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TOTAL
MARKS

INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
MAY 2023

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 on the question paper and hand it in at the end of the examination. Remember to write your examination number in the space provided.**
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 **ONE** decimal place, unless otherwise stated.
8. It is in your own interest to write legibly and to present your work neatly.
9. TWO blank pages (pages 23 –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	15	14	10	15	7	13	10	15	15	5	11	/150

QUESTION 1

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

(1) $x^2 + x - 6 = 0$ (2)

(2) $(2x + 1)(x - 3)(x^2 - 5) = 0$, if:

(i) $x \in \mathbb{N}$ (1)

(ii) $x \in \mathbb{Q}'$ (2)

(iii) $x \in \mathbb{Q}$ and $x \notin \mathbb{Z}$ (1)

(3) $x^2 - 3x > -2$ (3)

(4) $x - \sqrt{x-3} = 5$

(5)

(5) $\log_3 2 + \log_3 (x+5) = \log_3 16$

(3)

(b) For which value(s) of k will the equation $x^2 - 2x + 2 + k = 0$ have equal roots? (3)

[20]

QUESTION 2

- (a) An arithmetic sequence has a first term of 120 and 10th term of 57.
Find the 15th term.

(3)

- (b) $2k + 2$, $5k + 1$ and $10k + 2$ are three successive terms of a geometric sequence.
Find the value(s) of k , where k is an integer.

(4)

(c) T_n is the n^{th} term of a quadratic sequence. It is further given that:

$$T_2 - T_1 = 7, \quad T_3 - T_2 = 13 \text{ and } T_4 - T_3 = 19$$

(1) Determine $T_{12} - T_{11}$ (2)

(2) Find T_{69} if $T_{89} = 23594$ (6)

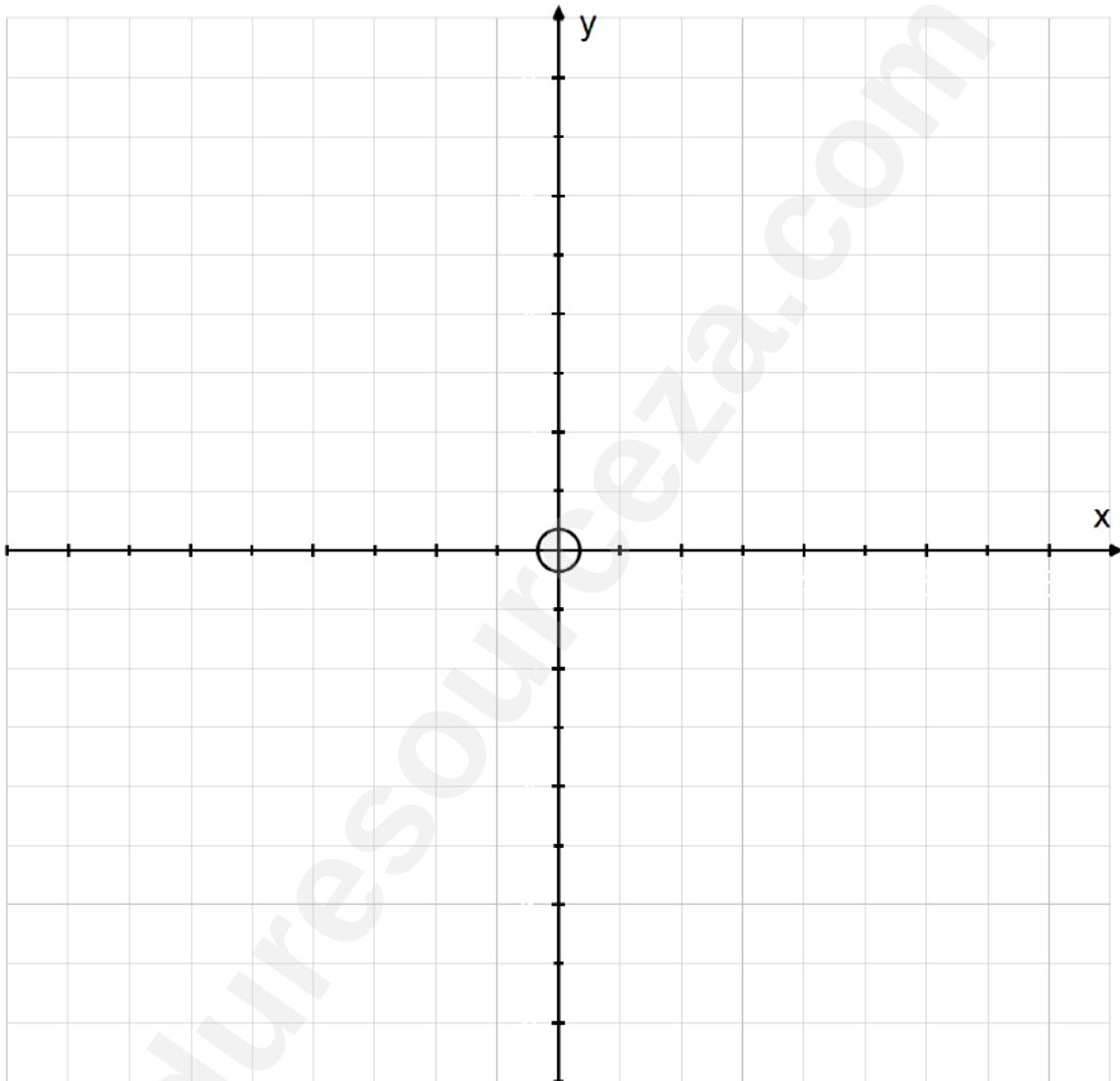
[15]

QUESTION 3

(a) Given the function $f(x) = \frac{6}{x-1} + 2$.

(1) Sketch the graph of f .

(5)

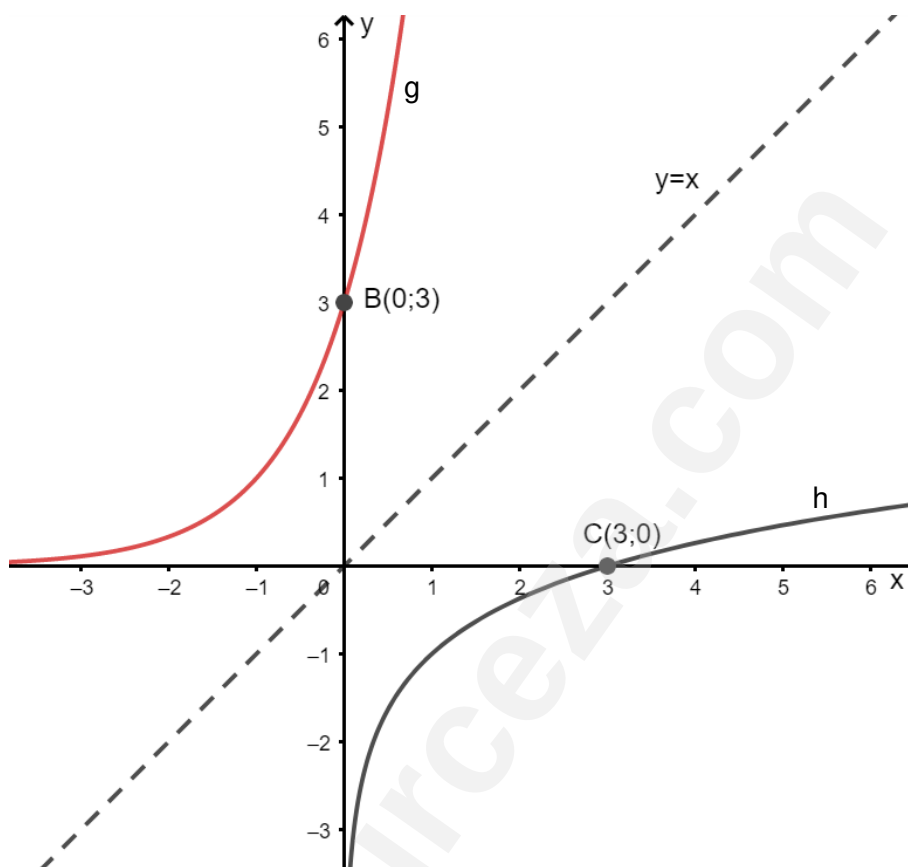


(2) Determine the domain of f .

(1)

(3) Determine the equation of the axis of symmetry with a positive gradient. (2)

- (b) In the sketch below, the graph of $g(x) = 3^{x+1}$ is given. The graph h is the reflection of the graph g in the line $y = x$.



- (1) Determine the equation of h . (3)

- (2) Determine, with the aid of the sketches given above, the value(s) of x for which:

(i) $3^{x+1} > 0$ (1)

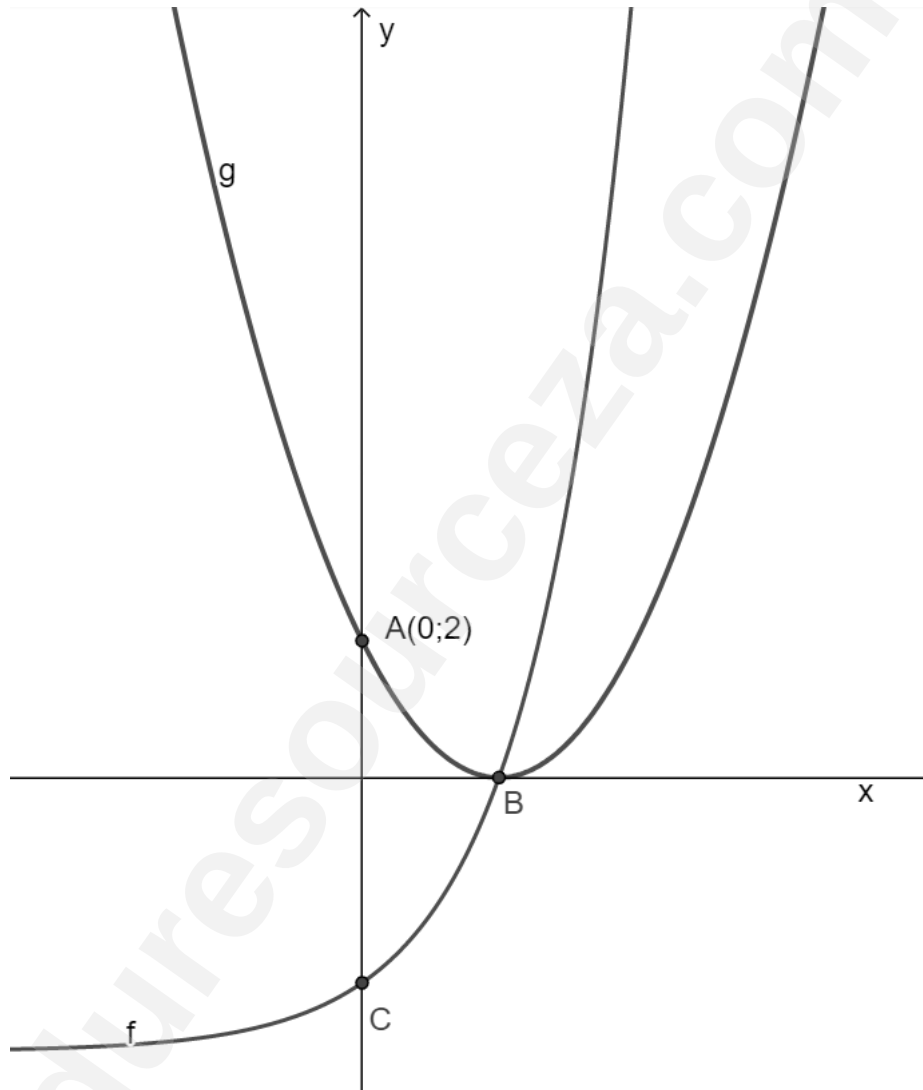
(ii) $h(x) < 0$ (2)

QUESTION 4

The graphs of $f(x) = 2^x - 4$ and $g(x) = ax^2 + bx + c$ are sketched below.

A (0 ; 2) and C are the y-intercepts of the graphs g and f respectively.

The two graphs intersect at B, which is the turning point of g and the x-intercept of both graphs.



- (a) Determine the coordinates of B and C.

(4)

(b) Find the values of a , b and c , in the equation of $g(x)$. (3)

(c) Write down the equation of $h(x)$ if h is a reflection of f in the x -axis. (2)

(d) How may the domain of g be restricted such that its inverse is a function? (1)

[10]

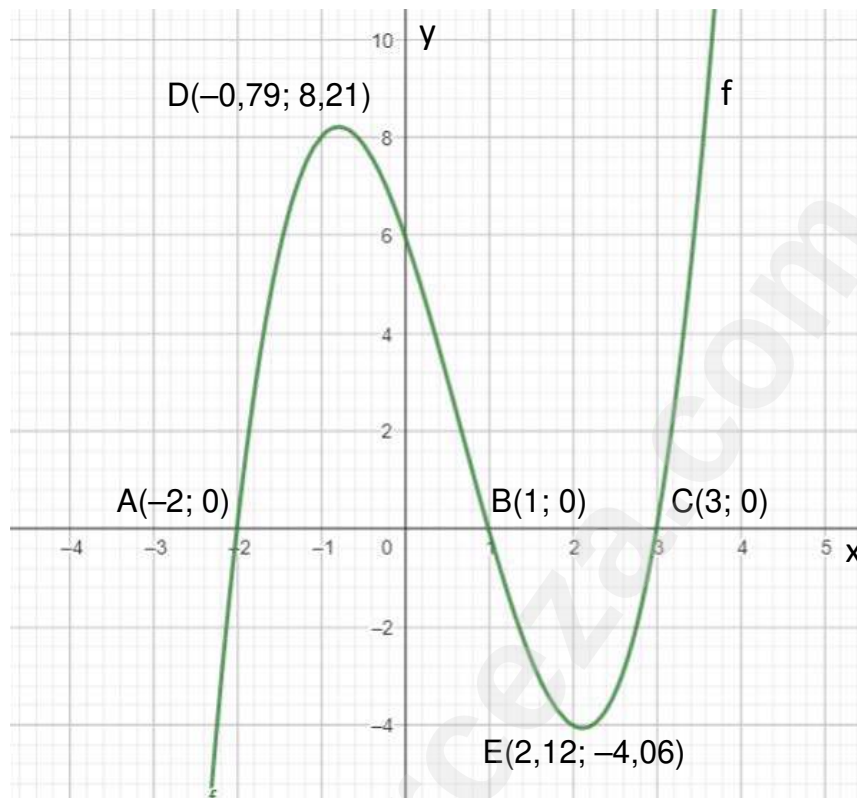
QUESTION 5

- (a) If $f(x) = 3x^2 + 2x$, determine $f'(x)$ from first principles. (5)

- (b) (1) Determine $\frac{dy}{dx}$ if $y = x(x^2 - 1)$ (3)

- (2) Determine $f'(x)$ if $f(x) = \frac{x^4 - x}{2x} - \sqrt{x^3}$ (3)

- (c) A function, f , is drawn below with x-intercepts at A, B and C, and stationary points at D and E.



Using the graph, determine the value(s) of x for which:

(1) $f(x) > 0$ (2)

(2) $f'(x) < 0$ (2)

[15]

QUESTION 6

Neo wishes to save R3 500 at the end of each month in an account paying 12% per annum, compounded monthly.

(a) How much will be in the account immediately after making the 38th payment? (3)

(b) How many months will it take for the savings to accumulate to at least R285 843,84? (4)

[7]

QUESTION 7

Peo wants to buy a house for R1 800 000. She is able to pay a 10% deposit and will take out a loan for the balance. This will be repaid monthly (at the end of each month) over 20 years at a rate of 8,5% per annum compounded monthly.

- (a) Calculate the amount of the loan. (2)
- (b) Calculate Peo's monthly repayments. (4)
- (c) After making her 158th payment, Peo wishes to settle the loan, as she has inherited money from her grandmother. What is the outstanding balance of the loan at this point? (4)
- (d) If the outstanding balance immediately after the 157th payment was R879 972,91, calculate what percentage of the 158th payment went towards reducing the balance of the loan. (3)

QUESTION 8

- (a) A ball is dropped vertically from a height of 10 metres. After each bounce the ball rises to three-quarters of the height of the previous bounce. Find the distance travelled by the ball before it comes to rest. (The ball does not move sideways). (4)

- (b) Determine the value of n if:

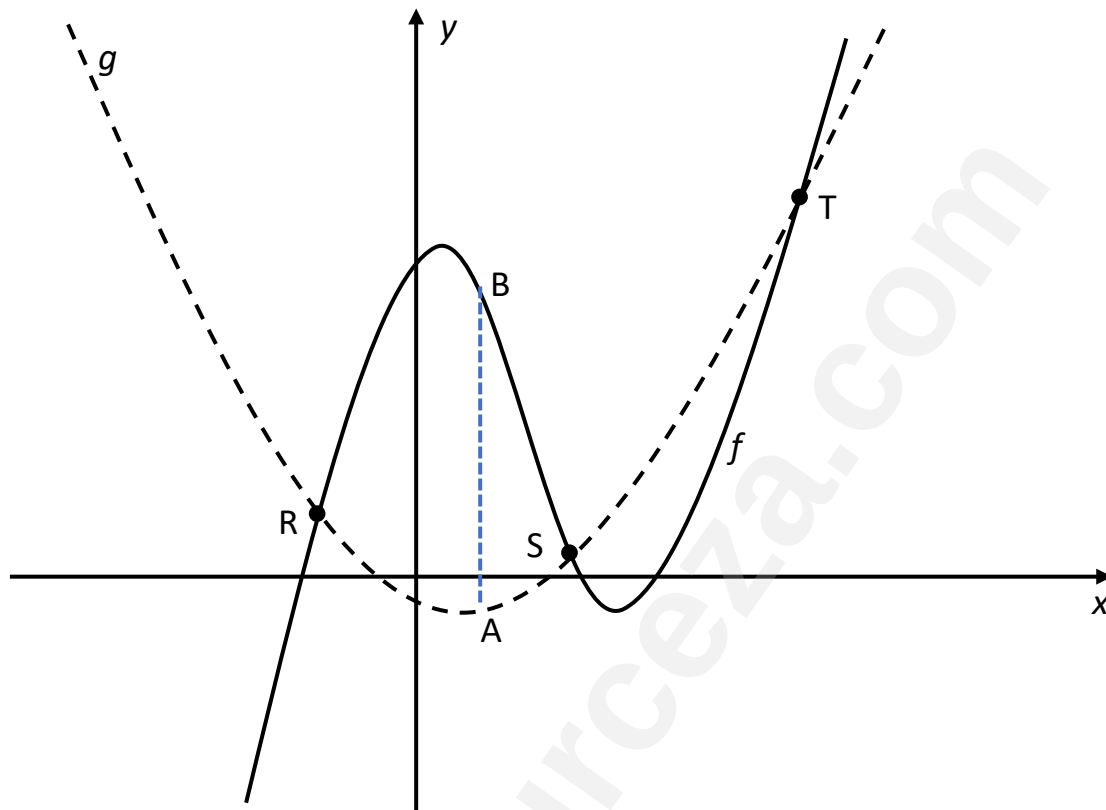
$$\sum_{i=1}^{\infty} 120 \left(\frac{2}{3} \right)^{i-1} + \sum_{i=1}^n 3(2)^{i-1} = 786\,789 \quad (6)$$

QUESTION 9

- (a) The function $h(x) = x^3 + px^2 + qx + 8$ has a point of inflection at $(2; -16)$.
Determine the values of p and q respectively. (5)

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- (b) Consider the functions $f(x) = x^3 - 9x^2 + 14x + 29$ and $g(x) = 2x^2 - 6x - 3$ drawn below (NOT TO SCALE). The graphs intersect at the points R, S and T.



- (1) Determine the values of the x-coordinates of the three points of intersection of f and g . (4)

- (2) AB is a vertical line with A on g and B on f .
Determine the maximum length of AB, between the points R and S. (6)

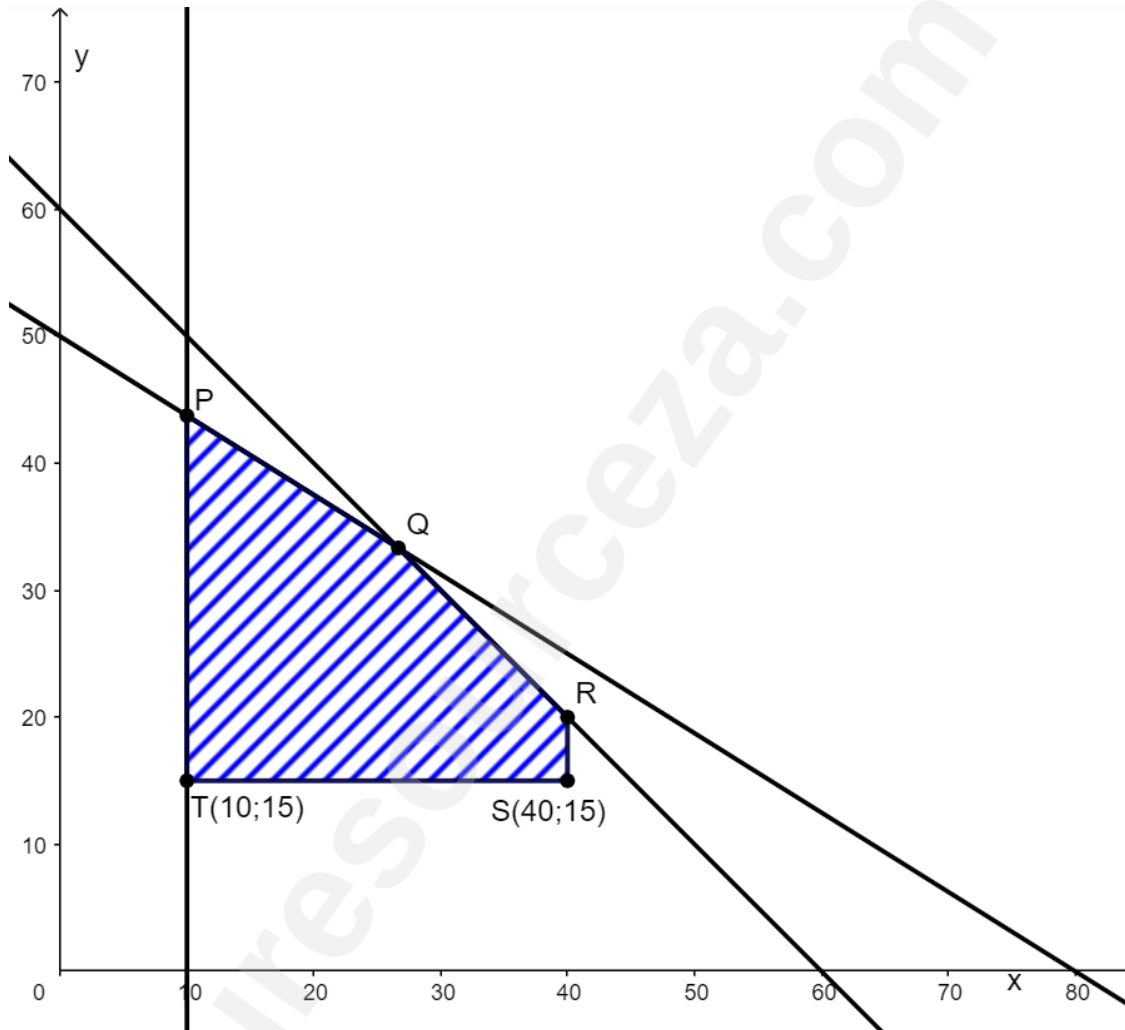
[15]

QUESTION 10

A stall owner at a Flea Market sells two types of products, A and B.

The shaded area in the diagram shown below represents the feasible region of the conditions under which the stall owner sells her products.

She sells x quantities of product A and y quantities of product B.



- (a) Use the information in the diagram to write down the inequalities for the constraints shown. (5)

- (b) If the stall owner sells product A at a profit of R7 and product B at a profit of R5, what is the maximum profit? (4)

- (c) If the stall sells product A at a profit of R k (k rands) and product B at a profit of R5, find the possible values of k if the maximum profit occurs at point Q. (6)

[15]

QUESTION 11

Solve simultaneously for x and y :

$$3^y \cdot 9^x = \frac{27^x}{3} \quad \text{and} \quad \sum_{m=3}^4 (mx + y) = 16$$

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QUESTION 12

- (a) For a particular function, f , it is given:

$$f(0) = 2023 \quad \text{and} \quad f(n+1) = \frac{1+f(n)}{1-f(n)} \quad \text{where } n \in \mathbb{Z}$$

What is the value of $f(2023)$?

(5)

- (b) Alice, Ben and Chad ran a race. They started at the same time with constant speeds. When Alice finished, Ben had 17 metres to run, and Chad had 37 metres to run. When Ben finished, Chad had 24 metres to run.

What was the length of the race?

[Hint: $Speed = \frac{Distance}{Time}$]

(6)
[11]

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.

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