

S.5 PRINCIPAL MATHS SAMPLE ITEMS

TERM 1 2026

ITEM 1

A local environmental group in Jinja is studying the population growth of a specific fish species in a protected section of the Nile River. Their initial estimate in 2020 was 1,200 fish. They believe the population P after t years can be modelled by $P(t) = 1200 \times (1.15)^t$. However, another model proposed is based on logarithms; $\log_{10} P = \log_{10} 1200 + t \log_{10} 1.15$.

Tasks:

- Using the index model $(t) = 1200 \times (1.15)^t$, Calculate the predicted fish population in the year 2025.
- Using the logarithmic model, show that it is equivalent to the index model.
- The group wants to know when the fish population is predicted to reach 5,000. Using logarithms and the model $(t) = 1200 \times (1.15)^t$. Determine the approximate number of years (t) it will take.

ITEM 2

An economist is studying the relationship between investment I and national income Y . The relationship involves a complex function where a particular term is given by $h(Y) = \frac{Y^3 + 2Y^2 - Y + 5}{Y^2 + Y - 2}$.

Before proceeding with the economic analysis, the economist needs to simplify this expression.

Tasks:

Help the economist to:

- Identify $h(Y)$ as a proper or improper rational function. Justify your answer.
- Express $h(Y)$ as the sum of a polynomial and a proper rational function.
- Take the proper rational fraction part obtained in (b) and decompose it into its partial fractions.
- Combine the results from (b) and (c) to write the complete simplified expression for $h(Y)$.

ITEM 3

The remote village of Kijungu relies heavily on its local well for water due to climate change and increasing population, the well's water output is becoming very low, an engineer has developed a model to predict the well's daily water output in liters based on the factor x which accounts for drought conditions, increased demand and underground water table depletion, the model is given by the equation $2^{2x+1} + 2^{x+1} + 1 = 2^x$.

Task.

As a mathematics student help in identifying the stress factor x at which the well's water output meets the condition described by the above equation.

ITEM 4

A certain city is experiencing social challenges with two distinct population groups having different experiences of urban life, the city planners are trying to understand if there is a common problem affecting both groups, they are modelling the wellbeing of two groups using two separate quadratic equations. $x^2 + px + q = 0$ p represents access to social services and q represents employment opportunities.

and $x^2 + mx + k = 0$. The collective wellbeing is given by $\frac{q-k}{m-p}$, where m represents educational attainment and healthcare access, k represents safety quality. The social challenge exists if $(q - k)^2 = (m - p)(pk - mq)$.

Task.

As a data analyst identify whether the common social challenge exists or not.

ITEM 5

The city is facing a challenge in urban planning where by balancing economic development and preservation of green spaces, to model this relationship between economic development and preservation of the green space, the city planner comes up with a simplified system of logarithms with two indicators x and y , he believes that for optimal urban health, the indicators should satisfy the following two logarithmic relationships.

$$\log_{10} x - \log_{10} y = 1.0 \text{ and } \log_{10} x + \log_{10} y = \log_{10} 2.5$$

Task

Use the above system of simultaneous equations to obtain the indicators of sustainability economic development

ITEM 6

A treasure map uses a coordinate grid to help adventures locate hidden treasures in Kassanda district. The grid is labelled with coordinates (x, y) where each point represents a specific location. Two equations are used for safety of the treasures but the travelers have no knowledge of how to identify the coordinates. These equations are $5^{x+2} + 7^{y+1} = 3468$ and $7^y = 5^x - 76$ Task Help them to identify the location of the treasures.

ITEM 7

Your class teacher loses her phone after being stolen by thugs while coming to school. He decides to go to police so that the phone can be tracked using GPS coordinates. The phone's location at different times is recorded and the police are trying to find its movement pattern. The tracking device uses a logical operation given simultaneously as $2^x + 3^y = 5$ and $2^{x+3} - 3^{y+2} = 23$. When they got so close to the phone, they could not tell the coordinates to locate the phone with ease. The coordinates are in meters and one point gives the position of those with the tracking device, the other point gives the position of those with the phone.

Task

- (a) Help them find the coordinates.
- (b) How far is the phone from the police tracking it?

ITEM 8

In certain foreign exchange market model, there two possibilities, either a profit or a loss at any given time, one of the analysts has been tasked to work out the parameter for positive return on investment by solving $\frac{x+3}{x-2} > \frac{x+1}{x-3}$, with x representing risks.

Looking at the future investments in A.I a model for the industry was develop as a whole fraction. As shown $\frac{3x^2+2x+3}{(x+1)(x^2+3)}$. With its possible parts representing market share for USA and China

Task: Help the analyst to:

- (i) Find the regions of pure risk
- (ii) Identify the partials that represent market share.

ITEM 9

As part of preparation for African Olympiad mathematicians' program one student has come to an S5 principal mathematics student to help solve the following questions for his showing him all relevant steps

Question 1: solve $8^{x-y} = 4^{x+y}$ and $5^{x^2-y^2} = 15625$

Question 2: Show that $\log_5 21 = \frac{1}{2b}(2ab - 2b + a)$ if $a = \log_5 35$ and $b = \log_9 35$

Task: Help the show how this can be solved

ITEM 10

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Tasks:

- Using the index model $(t) = 1200 \times (1.15)^t$, calculate the predicted fish population in the year 2025.
- Using the logarithmic model, show that it is equivalent to the index model. c)
- The group wants to know when the fish population is predicted to reach 5,000. Using logarithms and the model $(t) = 1200 \times (1.15)^t$, determine the approximate number of years (t) it will take.

ITEM 11

An electrical engineering student at Makerere University is analysing a signal whose behaviour

over time x is related to the function $g(x) = \frac{2x^2+x-1}{x(x-1)^2}$. This expression needs to be broken down

for further analysis.

Tasks:

- Set up the appropriate form for the partial fraction decomposition of (x) .
- Determine the values of the unknown constants in the partial fraction decomposition.
- Write the final partial fraction decomposition of (x) .

ITEM 12

An economist is studying the relationship between investment I and national income Y. The relationship involves a complex function where a particular term is given by $h(Y) = \frac{Y^3 + 2Y^2 - Y + 5}{Y^2 + Y - 2}$. Before proceeding with the economic analysis, the economist needs to simplify this expression.

Tasks:

Help the economist to;

- a) Identify $h(Y)$ as a proper or improper rational function. Justify your answer.
- b) express $h(Y)$ as the sum of a polynomial and a proper rational fraction.
- c) Take the proper rational fraction part obtained in b) and decompose it into its partial fractions.
- d) Combine the results from b) and c) to write the complete simplified expression for $h(Y)$.

ITEM 13

A cooperative society of farmers in Luwero recorded the cassava yield (in tonnes per hectare) from 50 small plots. The data is grouped as follows:

Yield (Tonnes/Hectare)	Number of Plots (Frequency)
5 - < 10	6
10 - < 15	10
15 - < 20	15
20 - < 25	11
25 - < 35	8

Tasks:

- a) Construct a histogram to represent this data.
- b) Using the histogram, estimate the modal yield of cassava per hectare.
- c) Calculate an estimate of the mean yield and the standard deviation of the yield for these plots.

ITEM 14

The scores of 80 Senior Five students in a Mathematics mock exam at a school in Arua are summarised in the following cumulative frequency table:

Score (x)	Cumulative Frequency
$x \leq 20$	5
$x \leq 30$	15
$x \leq 40$	35
$x \leq 50$	55
$x \leq 60$	70
$x \leq 70$	77
$x \leq 80$	80

Tasks:

- a) Represent the data on a cumulative frequency curve (ogive) to represent this data and use it to estimate:
 - i) The median score.
 - ii) The interquartile range of the scores.
 - iii) The 80th percentile score.
- b) If the pass mark was set at 45 marks, estimate from your ogive the number of students who passed the exam.
- c) Explain what the interquartile range tells you about the spread of the students' scores.

ITEM 15

A veterinary officer recorded the weights of animals brought to a community clinic over one month. The animals were grouped by weight, and the number in each group was recorded as shown below:

Mass (kg)	21–25	26–30	31–35	36–40	41–50	51–65	66–75
Frequency	10	20	15	10	30	45	5

Task:

- (a) Help the veterinary officer to represent the data on a histogram and use it to estimate the mass with the highest number of animals.
- (b) Determine the median for the above data

ITEM 16

A local health clinic is conducting a study on the prevalence of obesity and malnutrition in a community. As part of their assessment, they measured the masses (in kilograms) of 40 individuals randomly selected from the community. The data collected is as follows:

46 52 62 55 61 48 57 46 70 60 54 49
47 52 48 52 60 55 50 53 64 54 54 53 57
58 51 64 56 61 52 58 41 59 57 44 51
58 68 65

The clinic is particularly concerned about identifying mass ranges that might indicate a higher risk of health issues within the community.

Task.

Help the clinic to:

- (a) Construct a frequency distribution table with equal class intervals, beginning with the 41-45 kg class.
- (b) Determine the expected mass.
- (c) calculate the standard deviation of the above given information
- (c) using an appropriate diagram, determine
 - (i) the number of individuals above 50kg mass.
 - (ii) the middle 40th percentile.