

# KARAMBI SECONDARY SCHOOL

S.6 MID TERM 1 EXAM 2026

MATHEMATICS PAPER 1

TIME 3HOURS

## INSTRUCTIONS TO CANDIDATES:

- This paper consists of three sections; A,B and C. It has six examinations items.
  - Section A has three items. Answer one item only.
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- Section B has one compulsory item.
  - Section C has two parts; *part I* and *part II*. Answer one item from each part.
  - Answer a total of four items.
  - Any additional item(s) answered will not be scored.
  - All answers must be written in the answer booklets/sheets provided.
  - Graph paper is provided.
  - Silent non-programmable scientific calculators and mathematical tables with a list of formulae may be used.

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SECTION A	ITEM 1	
	ITEM 2	
SECTION B	ITEM 3	
SECTION C	ITEM 4	
	ITEM 5	
	ITEM 6	
	TOTAL	

## SECTION A

### ITEM 1

Alex wishes to divide his garden into three rectangular plots for vegetables, herbs and flowers whose areas are  $x$ ,  $y$  and  $z$  respectively. The total of the garden is 2 square units. To ensure a balanced design, the head gardener, Alex, decides on a specific relationship between the areas of the plots. The final plan must satisfy the following condition:

$\frac{x+2y}{3} = \frac{y+2z}{4} = \frac{2x+z}{5} = k$  where  $x$ ,  $y$  and  $z$  represent the areas (in square units) of the vegetable, herb and flower plots, respectively and  $k$  is a constant.

Once the plot areas are known, the project manager, Ben, needs to order soil and compost. The delivery cost is more efficient when a bulk order is placed. Ben analyzes the cost-efficiency of ordering from two different suppliers. He defines the cost-efficiency for a given order quantity  $x$  (in cubic meters) as the point where cost per unit from a supplier A  $\left(\frac{x+2}{x-3}\right)$  is less than or equal to cost per unit from suppliers B  $\left(\frac{x+5}{x-5}\right)$ .

Tasks:

- Form an equation that relates  $x$ ,  $y$ ,  $z$  with the total area of the garden. Hence solve the system of simultaneous equations given to find the areas  $x$ ,  $y$  and  $z$  of the three plots.
- Form the budget constraint (inequality) of the cost per unit relating the two suppliers hence solve this system of inequalities to find the range of order quantities  $x$  for which it is both efficient to choose Supplier A such that the budget constraint is satisfied.

### ITEM 2

A certain programmer uses special mathematical codes when developing his software, defined as;  $p = \log_3 x$  and  $q = \log_{18} x$ .

The URA intends to purchase this software but is uncertain about its effectiveness. The software is said to be effective if the following condition holds:  $\log_6 3 = \frac{q}{p-q}$ .

The authority also wants buy a large water storage tank to supply more water to its facilities through two distribution pipes. The rate at which the water flows out of the tank depends on the volume of the water available. After conducting measurements, the engineer modelled the rate of water flow,  $R(x)$  in litres per minute as  $R(x) = \frac{3x^2 - 7x + 6}{(x+1)(x-3)^2}$  the number of hours after pumping has begun.

The authority hired a quality controller to establish the effectiveness of the model by splitting it into partial fractions and establish whether a flow rate of at least 6 litres per minute will be achieved after 4 minutes.

Task: you have been contacted by the Authority to;

- Advise whether the URA should buy the software or not.
- Split the model into partial fractions
- Help the quality controller whether the model is effective or not after 4 minutes

## SECTION B

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$$3^p = x$$

✓  
**ITEM 3 :** A community is experiencing weak network signal. A telecom company plans to put up a mast to serve three towns, A, B and C whose map coordinates (in hectometers) are (1,1) and (7,1) and (1,9) respectively. The mast must be positioned equidistant from all the three towns. A dish will be mounted on a mast at a height,  $h$  (in hectometers) so that the signal to any of the town makes an angle of  $60^\circ$  with the horizontal.

The signals transmitted by the dish are modeled by  $s(\theta) = 12\cos\theta + 5\sin\theta$ , where  $\theta$  is the angle of the dish's inclination and  $s(\theta)$  is signal strength in the direction  $\theta$ . The company wishes to determine the mast location, suitable height, the maximum signal strength and the angle at which it occurs for proper planning.

The community well-wisher also plans to construct a community school along a path that connects all the three towns and keeps a constant distance from the mast to ensure steady network coverage.

The team that has to deal with the installation had to be chosen by verifying that expression below is true without use of computers.

Expression:  $\tan^{-1}\left(\frac{1}{2}\right) + \tan^{-1}\left(\frac{1}{5}\right) = \tan^{-1}\left(\frac{7}{9}\right)$

**Task:**

- Help the company to plan accordingly.
- Analyse the path that connects the three towns and advise the community well-wisher where to construct the school. Justify your reasoning.
- Given your part of team, verify the expression to enable your team do the installation

✓  
**SECTION C**

**ITEM 4**

You are an agricultural consultant, and a local farmer, Ms. Anya Sharma appreciates your expertise. She wants to create a new rectangular paddock for her livestock using a unique setup. A long, straight river borders her property, and she plans to use this natural boundary as one side of the paddock meaning she only needs to build a fence on the other three sides. Ms. Sharma has informed you that she has exactly 10 meters of electric fencing with available for this project.

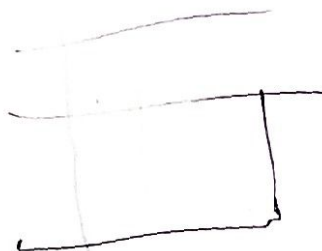
Your task is to determine the optimal dimensions for the paddock that will maximize the grazing area for her animals. By defining the variables:  $x$  meters as the length of each of the two sides perpendicular to the river,  $y$  meters as the length of the side parallel to the river and  $A$  as the total area of the rectangular tank for her rabbits to drink water.

The tank is to be made by cutting square corners out of a square piece of a stainless-steel sheet measuring 60cm by 60cm and folding up sides. She wants to know the maximum volume of water the tank can hold for better planning.

**Tasks:**

- Based on the 100 meters of available wiring, derive a formula that expresses the length  $y$  of the paddock in terms of  $x$ .  
 Use your answer to find a formula for the area ( $A$ ) of the paddock in terms of  $x$ . hence determine the exact dimensions that will maximize the area of the paddock hence find the maximum area.

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$R_{\text{side}}(\alpha)$

- b) Help Ms. Sharma to find the dimensions of the box that will maximize the volume hence, state the maximum volume of the tank.

### ITEM 5

You are a structural engineer designing a new pedestrian bridge. A crucial part of your design is the main supporting arch, which needs to be both pleasing and structurally sound. You have modelled the shape of one section of this arch using a mathematical equation.

The curve representing the bridge arch is given by the equation:  $y = x^3 - 4x^2 + 3x$

Where  $y$  represents the height of the arch (in meters) and  $x$  represents the horizontal distance from one end of the bridge (in meters).

For understanding the arch's overall shape, you need to identify the exact horizontal positions ( $x$ -values) and corresponding heights ( $y$ -values) where the arch reaches its **maximum or minimum points and distinguish between them**. Your employers seek to know the total area the arch is likely to occupy for proper procuring of the building materials.

To access the arch during construction, a straight, temporary ramp (tangent to the arch) needs to be built so that it just touches the arch at the point where the horizontal distance  $x = 2$  meters.

#### Task:

- Establish the maximum and minimum points of the arch and distinguish between them and sketch the arch.
- Find the area the arch is mostly likely to occupy.
- Determine the steepness (gradient) of the straight temporary access ramp and establish the full equation of this straight temporary access ramp.

### ITEM 6

A tech Company is organizing a 1-day innovation expo. Visitors enters a main hall where attendance varies throughout the day, and the organizes must booth arrangements and analyse crowd flow.

To manage congestion limits, the number of visitors in the expo mainhall is modelled as

$V(t) = 600 \tan^{-1}(0.4t^2 + 1)$  where  $t$  is the time in hours after opening

The rate at which visitors enter the hall (visitors per hours) given by  $R(t) = \frac{400t^3 - 60t^4}{t^2}$ . There

is need to know the total number visitors during the first 5 hours

The expo has **6 featured booths** where there 7 AI related startup and 8 social media related.

There is need to figure out the different ways arranging over two sessions.

**Session 1:** should have at least 4 social media startups

**Session 2:** either 3 AI startups or 5 AI startups

#### TASK:

- Find the instantaneous rate of change of visitors  $\frac{dv}{dt}$ . Hence evaluate the rate at  $t = 1$ .
- Use the definite integral to determine how many visitors come through the first five hours.
- Verify the number of ways of displaying the start ups during each session

END

$$\int_a^b y^2 dx$$

$$1 - 2 + 4 - 5 + 2$$