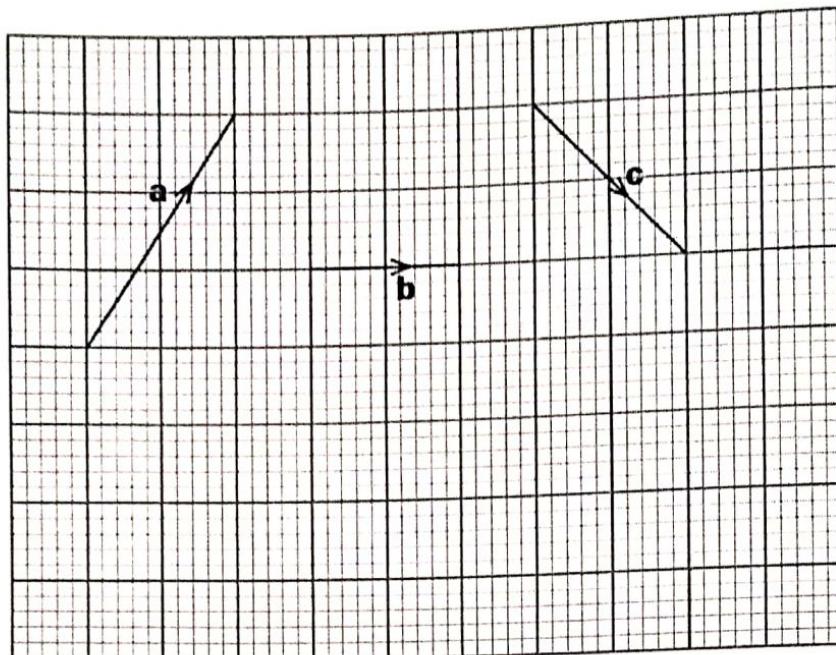
(3 marks)



- 11 The equation of a curve is given by  $y = x^2$ . Using the trapezium rule with 4 strips, estimate the area enclosed by the curve  $y = x^2$ , the lines  $x = 1$ ,  $x = 5$  and the  $x$ -axis. (4 marks)

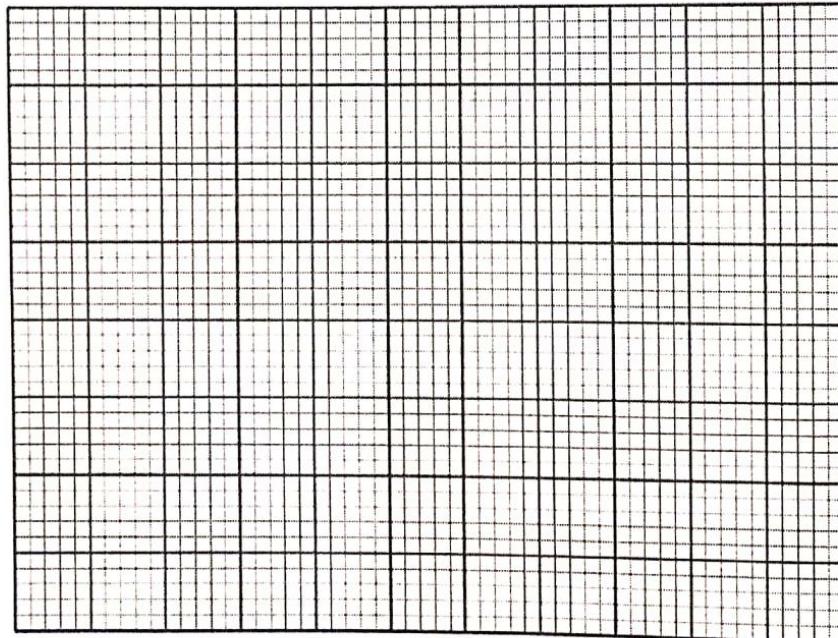


- 12 Vectors  $\mathbf{a}$ ,  $\mathbf{b}$  and  $\mathbf{c}$  are represented on the following grid.



On the following grid, represent:

- (a) the resultant vector  $\mathbf{a} + \mathbf{b}$  (2 marks)
- (b) the resultant vector  $(\mathbf{a} + \mathbf{b}) + \mathbf{c}$  (2 marks)



- 13 Given matrix  $P = \begin{pmatrix} 4 & 2 \\ -7 & -1 \end{pmatrix}$ ,  $Q = \begin{pmatrix} -1 & 5 \\ 6 & -3 \end{pmatrix}$  and  $R = 20P^{-1} + Q$ , determine matrix  $R$ . (3 marks)



- 14 In a sub county the number of children per family was recorded from 30 families. The data recorded is as follows:

2	3	2	3	4	1	4	3	0	3
2	2	1	3	4	5	2	7	6	3
6	2	2	3	3	3	5	1	3	2

(a) Represent the data in a frequency distribution table. (1 mark)

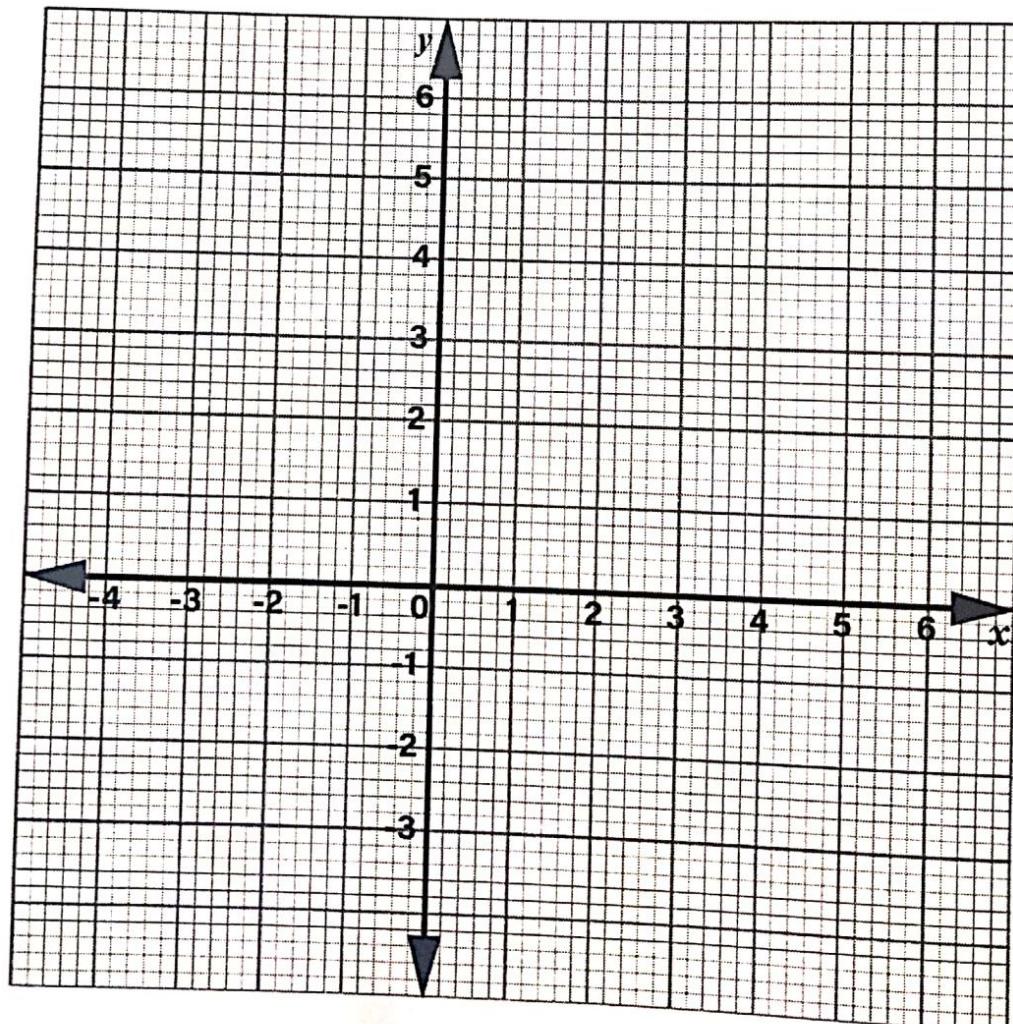
(b) Calculate the mean number of children per family. (2 marks)



- 15** The equation of a curve is given by  $y = 3x^2 - 2x$ . Determine the equation of a normal to the curve at  $x = 2$ . (4 marks)

- 16** On the following cartesian plane provided, solve the simultaneous equations.

$$\begin{aligned}y &= \frac{4}{3}x + 2 \\3y &= x - 3\end{aligned}$$



(3 marks)

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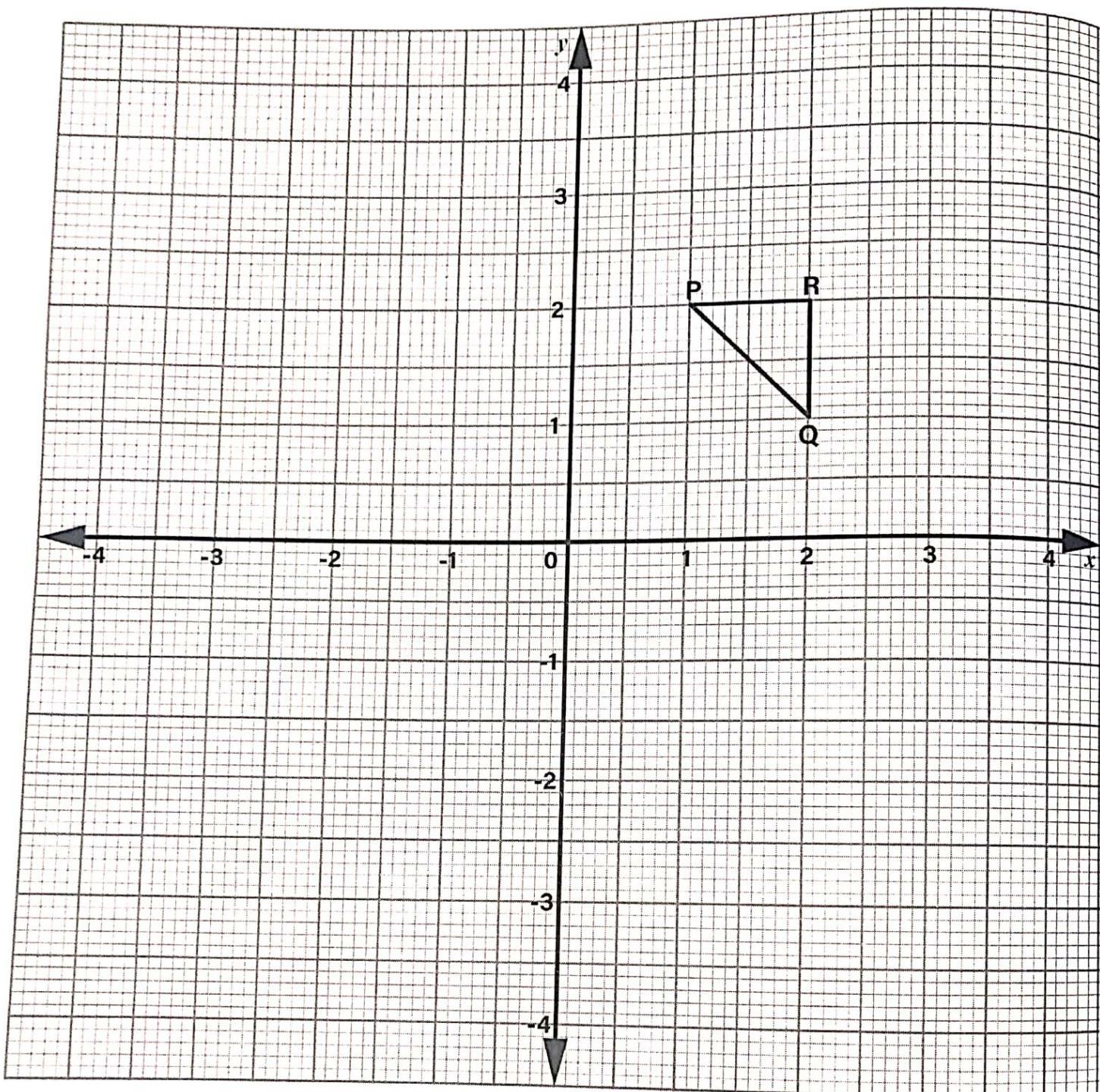
## SECTION II (50 marks)

*Answer only five questions in this section in the spaces provided.*

- 17 Two towns, A and B are 400 km apart. A motor cyclist travelling at an average speed of 60 km/h left town A for town B at 1.20 p.m. A matatu travelling at an average speed of 80 km/h also left town A for town B at 2.00 p.m.
- (a) Calculate, the:
- (i) distance covered by the motor cyclist by 2.00 p.m. (2 marks)
  - (ii) distance from town A in km, where the matatu caught up with the motor cyclist. (3 marks)
  - (iii) time when the matatu caught up with the motor cyclist. (2 marks)
- (b) A lorry travelling at an average speed of 40 km/h left town B for town A at 2.00 p.m. Determine the time when the lorry and the matatu met. (3 marks)



- 18 On the following grid, triangle PQR is drawn.



(a) On the same grid, draw:

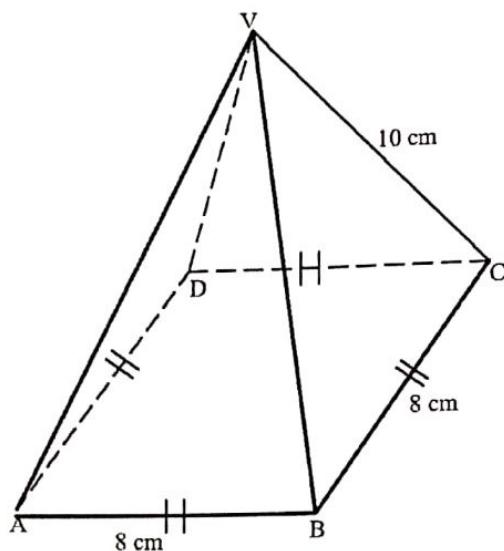


- (i) Triangle  $P'Q'R'$ , the image of  $\Delta PQR$  under a reflection in the line  $y = 0$ .  
(2 marks)
- (ii) Triangle  $P''Q''R''$ , the image of  $\Delta P'Q'R'$  under an enlargement scale factor  
– 1.5, centre O.  
(3 marks)
- (iii) Triangle  $P'''Q'''R'''$ , the image of  $\Delta P''Q''R''$  under a half turn about O.  
(2 marks)



- (b) Describe a single transformation that maps  $\Delta P'Q'R'$  onto  $\Delta P'''Q'''R'''$ .  
(3 marks)

- 19 The following figure shows a right pyramid VABCD. The base ABCD of the pyramid is a square of side 8 cm. The length of the slanting edges  $VA = VB = VC = VD = 10$  cm.



Calculate:

- (a) the vertical height of the pyramid correct to 2 decimal places. (4 marks)



- (b) surface area of the pyramid. (4 marks)

- (c) the volume of the pyramid. (2 marks)

- 20** Neema went to the market to buy bananas worth Ksh 2 100 for a school. The seller offered a discount of Ksh 3 per banana which enabled Neema to buy 35 more bananas.

(a) Taking Ksh  $x$  as the price per banana before discount, write an expression for the:

(i) number of bananas that Neema would have bought before discount.

(1 mark)

(ii) actual number of bananas that Neema bought after the discount.

(1 mark)

(b) Form an equation in terms of  $x$  and hence determine the actual number of bananas Neema bought. (6 marks)

(c) The bananas were given to students in a school. Two fifths of the students got 2 bananas each while the rest got a banana each.

Determine the number of students in the school.

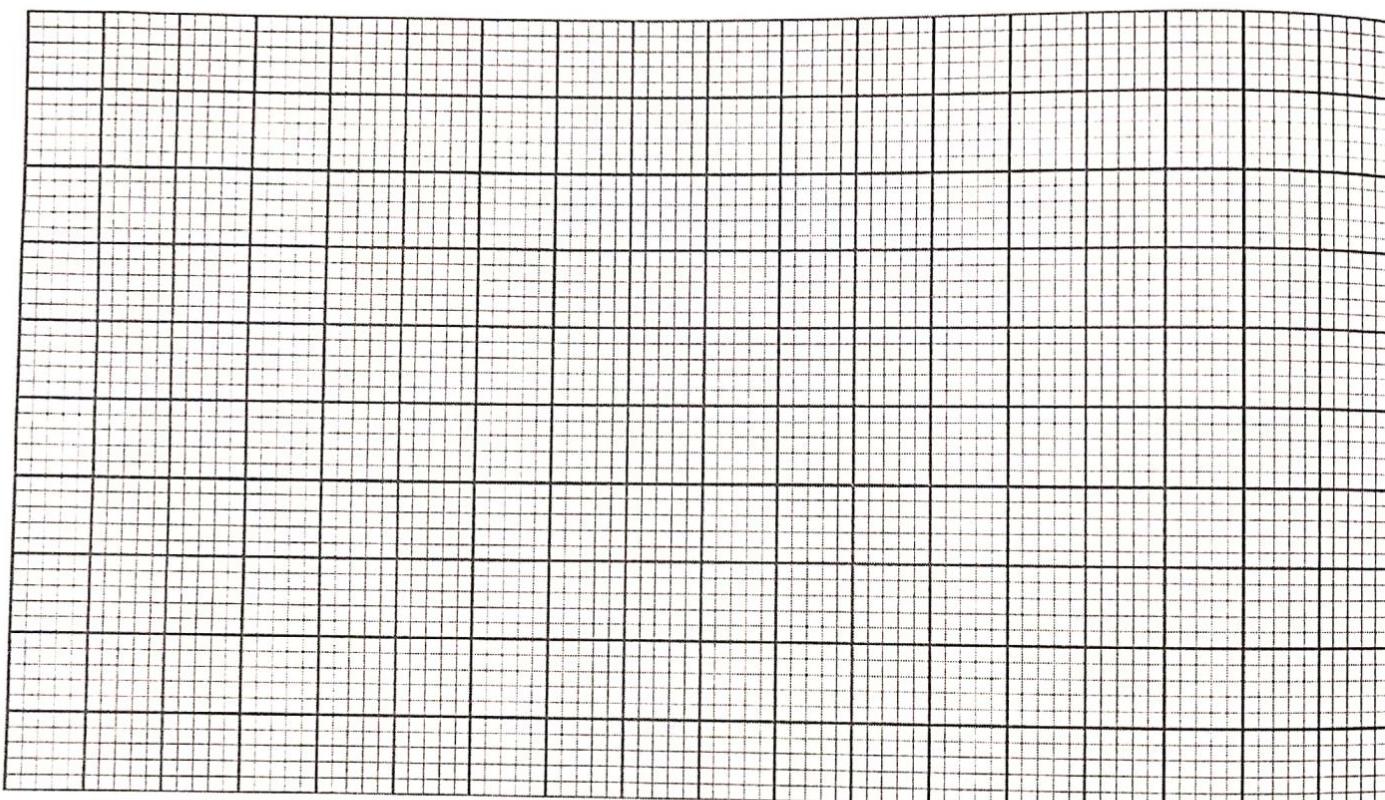
(2 marks)



- 21** The end of term test scores of 100 students were recorded as shown in the following table.

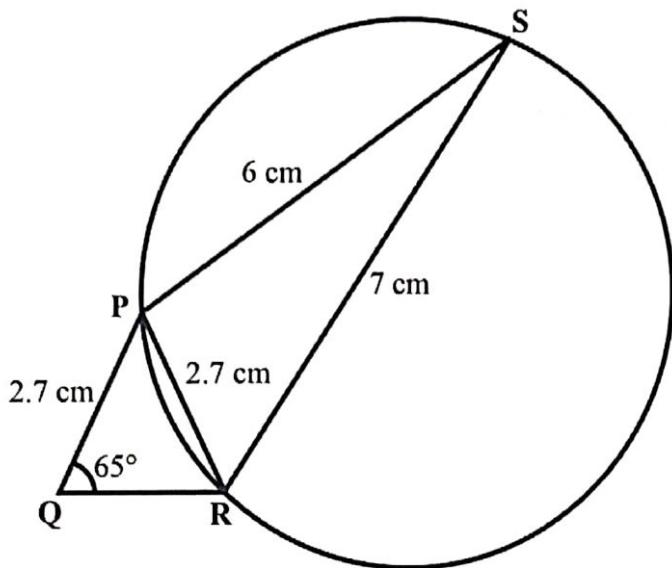
Scores	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89
No. of Students	8	10	28	32	12	10

- (a) State the modal class. (1 mark)
- (b) Calculate the median score. (3 marks)
- (c) On the grid provided, represent the above data using a histogram. (4 marks)



- (d) Use the histogram to determine the number of students who scored from 71.5 to 76.5. (2 marks)

- 22 The following figure shows a quadrilateral PQRS and a circle passing through the vertices P, R and S. Lines  $PQ = PR = 2.7 \text{ cm}$ ,  $PS = 6 \text{ cm}$ ,  $SR = 7 \text{ cm}$  and  $\angle PQR = 65^\circ$ .



(a) Calculate:

(i) length QR. (3 marks)

(ii)  $\angle PRS$ . (3 marks)

(b) Determine the area of the circle. (4 marks)



- 23 The displacement,  $x$  metres, of a particle moving a long straight line after  $t$  seconds is given by  $x = \frac{t^3}{3} - 3t^2 + 9$ .

(a) Determine:

(i) the values of  $t$  when the particle is momentarily at rest.

(3 marks)

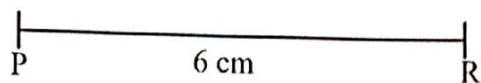
(ii) the values of the displacement  $x$  metres by the time the particle comes to rest.  
(2 marks)

(b) Determine the values of  $t$  when the velocity of the particle is  $-5$  m/s. (3 marks)

(c) Determine the acceleration of the particle at  $t = 2$  seconds. (2 marks)

**24** In this question, use a ruler and a pair of compasses only.

Line PR is a diagonal of a quadrilateral PQRS. PR = 6 cm.



- (a) Locate vertex Q of the quadrilateral PQRS such that  $\angle RPQ = 60^\circ$  and  $\angle PRQ = 45^\circ$ .  
Complete triangle PQR and hence measure length PQ. (4 marks)
- (b) Diagonal QS, which is 10 cm long, intersects with diagonal PR at a right angle.  
Complete the quadrilateral PQRS. (3 marks)
- (c) Calculate the area of the quadrilateral PQRS. (3 marks)



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**THE KENYA NATIONAL EXAMINATIONS COUNCIL**  
**Kenya Certificate of Secondary Education**



**121/2**

**MATHEMATICS Alt. A**

**Nov. 2023 – 2½ hours**

**Paper 2**

Serial No.
19460040

**Name:** ..... **Index Number:** .....

**Candidate's signature:** ..... **Date:** .....

**Instructions to Candidates**

- (a) Write your name and index number in the spaces provided above.
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- (g) **Non-programmable** silent electronic calculators and KNEC Mathematical tables may be used except where stated otherwise.
- (h) **This paper consists of 19 printed pages.**
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**Section I**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total

**Section II**

17	18	19	20	21	22	23	24	Total

**Grand  
Total**



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**SECTION I (50 marks)**

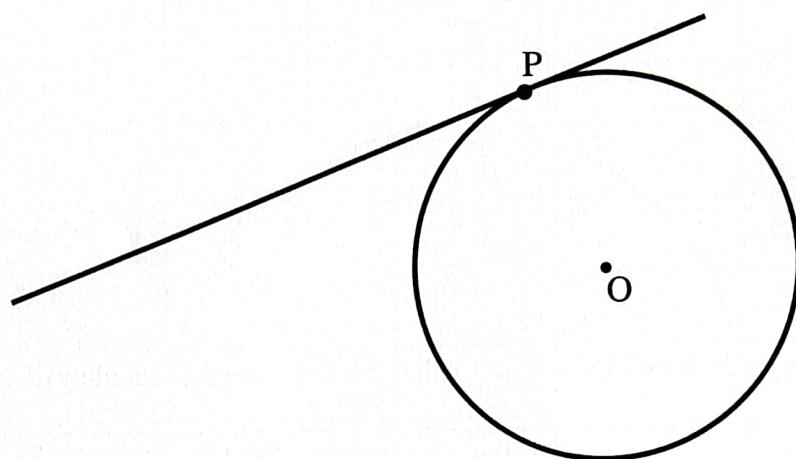
*Answer all the questions in this section in the spaces provided.*



- 1 Solve the equation  $1 + \log(2x - 9) = \log(3x + 5) - \log 2$ . (3 marks)
- 2 The masses of two students in a class were measured as 30.5 kg and 36.8 kg. Determine the least possible difference in the masses of the two students. (3 marks)
- 3 Make  $x$  the subject of the formula  $a = \frac{bx}{\sqrt{x^2 - 9}}$ . (3 marks)



- 4 In this question, use a ruler and a pair of compasses. The following figure shows a circle, centre O. A tangent to the circle at P is drawn.



Construct another tangent to the circle to intersect the drawn tangent at an angle of  $60^\circ$ .  
(3 marks)

- 5 A plane took 3 hours to fly from P( $66.42^\circ\text{N}$ ,  $30^\circ\text{E}$ ) to Q( $66.42^\circ\text{N}$ ,  $52.5^\circ\text{E}$ ). Determine the speed of the plane in knots correct to one decimal place.  
(3 marks)

- 6 Solve  $6\cos^2 x = 5\sin x$  for  $0 \leq x \leq 180^\circ$ .

(4 marks)



- 7 The following table shows the frequency distribution of marks scored by 40 students in a test.

Marks	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50
Frequency	4	10	13	8	5

Calculate the upper quartile mark.

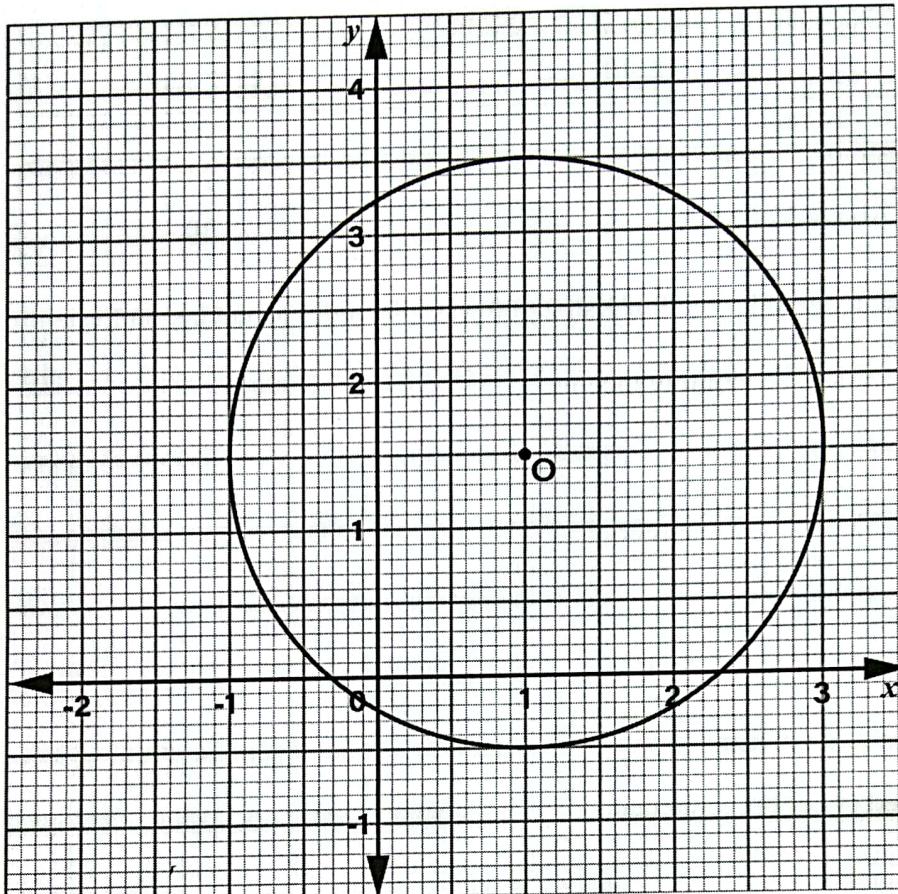
(3 marks)



- 8 Given that  $\mathbf{p} = 5\mathbf{i} - \mathbf{j} + 3\mathbf{k}$ ,  $\mathbf{q} = 8\mathbf{i} + \mathbf{j}$  and  $\mathbf{r} = 2\mathbf{p} - \mathbf{q}$ , determine the magnitude of  $\mathbf{r}$ .

(3 marks)

- 9 The following figure shows a circle centre O.



(a) Determine the equation of the circle. (2 marks)

(b) Use the equation in part (a) to determine the  $x$ -intercept of the circle correct to 3 decimal places. (2 marks)

- 10** The following table shows monthly income tax rates of a certain year.

Monthly Income in Kenya Shillings (Ksh)	Tax rate percentages (%) in each shilling
0 - 24 000	10
24 001 - 32 333	25
Above 32 333	30



In that year, a monthly relief of Ksh 2 400 was allowed. The net tax on Lesianto's monthly income was Ksh 1 500.

Calculate Lesianto's monthly income.

(3 marks)

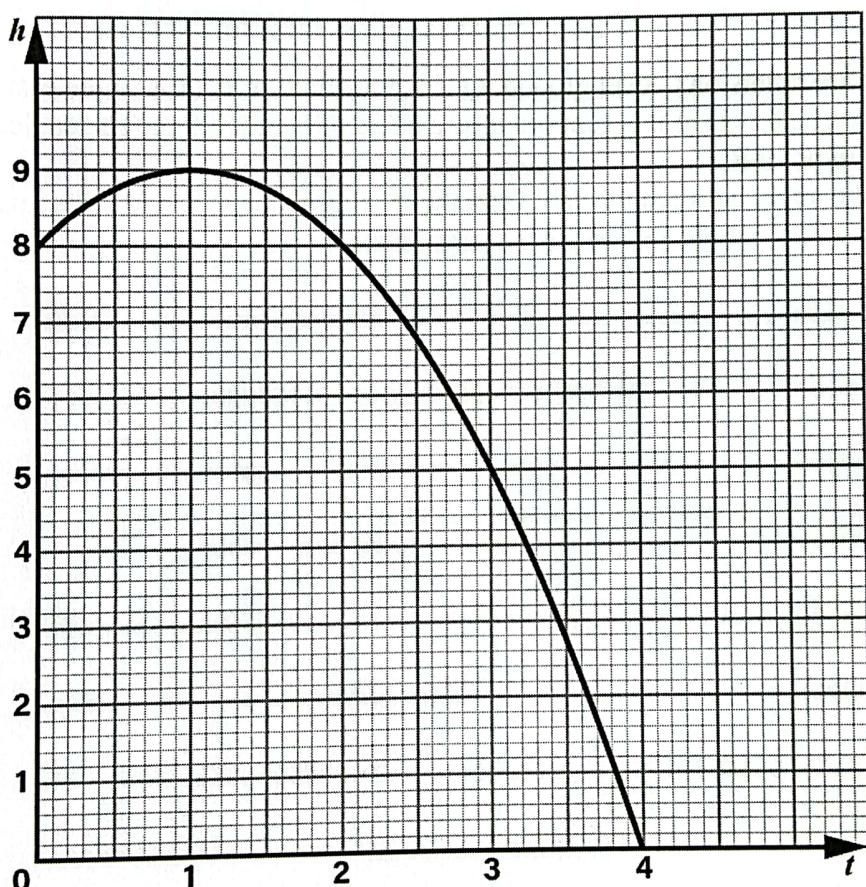
- 11** A transformation matrix  $\mathbf{T} = \begin{pmatrix} 1 & 0 \\ k & 0 \end{pmatrix}$  maps  $P(2, 3)$  onto  $P'(2, 10)$ . Point  $Q(-4, 4)$  is transformed under the same matrix  $\mathbf{T}$ . Find the coordinates of  $Q'$ , the image of  $Q$ . (3 marks)
- 12** The length and width of a rectangular floor of a room are 10 m and 7 m respectively. A rectangular carpet of area  $28 \text{ m}^2$  is placed on the floor. The carpet leaves a uniform space of  $x$  m with each of the walls of the room.  
Form a quadratic equation in  $x$  and hence solve for  $x$ .

(3 marks)

- 13 A quantity  $v$  varies directly as the square of  $u$  and inversely as the cube root of  $w$ . When  $u = 5$  and  $w = 8$ , the value of  $v = 375$ . Find the value of  $v$  when  $u = 8$  and  $w = 125$ . (3 marks)



- 14 A stone was thrown upwards from a point 8 metres above the ground. The following graph shows the height,  $h$  metres of the stone above the ground at time  $t$  seconds in the interval  $0 \leq t \leq 4$ .



Determine the rate of change of  $h$  at  $t = 2$  seconds.

(3 marks)

- 15 The gradient function of a curve is given by  $\frac{dy}{dx} = 3 - 4x$ . If the curve passes through the point  $(-1, 10)$ , find the equation of the curve.

(3 marks)

- 16 P, Q and R are points on a level ground. Q is 4.5 m south of P. R is to the east of P and 5.3 m from Q. A vertical post at P is supported by a cable of length 3.5 m. The cable joins the top T of the post to point R.  
Calculate the angle between the cable and the level ground correct to 2 decimal places.

(3 marks)



**SECTION II (50 marks)**

*Answer only five questions from this section in the spaces provided.*

- 17 The first term of an arithmetic progression (A.P.) is  $a$  and the common difference  $d$ . The 7<sup>th</sup> term of the A.P. is 11. The sum of the first 12 consecutive terms of the A.P. is 123.

(a) (i) Form two simplified equations involving  $a$  and  $d$  to represent the information. (2 marks)



(ii) Find the values of  $a$  and  $d$ . (3 marks)

- (b) The 1<sup>st</sup>, 3<sup>rd</sup> and 8<sup>th</sup> terms of the A.P. form the first 3 consecutive terms of a geometric progression (G.P.).

Calculate:

(i) the 6<sup>th</sup> term of the G.P. (3 marks)



(ii) the sum of the first 6 terms of the G.P. (2 marks)

- 18** A welfare group invested Ksh 75 000 in shares and another Ksh 75 000 in a piece of land for a period of 5 years. The shares appreciated in value at a rate of 6% per annum (p.a) for a period of 3 years. In the remaining period of 2 years, the shares appreciated in value at a rate of 4.5% every 6 months.

During the 5 years, the piece of land appreciated in value at a constant annual rate. At the end of the 5<sup>th</sup> year, the values of the two investments were equal.

(a) Determine:

(i) the value of the shares at the end of the 5<sup>th</sup> year. (4 marks)

(ii) the annual rate of appreciation in the value of the piece of land over the period of 5 years. (3 marks)



(b) After the 5 year period, the shares depreciated in value at a rate of 3.5% p.a. for  $n$  years. The shares lost 10% of their value during this period. Determine the value of  $n$  correct to 2 decimal places. (3 marks)

- 19 (a) A number is selected at random from the numbers 90, 91, 92, 93 and 94. A second number is then selected at random from the numbers 2, 3, 4 and 5. Afterwards a quotient is obtained by dividing the first number selected by the second number.

- (i) Complete the probability space in the following table.

		1 <sup>st</sup> number					
		÷	90	91	92	93	94
2 <sup>nd</sup> number	2					$46\frac{1}{2}$	
	3			$30\frac{2}{3}$			
	4		$22\frac{3}{4}$				
	5	18					

(2 marks)

- (ii) Determine the probability that the quotient obtained is a whole number.

(2 marks)

-  (iii) Determine the probability that the quotient obtained is a recurring decimal.  
(1 mark)

- (b) In a shooting practice the probability that a soldier will hit the target in his first attempt is 60%. This probability increases by 10% in the second attempt. The soldier shoots at the target twice. Determine the probability that:

- (i) the soldier will miss the target only once. (3 marks)

- (ii) the soldier will miss the target in both attempts. (2 marks)

- 20** (a) The table below shows values of  $x$  and some values of  $y$  for the curve  $y = 14 + 10x - 8x^2 - 4x^3$ .



Complete the table.

$x$	-2.5	-2	-1.5	-1	-0.5	0	0.5	1	1.5
$y = 14 + 10x - 8x^2 - 4x^3$		-6		0		14		12	

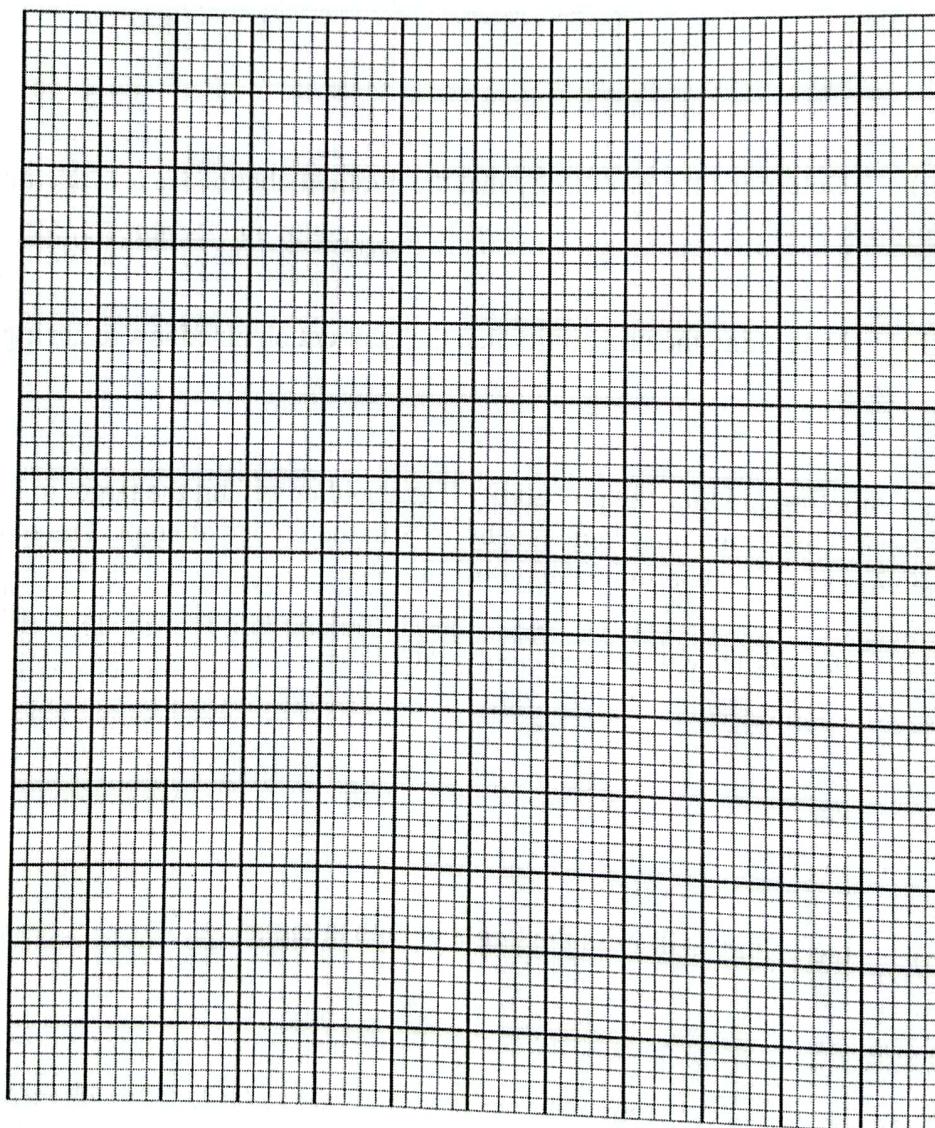
(2 marks)

- (b) On the grid provided, draw the graph of  $y = 14 + 10x - 8x^2 - 4x^3$  for  $-2.5 \leq x \leq 1.5$ .

Use the scale: 1 cm represents 0.5 units on  $x$ -axis.

2 cm represents 5 units on  $y$ -axis

(3 marks)



13

- (i) Use the graph to solve the equation  $14 + 10x - 8x^2 - 4x^3 = 0$ . (1 mark)
- (ii) By drawing a suitable line graph on the same grid, solve the equation  $4x^3 + 8x^2 - 5x - 4 = 0$ . (4 marks)

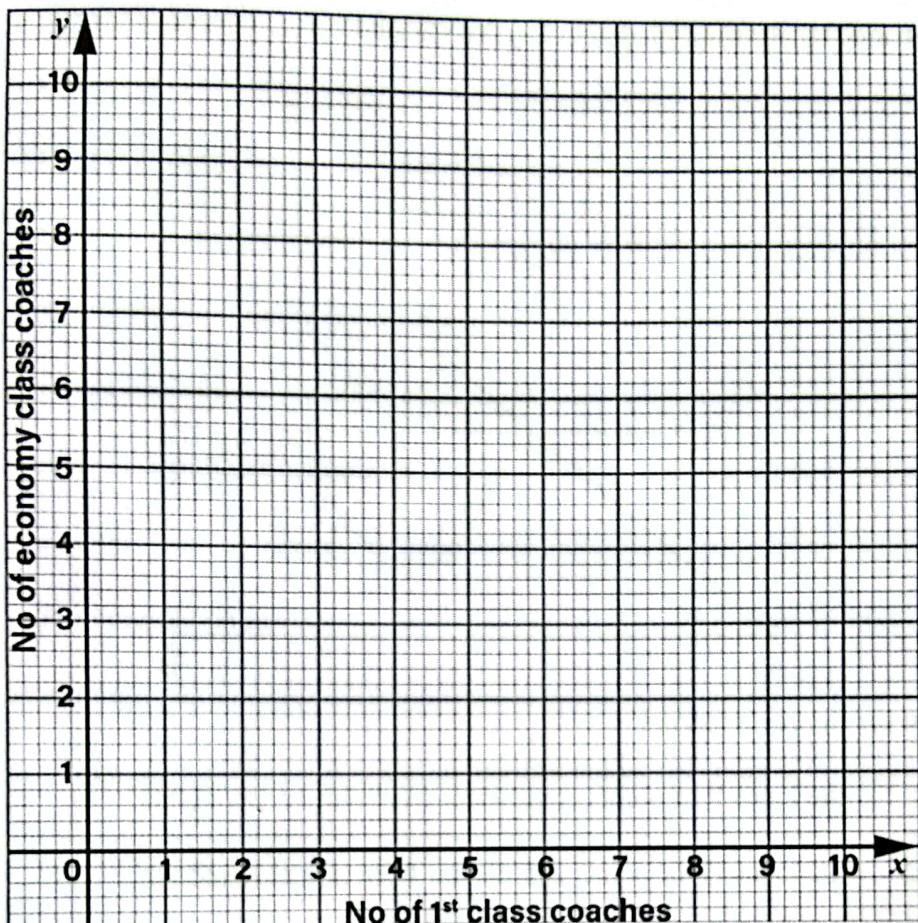


- 21 An express train operates between two towns. The train pulls  $x$  coaches on first class and  $y$  coaches on economy class. Each first class coach can hold 72 passengers while each economy class coach can hold 120 passengers.

- (a) Write down the inequalities that express the following conditions for a trip made by the train where the:
- (i) total number of coaches used was less than 10.
  - (ii) train was pulling at least one first class coach.
  - (iii) number of economy class coaches was more than the number of first class coaches.
  - (iv) total number of passengers exceeded 360.

(4 marks)

- (b) Represent the inequalities in (a) on the grid provided. (4 marks)

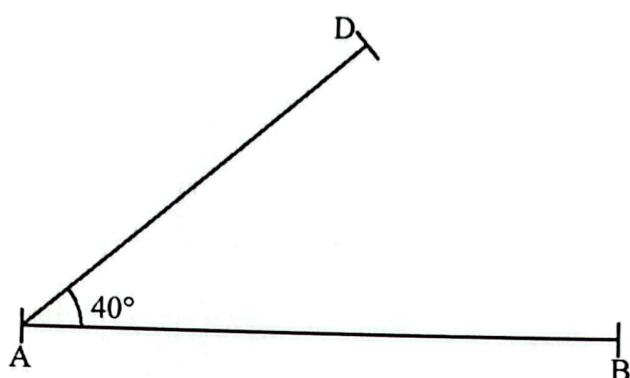


- (c) The coaches for the trip were all fully booked. Each first class ticket costs Ksh 3000 while each economy class ticket costs Ksh 1000. Determine the maximum possible amount realised from the sale of tickets for the trip. (2 marks)

22

In this question, use a ruler and a pair of compasses only.

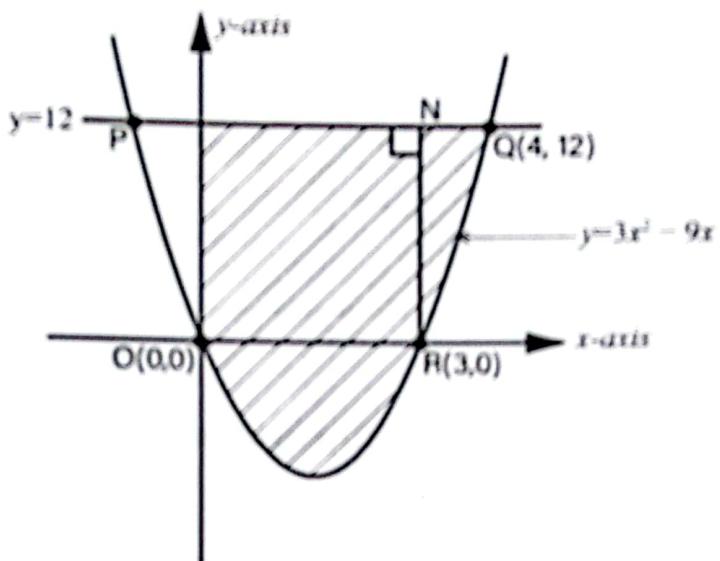
The following figure is drawn to scale. It shows sides AB and AD of a trapezium ABCD in which AB and DC are parallel. Angle DAB = 40° and vertex C is not shown.



- (a) On the figure, construct:
- (i) the locus P of points equidistant from sides AB and AD. (1 mark)
  - (ii) the locus Q of points equidistant from points A and B. (1 mark)
  - (iii) the locus R of points such that  $\angle ARB = 70^\circ$ . (2 marks)
- (b) Vertex C is such that  $\angle ACB = 70^\circ$  Locate vertex C and hence complete the trapezium ABCD. (3 marks)
- (c) Calculate the area of trapezium ABCD. (3 marks)

13

The following figure is a sketch of a curve whose equation is  $y = 3x^2 - 9x$ .  
 The curve cuts the  $x$ -axis at  $O(0, 0)$  and at  $R(3, 0)$ . The curve cuts the line  $y = 12$  at  $P$  and  $Q$ . The coordinates of  $Q$  is  $(4, 12)$ . Line  $RN$  is perpendicular to  $PQ$  at  $N$ .

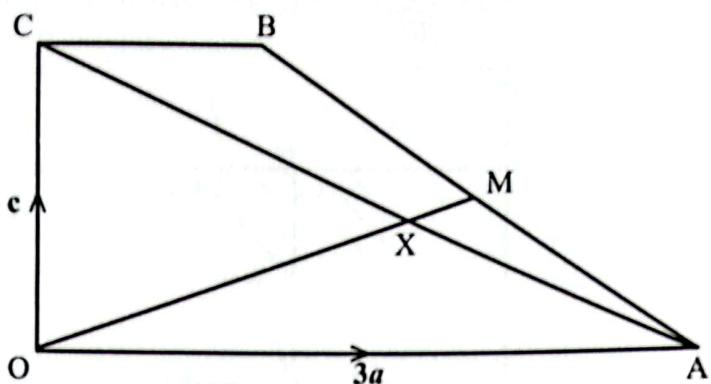


(a) Calculate:

(i) the area of the shaded region that lies below the  $x$ -axis. (4 marks)(ii) the area of the shaded region that lies to the right of line  $RN$ . (4 marks)

(b) Hence calculate the total area of the shaded region. (2 marks)

- 24 In the following figure OABC is a trapezium. OA is parallel to CB and  $OA = 3 CB$ . M is the midpoint of AB.



- (a) Given that  $OA = 3a$  and  $OC = c$  express in terms of  $a$  and  $c$ .
- $AC$  (1 mark)
  - $AB$  (2 marks)
  - $OM$  (2 marks)
- (b) Lines AC and OM intersect at X such that  $OX = h OM$  and  $AX = k AC$  where  $h$  and  $k$  are scalars. Determine the values of  $h$  and  $k$ . (5 marks)