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**TOTAL
MARKS**

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INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
NOVEMBER 2024

MATHEMATICS: PAPER I

EXAMINATION NUMBER

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Time: 3 hours

150 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 23 pages and an Information Sheet of 2 pages (i–ii). Please check that your question paper is complete.
2. Read the questions carefully.
3. **Answer ALL the questions on the question paper and hand it in at the end of the examination. Remember to write your examination number in the space provided on the question paper.**
4. You may use an approved non-programmable and non-graphical calculator unless otherwise stated.
5. Clearly show **ALL** calculations, diagrams, graphs, etc. that you have used in determining your answers.

Answers only will NOT necessarily be awarded full marks.

6. Diagrams are not necessarily drawn to scale.
7. If necessary, round off answers to **TWO** decimal places, unless otherwise stated.
8. It is in your own interest to write legibly and to present your work neatly.
9. Two blank pages (pages 20 and 21) and extra graphs (pages 22 and 23) are included at the end of the paper. If you run out of space for a question, use this page. Clearly indicate the question number of your answer should you use this extra space.

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	TOTAL
21	17	16	10	10	10	15	18	9	11	13	/150

SECTION A**QUESTION 1**

(a) Solve for x in terms of p :

(i) $(x-1)^2 = 4p^2$ (3)

(ii) $3^{2-x} = p$ (3)

(b) $x = \frac{-3 \pm \sqrt{9-8k}}{4}$ are roots of a quadratic equation.

(i) Given that $ax^2 + bx + k = 0$ is the quadratic equation whose roots are given above, write down the values of a and b . (2)

(ii) For which values of k , where k is a whole number, will the quadratic equation have rational roots? (2)

(iii) Find all real value(s) of k for which the equation has two unequal real roots. (2)

- (c) Solve for x given that $x = 3 + \sqrt{2x - 3}$ (4)

- (d) If $\log 2 = a$ and $\log 3 = b$, determine $\log 0,5 - \log 48$ in terms of a and b . (5)

QUESTION 2

- (a) The following number sequence is given:

$$4; 2; 1; \frac{1}{2} \dots$$

Find the n^{th} term of this sequence leaving your answer as a single power. (3)

- (b) The sum of the first n terms of a geometric series is given as:

$$S_n = a + ar + ar^2 + \dots + ar^{n-1}$$

- (i) Use the formula of S_n given above to write down rS_n . (2)

- (ii) Hence derive the formula $S_n = \frac{a(r^n - 1)}{r - 1}$, showing all your steps. (4)

(c) The first, fifth and fifteenth terms of an arithmetic sequence are the first three terms of a geometric sequence.

(i) Show that $3a = 8d$. (5)

(ii) Find r . (3)

[17]

QUESTION 3

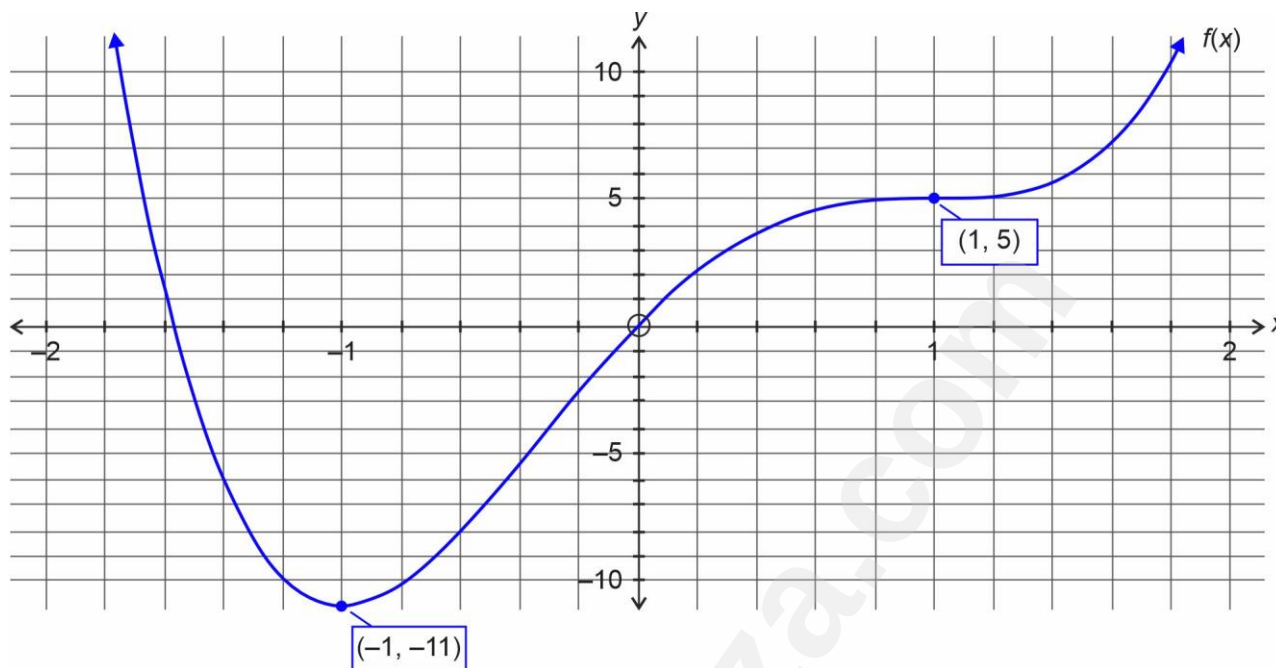
(a) Find $\frac{dy}{dx}$ and $g'(x)$, respectively for the following:

(i) $y = 3\sqrt{x} - \frac{1}{\sqrt{x}}$ (3)

(ii) $g(x) = \frac{(\pi x - \pi)(x^2 - 3x + 3\pi)}{x - 1}$ (4)

(b) Find $f'(x)$ from first principles if $f(x) = \frac{3}{x}$ (5)

(c) The graph of a function, f , is shown below.



- The stationary points of $f(x)$ at $x = -1$ and at $x = 1$ are marked.
- The graph has a second point of inflection at $x = -\frac{1}{2}$.

Use the graph to answer the following:

(i) Find the value(s) of x at which $f'(x) < 0$. (1)

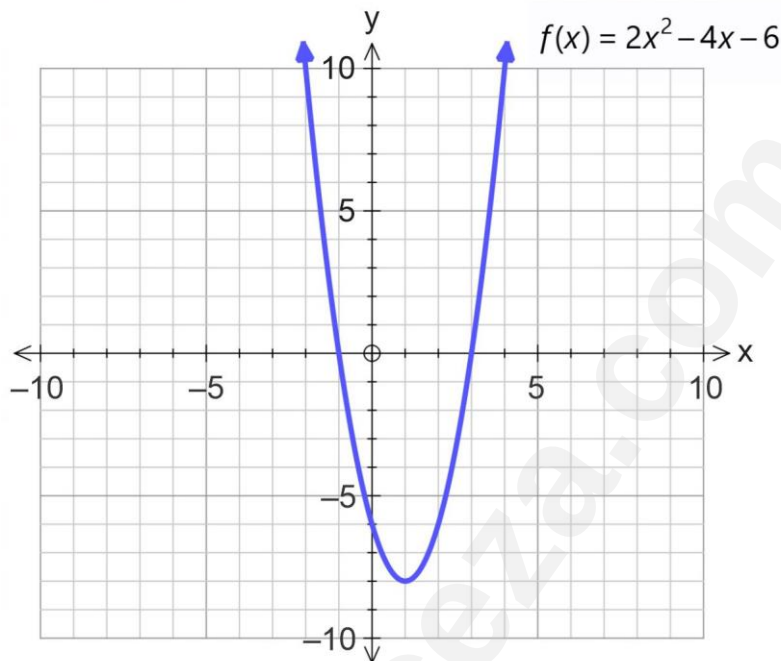
(ii) At what point(s) on the graph are values of $f'(x)$ and $f''(x)$ simultaneously zero? (1)

(iii) Write down the values of x for which $f(x)$ is concave down. (2)

[16]

QUESTION 4

The quadratic function $f(x) = 2x^2 - 4x - 6$ is drawn on a scaled axis.



- (a) The domain of the above function is restricted to $x \leq k$. State the value of k such that the inverse of $f(x)$ is a function and the range is not affected by this restriction. (1)
- (b) Write $f(x)$ in the form $f(x) = 2(x + p)^2 + q$ replacing p and q with numerical values. (2)
- (c) Hence write the equation of the inverse of $f(x)$, $x \leq k$ in the form $f^{-1}(x) = \dots$, stating the domain of this inverse (4)
- (d) Draw the graph of $f^{-1}(x)$ on the above axes clearly showing the points of intersection with the axes. (3)

[10]

QUESTION 5

Tim is planning to buy a motorbike.

He has identified a brand new bike (see image) but he does not have enough money.

He plans to save the money he has with the aim of earning enough interest to afford the bike.



[Source: <<https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.motorbikesplus.com>>]

- (a) Find a quartely per annum interest rate equivalent to an effective rate 12,75% per annum. Give your answer as a percentage to **two decimal places**. (4)

- (b) A brand new bike is being sold for R200 000.

- The price depreciates at a rate 8,7% per annum on a reducing balance.
- Tim strikes a deal with the shop to buy the bike at the depreciated price in two years' time.

Calculate how much money Tim can save at an interest rate of 12,75% per annum compounded monthly in order to buy the depreciated bike in two years time. (6)

[10]

SECTION B**QUESTION 6**

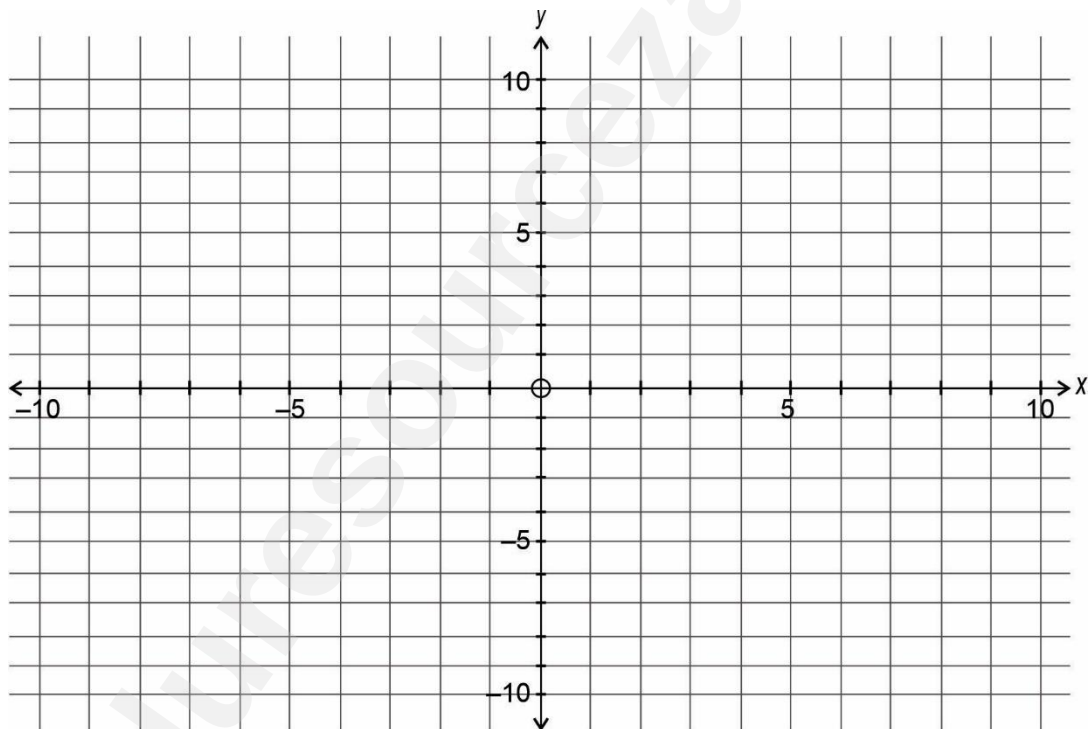
- (a) A hyperbola is represented by the function $f(x) = \frac{a}{x+p} + q$.

Write the equation of $f(x)$ as a single fraction.

(2)

- (b) Hence or otherwise, draw the graph of $y = \frac{x+2}{x-2}$ on the grid below, showing any asymptotes and intercepts.

(6)



Space for working.

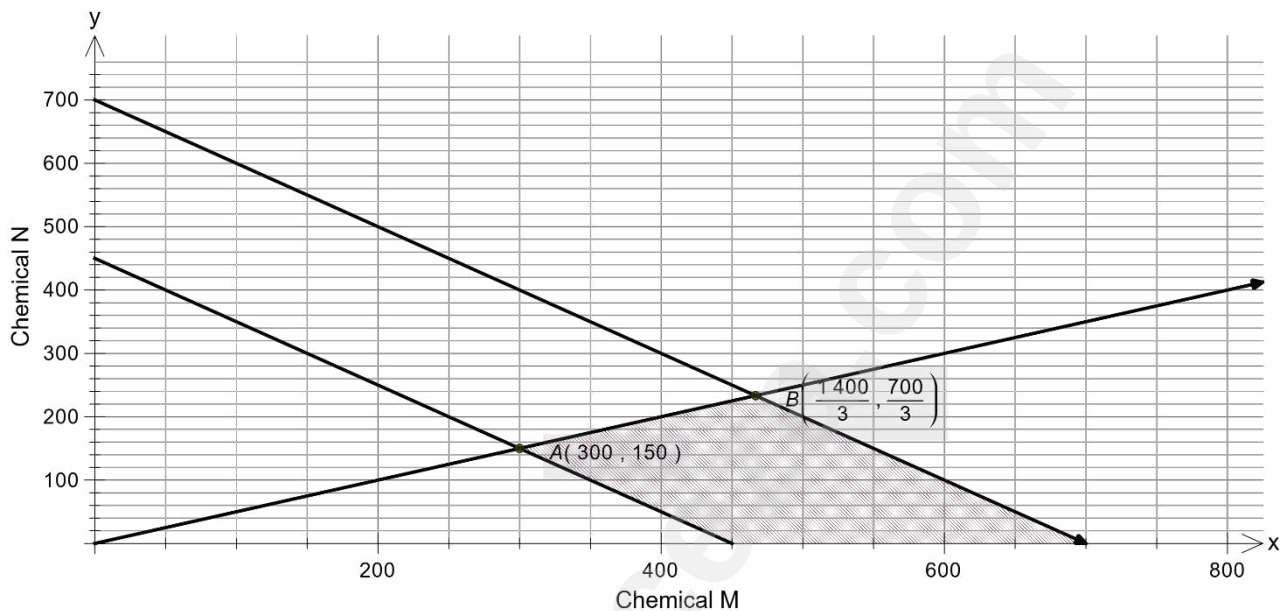
- (c) Given the function $y = \frac{4}{x-2} + 1$, determine the equation of the decreasing axis of symmetry. (2)

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QUESTION 7

Two chemicals M and N are required to make a fertiliser. The agricultural scientist mixes x kg of M and y kg of N.

The graph below shows inequalities representing the feasible region (shaded).



- (a) It is discovered that the constraint $x \geq 0$ has been erroneously included in the diagram.

Write down the three valid constraint inequalities.

(6)

- (b) It is further provided that the fertiliser must contain at least 100 kg of N. Represent this information on the graph and shade the updated feasible region, using letters C and D to label your new feasible region vertices.

(2)

- (c) M costs R16 per kg and N costs R10 per kg. If the objective is to minimise the costs, state the number of kgs of M and N respectively for which this will be achieved. (4)

- (d) Determine the most economical mixture if the cost of M and N is exactly the same. (3)

[15]

QUESTION 8

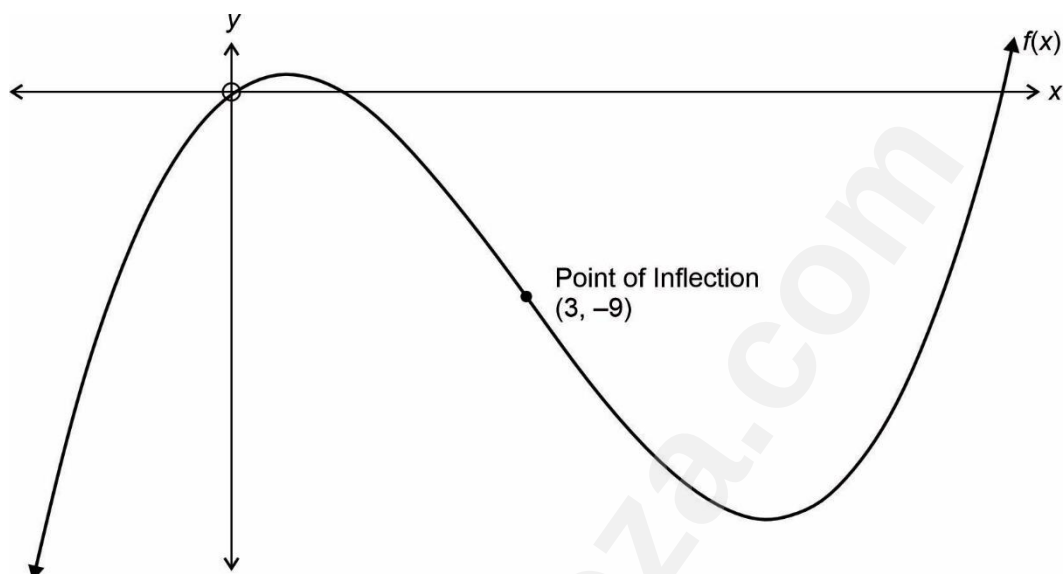
A cubic function of the form $f(x) = ax^3 + bx^2 + cx + d$, has a point of inflection at $(3; -9)$. The graph passes through the origin and has a gradient of 3 at the origin.

- (a) Show that $b = -9a$. (4)

- (b) By finding the values of a , b , c and d , determine the equation of the graph. (6)

(c) The following information is given:

- $f(x) = 0$ at $x = 0$, $x = 1,15$ or $x = 7,85$.
- There is a local maximum at $(0,55; 0,8)$.
- There is a local minimum at $(5,45; -18,80)$.



(i) For which values of k will $f(x) + k = 0$ have three real roots? (2)

(ii) Find m for which $a(x-m)^3 + b(x-m)^2 + c(x-m) + d = 0$ will have two solutions of the same sign and one solution of the opposite sign. (3)

(d) Draw the graph of $f'(x)$ on the same axes as $f(x)$ showing x -intercepts and stationary points. (3)

QUESTION 9

- (a) Find the general term (T_k) of the series $\sum_{k=1}^n T_k = 2n^2 - n$. (4)

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(b) A robot is programmed to move the following way on the cartesian plane:

From the start point with coordinates $(8; -5)$ the robot will move 12 units to the right, then it will make a 90° turn to the left to move 4 units up.

Thereafter, the robot will continue making 90° left turns by following a pattern as given below.

- The robot will move half of its previous horizontal distance whenever a horizontal turn is made.
- Similarly, the vertical distance moved will also be halved following the next vertical turn.

Find the coordinates of the point where the robot will eventually end up on the cartesian plane. (5)

QUESTION 10

Five years ago, Keberon took out a 25-year loan for R1 000 000 to be settled with monthly repayments.

The interest rate was 7,2% per annum compounded monthly.

Five years after the loan was granted, the interest rate changes to 6,8% per annum compounded monthly.

- (a) Show that Keberon's monthly repayment in the first five years was R7 195,89. (4)
- (b) By finding Keberon's outstanding balance at the change of rate, calculate by how many months (to the nearest month) Keberon's repayment period will be reduced. (7)

QUESTION 11

(a) Solve for x given: $-2^x(x-3)(x+2) \leq 0$. (4)

(b) The running cost of an electric bike is $(2 + 0,001v^3)$ rands per hour when the speed is v kilometres per hour.

(i) Show that the cost C of a trip of k kilometres is given by $C = 2kv^{-1} + 0,001kv^2$. (3)

(ii) Find the speed that minimises the running cost. Use mathematical reasoning to justify your response. (6)

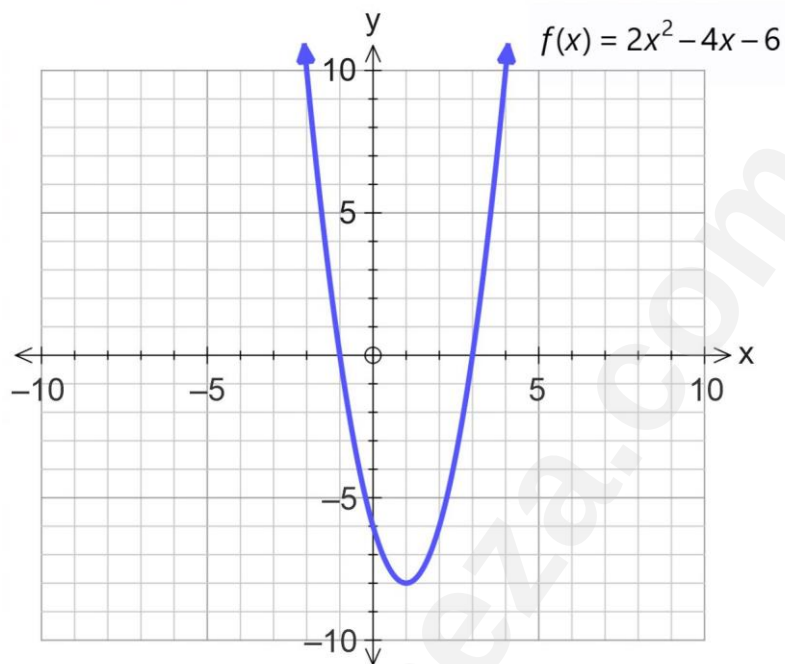
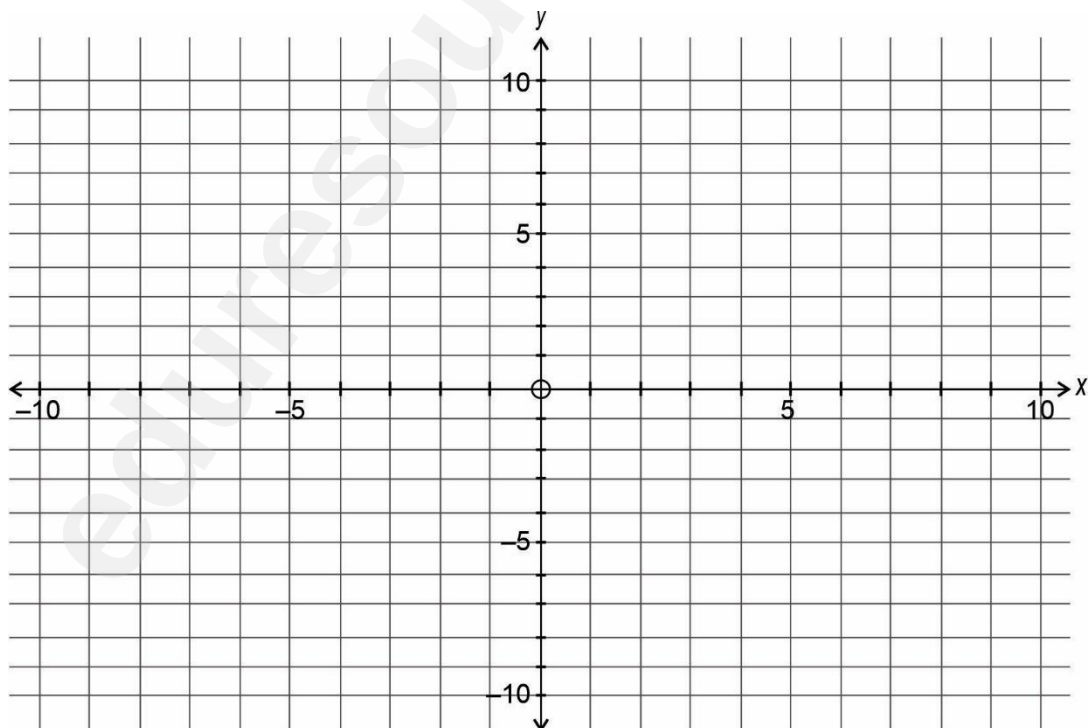
[13]**76 marks****Total: 150 marks**

ADDITIONAL SPACE (ALL QUESTIONS)

**REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE
ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.**

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EXTRA GRAPHS**QUESTION 4 (d)****QUESTION 6 (b)**

QUESTION 7 (b)

