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TOTAL
MARKS

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INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
MAY 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 24 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.
4. Write your answers in the spaces provided.
5. You may use an approved non-programmable and non-graphical calculator unless otherwise stated.
6. Clearly show **ALL** calculations, diagrams, graphs, etc. that you have used in determining your answers.

Answers only will NOT necessarily be awarded full marks.

7. Diagrams are not necessarily drawn to scale.
8. If necessary, round off answers to **TWO** decimal places, unless otherwise stated.
9. You must write legibly and present your work neatly.
10. Two blank pages (page 23 and 24) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the question number of your answer should you use this extra space.

FOR MARKER'S USE ONLY

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	TOTAL
20	16	9	16	15	8	12	14	7	9	18	6	/150

SECTION A**QUESTION 1**

(a) Solve for x in each of the following equations:

(1) $x^2 + 12 = 7x$ (2)

(2) $(5 - x)^{\frac{3}{2}} = 27$ (2)

(3) $6 \geq 11x - 3x^2$ (4)

(4) $\log_b(2x + 7) - \log_b x = 2\log_b 3$

(4)

(5) $\left(\frac{1}{2}\right)^{6x-x^2} = 128$

(4)

(b) For which value(s) of k will the equation given have equal roots?

$$x^2 + (k + 2)x + 4k - 7 = 0 \quad (4)$$

QUESTION 2

(a) In an arithmetic sequence, the 7th term is 28 and the 12th term is 73.

(1) Determine the value(s) of the 1st term and the common difference of the sequence. (4)

(2) Calculate the sum of the first 50 terms of the sequence. (2)

(b) The sum of the first n terms of a sequence of numbers is given as: $S_n = \frac{n}{2}(8n^2 + 7n)$. Determine the 8th term of the sequence. (3)

(c) The first 4 terms of a quadratic sequence are given: 4 ; a ; 20 ; 37.

(1) Calculate a . (4)

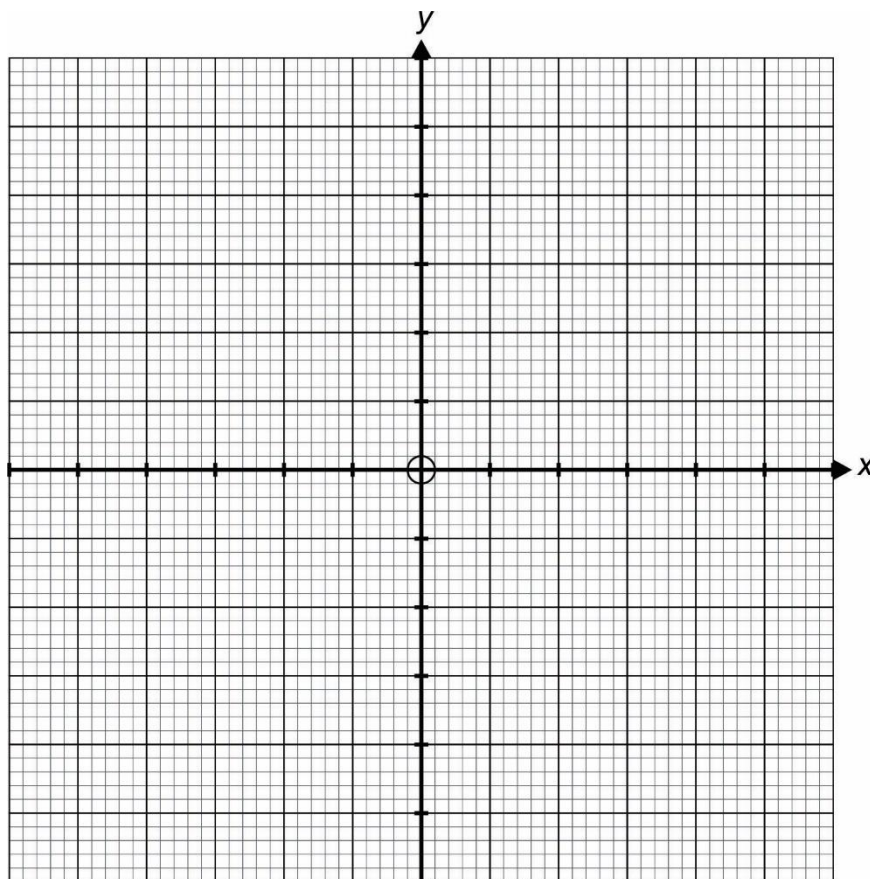
(2) Determine the general term, T_n , of the quadratic sequence if $a = 9$. (3)

[16]

QUESTION 3

Given the function $f(x) = -\frac{2}{x+1} - 2$.

- (a) Sketch the graph of $f(x)$. (4)



- (b) Determine:

- (1) the equation of the inverse of $f(x)$, i.e. $f^{-1}(x)$. (3)

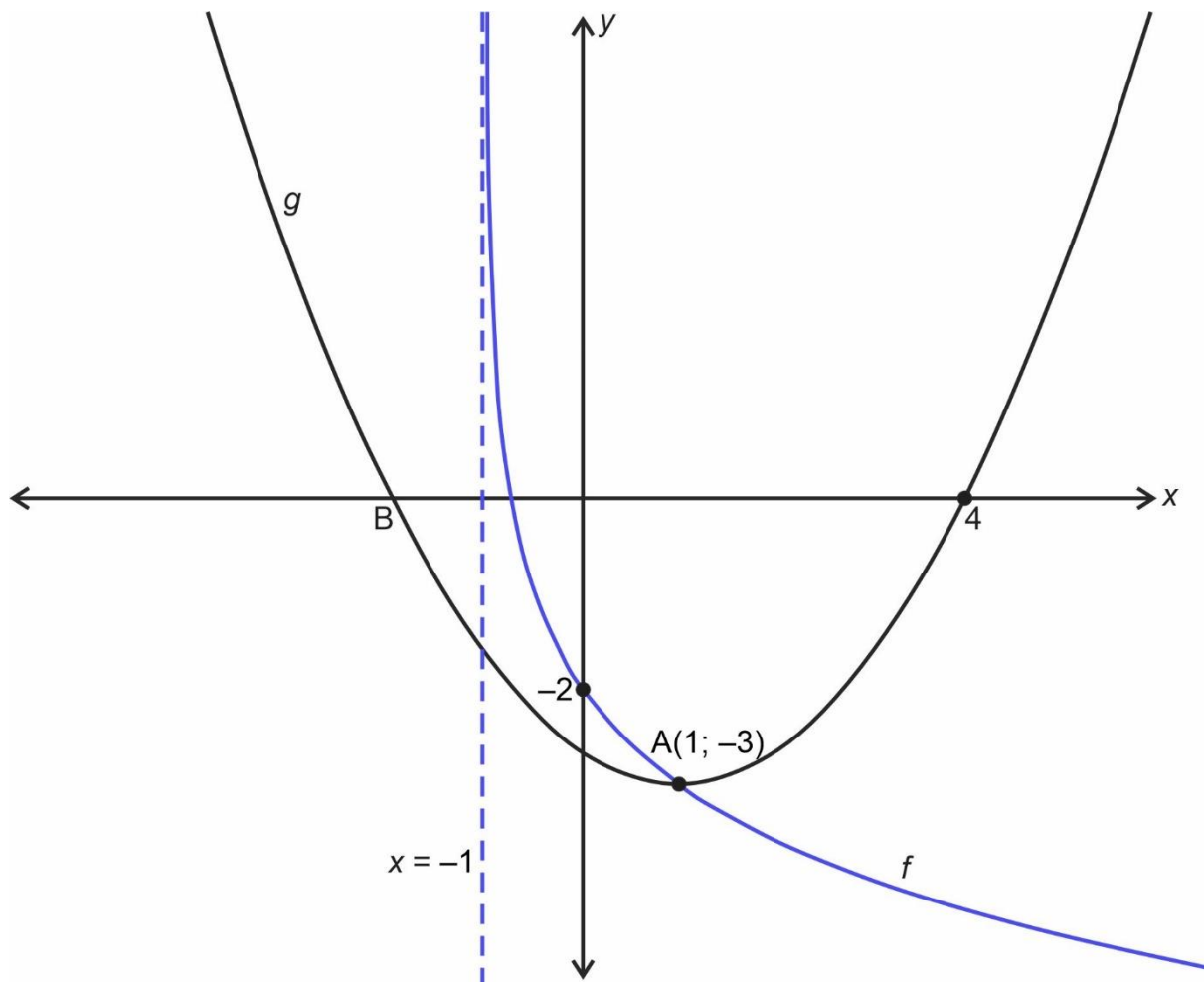
- (2) Hence, or otherwise, determine the domain of $f^{-1}(x)$. (2)

[9]

QUESTION 4

The graphs of $f(x) = \log_a(x+b) - 2$ and $g(x) = p(x-1)^2 - 3$ are sketched below.

The two graphs intersect at $A(1; -3)$, which is the turning point of $g(x)$.



(a) Determine the domain of $f(x)$ and the range of $g(x)$. (2)

(b) Write down the coordinates of B , the x-intercept of $g(x)$. (2)

(c) Determine the value of p , in the equation of $g(x)$. (2)

(d) Write down the equation of $h(x)$, if $h(x)$ is the image of $g(x)$ under the following transformations (in order):

Translate 2 units to the right, translate 3 units down and reflect in the x -axis. (3)

(e) Determine the values of a and b , in the equation of $f(x)$. (4)

(f) Using the graph, state the values of x for which $f(x) \leq 0$. (3)

[16]

QUESTION 5

(a) If $f(x) = \frac{1}{x^2 + 2xh + h^2} - \frac{1}{x^2}$, determine: $\lim_{h \rightarrow 0} \left(\frac{f(x)}{h} \right)$. (5)

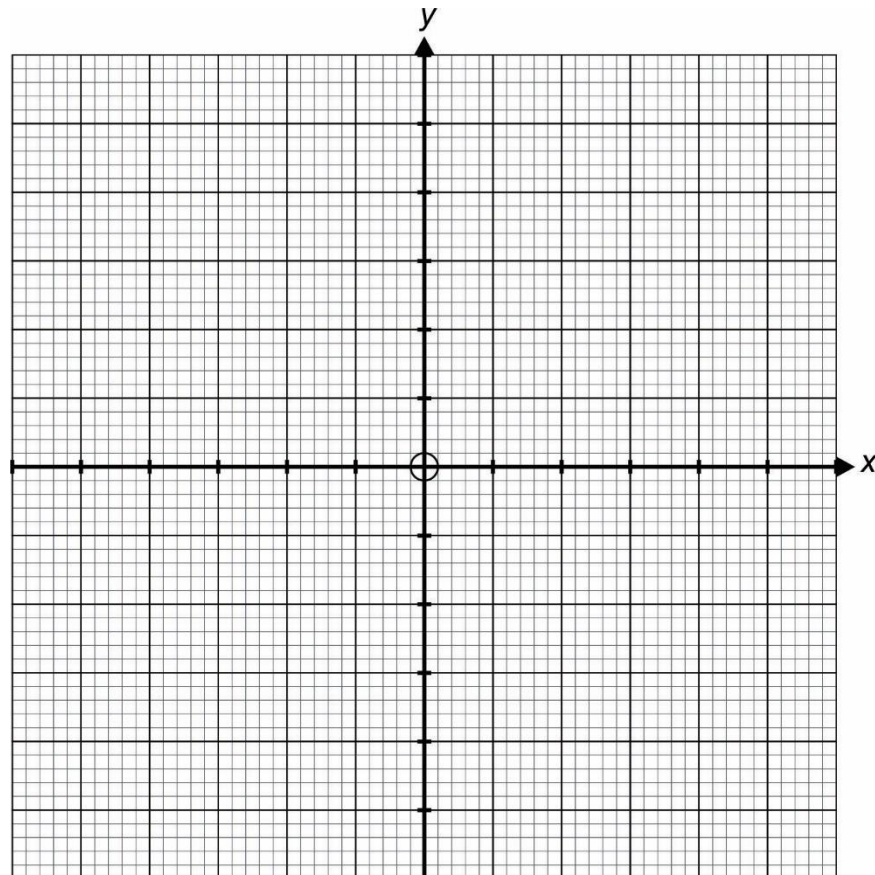
(b) Determine $\frac{dy}{dx}$, if $y = (2x - 3\sqrt{x})^2$. (4)

(c) A cubic function f has the following properties:

- $f(0) = -5$
- $f(4) = 0$
- $f'(1) = f'(3) = 0$
- $f(1) = -1$
- $f(3) = -5$

(1) Sketch the cubic function showing all key points.

(4)



(2) Determine the value(s) of x for which the cubic function is concave up.

(2)

[15]

76 marks

SECTION B**QUESTION 6**

At the start of your Grade 8 year, your parents decided to save R1 600 at the end of each month in an account offering an interest rate of 9% per annum compounded monthly, for you to use as start-up capital when you finish high school.

(a) How much will be in the account immediately after the 48th payment? (3)

(b) Immediately after the 48th payment, your parents make a once-off deposit of R10 000 into the same account to accumulate interest for 12 months, in addition to the monthly payments.

How many months will it take for the savings to accumulate to at least R132 000? (5)

QUESTION 7

One of the most affordable electric cars in South Africa is the GWM Ora which costs R716 900.



[Taylor, D. (2023) 'GWM Ora '. South Africa: <cars.co.za>]

To purchase this car, 5% of the cost of the car must be paid in advance. The remainder will be taken as a loan and repaid monthly (at the end of each month) over 6 years at a fixed rate of 14,5% per annum compounded monthly.

- (a) Calculate the amount of the loan. (2)

(b) Calculate the monthly repayments. (4)

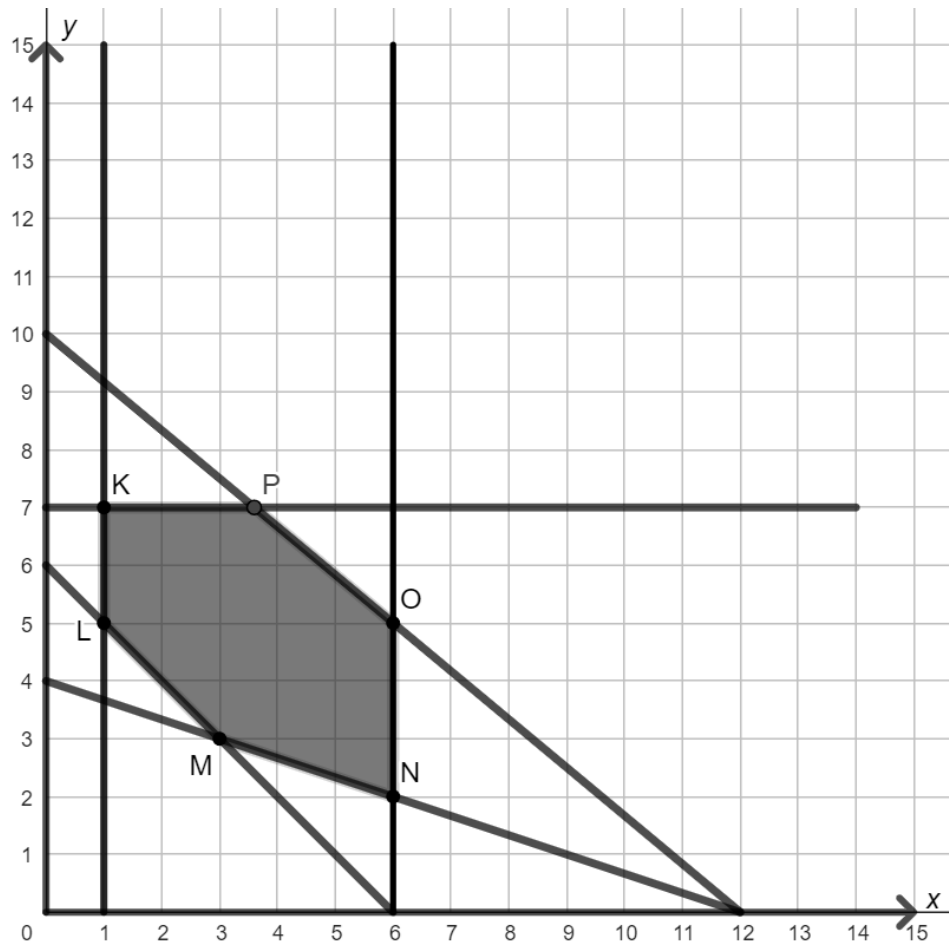
(c) After making the 54th payment, what is the outstanding balance on the loan? (4)

(d) What is the amount of interest paid in the 55th month? (2)

[12]

QUESTION 8

The shaded area, in the diagram shown, represents the feasible region of a problem in linear programming.



- (a) $y + x \geq 6$ and $1 \leq x \leq 6$ are two of the constraints. Write down the inequalities that represent the other three constraints. (3)

(b) The point $Q(2;a)$ satisfies all the constraints and the point $R(b;3)$ is not in the feasible region. Write down one possible value of a and one possible of b . (2)

(c) If $(x;y)$ is a point in the feasible region, find:

(1) the minimum value of S if $S = 8x + 4y$. (3)

(2) the maximum value of T if $T = 3y + 4x$. (3)

(d) Find the range of values of $\frac{c}{d}$, if $S = cx + dy$ is minimised only at M . (3)

[14]

QUESTION 9

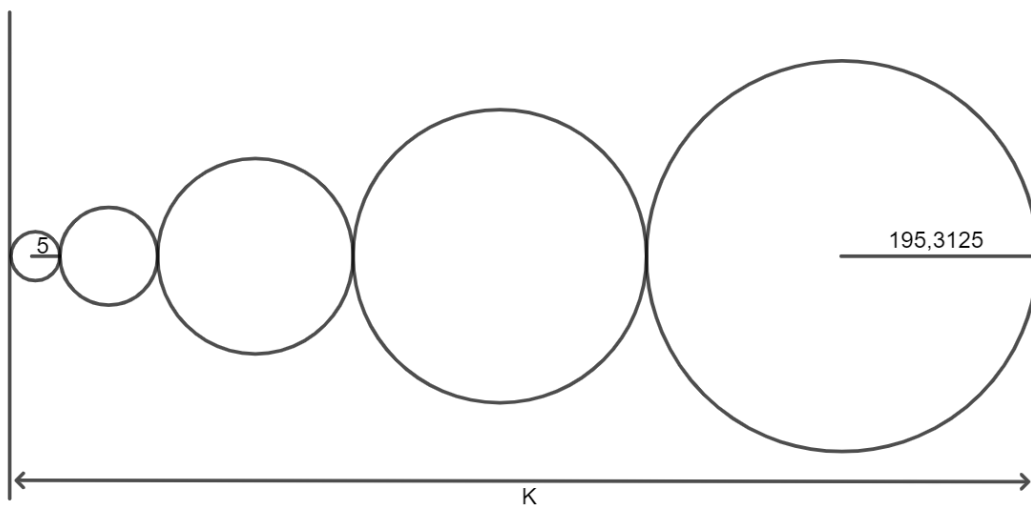
Given: $\frac{4^q}{2^p} = \frac{1}{2}$ and $\log_5(p^2 + q^2 - 4) = 2$, solve for p and q .

[7]

QUESTION 10

The figure below shows a pattern of 5 circles, touching externally, whose centres lie on a straight line of K units.

The radii of the circles form a geometric progression, where the radius of the smaller circle is 5 units and that of the fifth (largest) circle is 195,3125 units long.



- (a) Find the common ratio of the geometric progression. (2)

- (b) The pattern is extended by 5 more circles to make 10 circles in total.
Determine the new value of K . (3)

- (c) Calculate the total area of the 10 circles of the new pattern. (4)

[9]

QUESTION 11

- (a) The point R , whose x coordinate is $\frac{1}{4}$ lies on the curve with the equation

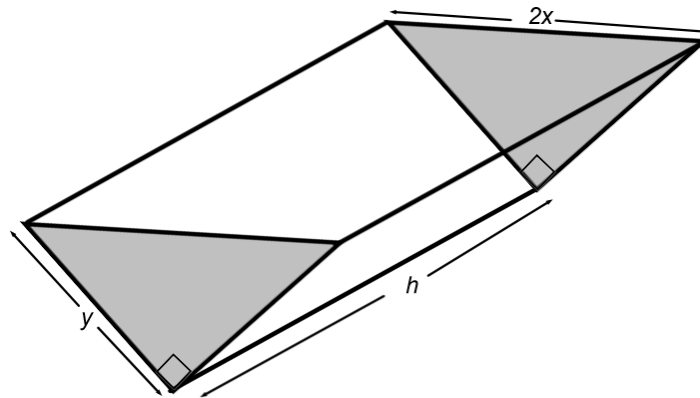
$$f(x) = \frac{b + 2x\sqrt{x}}{3x}, \quad x \in \mathbb{R}, \quad x > 0, \quad b \neq 0.$$

- (1) Determine, in terms of b , the gradient of the curve at R . (4)

- (2) The tangent to the curve at R is parallel to the straight line with equation $30x + 3y - 4 = 0$.

Find the equation of the tangent to the curve at R . (5)

- (b) The figure shows the design of a cattle feeder, which is the shape of a hollow, opened top right-angled isosceles triangular prism. The volume of the feeder is 64 units^3 .



Given that x and h can vary, determine, using calculus methods, the minimum outer surface area of the feeder. (9)

[18]

QUESTION 12

A tank is full of liquid. The tank has 3 outlet pipes, each having a constant drainage rate, when the liquid is allowed to flow out of the tank.

Let X, Y, Z be labels for each of the three outlet pipes.

If only X and Y are turned on, it takes 12 hours to drain the tank.

If only X and Z are turned on, it takes 15 hours to drain the tank.

If only Y and Z are turned on, it takes 20 hours to drain the tank.

Determine how long it takes outlet pipe Y, on its own, to drain a full tank.

[6]

74 marks

Total: 150 marks

ADDITIONAL SPACE (ALL QUESTIONS)

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

