P425/1

Mathematics

Paper 1

Jul/Aug. 2026

3 hours

WEST NILE SECONDARY SCHOOLS EXAMINATION COUNCIL

(WENSSEC)

Uganda Advanced Certificate of Education

PRINCIPAL MATHEMATICS

PAPER 1

3 HOURS

INSTRUCTION TO CANDIDATES

This paper consists of two sections A and B. It has five (5) examination items.

*Section A has only **one** item and it is compulsory.*

*Section **B** has **two parts**, part (i) and part (ii). Each part has **two** items, respond to only **one** item from each part.*

*Respond to **three (3)** items in all.*

*Any additional item (s) responded to will **not** be scored.*

*All answers **must** be written in the booklets or sheets provided.*

*All necessary workings **must** be shown clearly*

Graph paper is provided therefore graph work must be done in a graph paper.

Begin each item on a fresh page

Silent non- programmable scientific calculator and mathematical tables with a list of formulae may be used.

Turn Over

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SECTION A

The item in this section is compulsory

Item 1

A technology company in Kampala City Innovation Mathematics Club is designing drone- navigation and signal- processing system for agricultural monitoring. Two drones were launched and their movement from the control station is represented by the vectors. They were launched using different routes and at one point they are supposed to meet. One of the drones took the route described by the vector equation $r_1 = \lambda\begin{pmatrix}1\\-3\\4\end{pmatrix} + \mu\begin{pmatrix}-1\\-3\\1\end{pmatrix}$, while the other drone took the route described by equation $r_2 = \lambda\begin{pmatrix}0\\-2\\5\end{pmatrix} + \mu\begin{pmatrix}1\\-2\\-1\end{pmatrix}$. The controller is not sure where the two drones will meet and the angle between the two routes if they are to meet. The same company were asked to designed a rotating spotlight to shine on the students performing during their cultural galas as they move on stage. They discovered that the brightness of the light at any instant depends on the angle of rotation. From the design notes, students observed that when the rotation angle is A (where A is acute angle), the brightness after three rotations can be expressed as $sin3A = 3sinA - 4sin^3A$. Before presenting their project to the judges, the company were task to confirm that this rotation is mathematically correct and to determine the value of A when $3cosA - 4sinA = 5$ but lack idea on how to confirm it. The same company plans to install a modern signal transmission system in a newly developed city. The engineers in the company decide to use different mathematical models to design the system efficiently. At the Centre of the city, a circular recreational park is constructed such that its boundary is represented by the equation $x^2 + y^2 - 8x + 6y - 11 = 0$. Far away from the city, an elliptical racing track is constructed for testing autonomous vehicles. The track has equation

$$\frac{x^2}{25} + \frac{y^2}{9} = 1.$$

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Task

(a) Help the controller out of the challenge.

(b) As a student of pure mathematics, help the company clearly verify that the two equations are equal and to find the value of A.

(c) Help the company determine the Centre and radius of the circular park and determine the eccentricity of the ellipse.

SECTION B

*Answer any **two** items from this section, choosing **one** item from each of the parts I and II*

Part I

Item 2

Company wants to install two signal boosters to improve communication between fishing boats and the mainland along Lake Albert in Panyimur. One emergency signal beacon was located at the complex point $z = x + iy$, where x and y are real numbers. The engineers discovered that the beacon always satisfied the condition $|z - (3 + 2i)| = 5$, meaning that the beacon remained at a constant distance from the relay station located at $3 + 2i$. Technicians in the same company were investigating the performance of an automated glaze- mixing and delivery system used during porcelain tile production. The rate at which a liquid glaze moved through one section of the pipe network was modeled by the rational function, $G(t) = \frac{5t+9}{(t-2)(t^2+3t+4)}$ where t represents time in minutes and $G(t)$ represents the flow rate in litres per minute. To simplify the model for analysis, the engineering students working in the company were asked to express the function into partial fractions in the form $\frac{5t+9}{(t-2)(t^2+3t+4)} = \frac{A}{t-2} + \frac{Bt+C}{(t^2+3t+4)}$. As the

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students were calibrating the machine for modeling the tiles, they discovered that three operating parameters x, y *and* z satisfies the equations

$$2x + y - z = 7$$
$$x - 3y + 2z = -4$$
$$3x + 2y + z = 12$$

The laboratory supervisor in the company requested the students to analyze both mathematical models before the machine could be approved for use.

Task

(a) Interpret geometrically the locus represented by $|z - (3 + 2i)| = 5$ and determine its centre and radius, hence sketch the locus.

(b) Express $G(t)$ into partial fraction and hence determine the valve of $G(1)$.

(c) Solve the simultaneous equations to determine x, y *and* z.

Item 3

A technology company designs a data storage system in which the amount of the data processed in the nth cycle is modeled by the polynomial $f(x) = x^3 + ax^2 + bx + 2$ such that when f(x) is divided by $x - 1$, the remainder is 4 and when divided by $x + 2$, the remainder is also 4.

The company also observed that the total amount of data processed after n cycles follow the sequence 5,10, 20…so that it can gives a sum greater than 500,000.

To estimate the future storage requirements, engineers use the expansion of $\sqrt{\frac{1+x}{1-x}}$ in ascending powers of x to the terms in x^2 and use the expansion $(1 + x)^{\frac{1}{2}}$ up to the terms in x^3 to find the value of $\sqrt{1.08}$ to 4 decimal places.

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Task

(a) Find the values of a *and* b.

(b) Help the company to find the smallest number of terms of the geometrical progression.

(c) Help the engineers to expand what is before them and use the information appropriately.

Part II

Item 4

At a carpentry workshop in Ombaci, decorative wooden panel is being designed for the reception area of the hotel. The edge of the panel is shaped using computer controlled cutting machine following a mathematical model $y = x^3 - x^2 - 5x + 6$. The designer wants to identify the exact point where the curve changes direction in order to smoothen sharp bends and ensure structural stability. The same carpenter also deals in metal fabrication and were instructed to design arch frame for advertising board at the roadside sign- post workshop in Ediofe Trading Centre. To ensure accuracy before cutting the metal sheets, the shape of the upper edge is first modelled using mathematical curves on the coordinate grid. The arc is modelled by $y = x^2 + 4x + 3$ and the fabricators needs clear sketch of the curve in order to identify the key features before fabrication begins.

Task

As a mathematics student,

(a) Help the designers to find the coordinates of the turning points and distinguish its nature.

(b) Help the fabricator to sketch the above curve, clearly showing all important features.

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Item 5

In a certain village, Agricultural extension officer carried out research to investigate the effect of a certain chemical on a virus infection crops. The research revealed that the rate at which the virus population is destroyed by the chemical is directly proportional to the population of the virus at that time. Initially, the population was p_0, but at t months later, it was found to be p. In his research, the extension officer wanted to know how long it will take for only 5% of the original population of the virus to remain but lack interpretation skills. The extension officer was also tasked to find the particular solution of the differential equation $x\frac{dy}{dx} + 3y = 5x^2$ at $y(1) = 3$ but express no idea on how to solve it.

Task

You have been contacted to help the Agricultural extension officer to have proper interpretation of the data obtained;

(a) Form a differential equation connecting p and t.

(b) Given that the virus population reduced to one third of the initial population in four (4) months, solve the equation in (a) above.

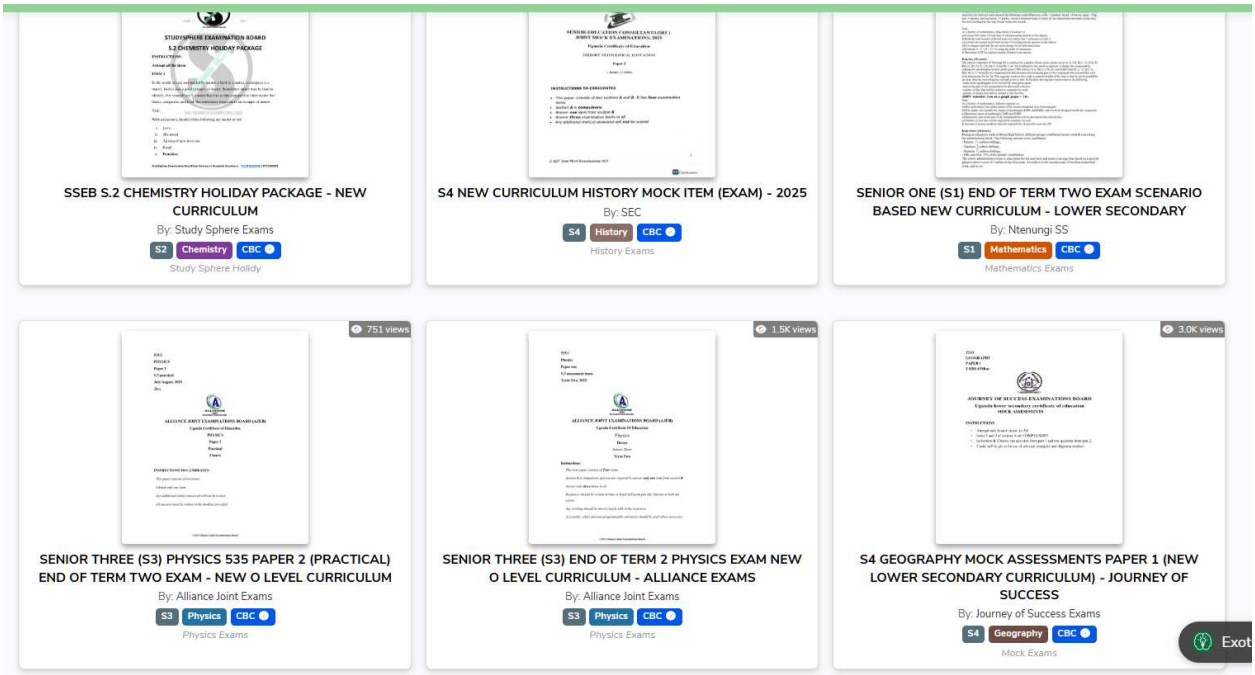
(c) Find how long it will take for only 5% of the original population to remain.

(d) Help the extension officer solve the equation.

END

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