P425/1
PRINCIPAL
MATHEMATICS
Paper 2
2026

3 hours

INTERNAL MOCK EXAMINATIONS 2026 SET 2

Uganda Advanced Certificate of Education

PRINCIPAL MATHEMATICS

Paper 2

3 hours

INSTRUCTIONS TO CANDIDATES

This examination paper consists of **two** *sections;* **A** *and* **B**. *It has* **five** *examination items.*

Section **A** *consists of* **one compulsory** *item.*

Section **B** *has two parts,* **I** *and* **II** *each with two optional items. Respond to only* **two** *items from Section* **B**, *choosing one item from* **each** *of the parts,* **I** *and* **II**.

Respond to **three** *items* **in all**.

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

Begin each item on a fresh page.

All *necessary working* **must** *be shown clearly.*

Graph paper is provided.

Where necessary, use $g = 9.8\, ms^{-2}$

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

SECTION A

The item in this section is **compulsory**.

Item 1

The Ministry of Fisheries intends to establish a commercial fish farming project in a natural water body. Before approving the project, surveyors measured the depths of the water body at equal intervals of $5\ m$ across the proposed site, as shown in the figure below, in order to estimate its cross-sectional area.

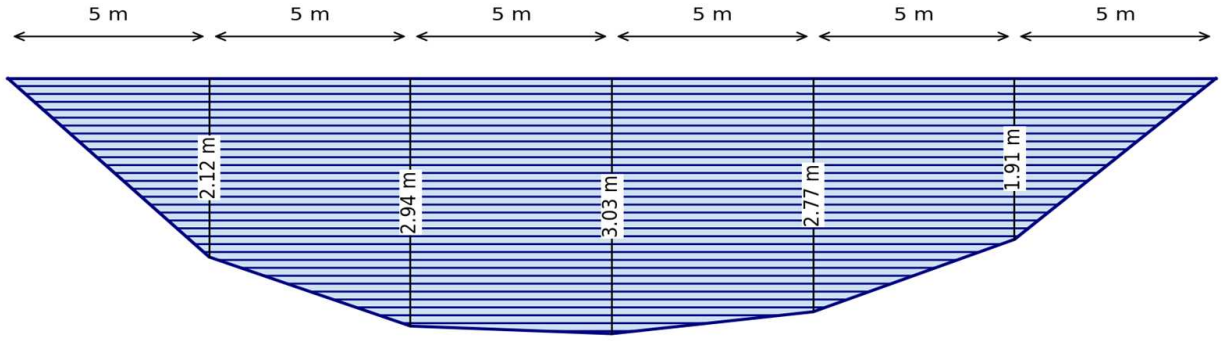


Figure 1: Cross-section of the proposed fish farming site (depths measured at $5\ m$ *intervals)*

The Engineering Department has recommended the site for commercial fish farming on condition that the estimated cross-sectional area of the water body is at least $62.85\ m^2$, the minimum area required for the project's accommodation requirements.

To accommodate workers at the project site, the Ministry has surveyed a rectangular piece of land measuring $123.65\ m$ in length rounded to two decimal places and $96.774\ m$ in width rounded to three decimal places. Each accommodation tent, including the required clearance around it, occupies a rectangular space measuring 4.50 m by $6.85\ m$, both rounded off to two decimal places. The Ministry will only proceed with the purchase if the land's minimum and maximum number of tents it can support falls strictly within the target range of 390 to 400 tents.

To maintain fish health, a solar-powered water oxygenation pump regulates a flow control valve. The valve's stable operating angle, x (measured in radians), is determined by the balance between the water pressure line, $y = 5x$, and the solar energy curve, $y = 3cos(2x)$, over the interval $[0, 1]$. An equilibrium point exists where these two forces balance, described by the equation: $5x - 3cos(2x) = 0$. To find the precise angle at the equilibrium point, the two functions must be graphed to determine an initial estimate, x_o. The Newton-Raphson iterative method is then used to find a better equilibrium point angle (root) until it stabilizes to 3 decimal places. If the angle x reaches 0.50 radians or more, the system will trigger a high-pressure warning, requiring an expensive structural reinforcement upgrade for the farm.

Task:

Using mathematical evidence, help to determine whether the:

a) commercial fish farming project should established.
b) Ministry should proceed with the purchase if the land.
c) system will trigger a high-pressure warning.

SECTION B:

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

PART I

Item 2

A Mathematics teacher in a certain secondary school stays some distance from school and usually comes to school by either road A or road B. Road A is shorter but often becomes busy in the morning, while road B is longer but usually has smoother traffic. From his past movement records, the probability that he uses road A is 0.25. The probability that he arrives late when he uses road A is 0.60, while the probability that he arrives late when he uses road B is 0.30. The teacher is responsible for opening the examination room and arranging answer booklets before the Mathematics test starts. Since the teacher commonly uses road B. the Head of Department will call one of the resident teachers to intervene if the probability that he uses this road, given that he arrives late, is greater than 0.50.

After the test, the Head of Department reviewed the performance of the 100 students in Senior Six Principal Mathematics class. The results were recorded as cumulative frequencies as shown below.

Marks	Number of students
< 30	2
< 45	8
< 50	24
< 60	50
< 70	76
< 80	92
< 85	98
< 100	100

Since the school is preparing candidates for national examinations, Mathematics consultation forms will be introduced if the standard deviation is greater than 12.98 marks and weekend individual coaching program will be implemented if the interquartile range is wider than 22 marks.

The Director of studies (DOS) needs to decide whether to host holiday Zoom revision sessions based on a recent examination. Historically, points scored by all senior six students follow a normal distribution with a mean of 11 points and a standard deviation of 3.5 points. To justify the budget for Zoom sessions to the school board, the DOS analyzes a random sample of 65 senior six students. The board approves the holiday Zoom sessions only if the probability of the sample mean falling between 10.9 and 11.2 points exceeds 30%. Otherwise, students receive self-study packets.

Task

As an assistant data analyst for the school, use your mathematical knowledge to help the school management make data-driven decisions.

Item 3

Joseph operates a busy maize milling machine in Kampala. The daily amount of diesel X (in litres) used by the generator varies depending on load shedding and the number of customers bringing maize. The daily fuel consumption is a continuous random variable with a probability density function given by:

$$f(x) = \begin{cases} \frac{3}{32}x(4-x) & 0 \le x \le 2 \\ \frac{1}{7}(x+1) & 2 \le x \le 3 \\ 0, & otherwise \end{cases}$$

Joseph wants to track hidden costs. If the standard deviation of daily fuel use is greater than $0.7\ litres$, he will buy a digital fuel monitor.

To pay for the diesel, Joseph relies on customers paying digitally. Because of network failures in his town, the likelihood that a customer successfully completes a Mobile Money transaction is 0.80. On a typical morning, a batch of 12 wholesale customers queue up to pay for their milled flour. Joseph can only afford the fuel if the chance that between 5 and 10 inclusive customers pay successfully is greater than 70% .

Joseph buys raw maize in bulk from farmers. The weights of maize packed in sacks are known to be normally distributed. To ensure he is getting the right amount of stock, he takes a random sample of 40 sacks from the latest truck delivery. The sample yields a total weight of $\sum x_i = 2000\ kg$ and a sum of squared weights of $\sum x_i^2 = 100{,}585\ kg^2$. Joseph wants to set an accurate pricing model based on a 95% confidence interval for the true mean weight of a maize sack. If the lower boundary of the interval is below $49\ kg$, he will change his suppliers.

Task
With clear Mathematical evidence, solve the three challenges faced by Joseph and help him to make decisions.

PART II

Item 4

The Uganda National Roads Authority (UNRA) is testing a towing vehicle that will be used to transport construction materials to a road project located on a steep hillside. Before the towing system is deployed, engineers must verify that it can safely pull a fully loaded trailer up the access road. A trailer of mass $600\ kg$ is connected to a car of mass $1500\ kg$ by a light rigid tow bar. The car moves up the line of greatest slope of a road inclined at an angle θ to the horizontal, where $\sin\theta = \frac{7}{25}$, as shown in the figure below.

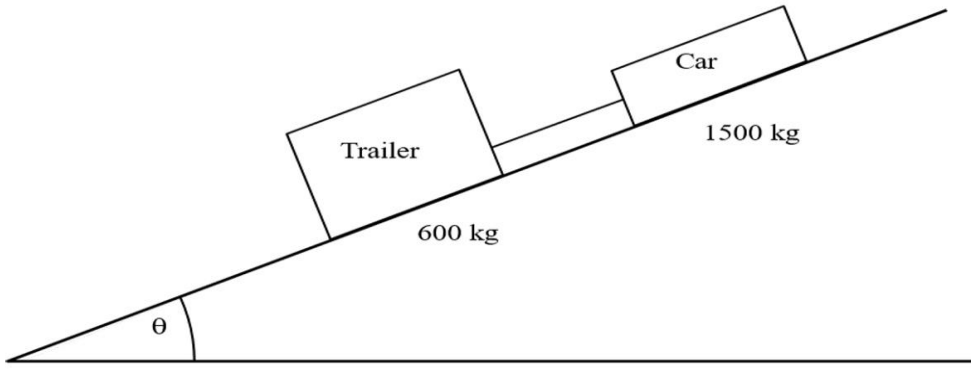


Figure 2: Car–trailer system connected by a rigid tow bar, moving up an incline of angle θ

A constant resistance of $400\ N$ acts on the car, while a constant resistance of $300\ N$ acts on the trailer. The engine of the car produces a constant driving force of $8400\ N$. According to the Project Engineer, the proposed towing system is suitable for transporting construction materials provided that the tension in the tow bar does not exceed $2600\ N$. The Executive Director requires evidence to verify the Project Engineer's recommendation before approving the towing system for use at the construction site.

To safely deliver emergency materials across the steep hillside, UNRA engineers are evaluating a projectile delivery system. A supply package is launched from a raised construction platform $4.9\ m$ above the ground. The package leaves the platform with a speed of $49\ ms^{-1}$ at an angle of elevation 15^0, aiming for a landing zone at point B. The trajectory of the package is modeled as a particle moving freely under gravity, neglecting air resistance. The Project Engineer will approve this delivery technique if it meets the following safety criteria:

- The total flight time of the package does not exceed $2.2\ s$.
- The maximum height reached by the package does not exceed $22\ m$ above the ground.
- The package lands directly within a target landing zone at point B within a horizontal distance range of $100\ m\ to\ 105\ m$.

To inspect the construction site, an inspection team must travel from regional headquarters (Point A) to an airstrip (Point B), located $500\ km$ away from point A at a bearing of 060^0. A chartered aircraft with an air speed of $200\ km^{-1}$ is to be used. Meteorological reports indicate a steady wind of $40\ km^{-1}$ blowing directly from the west. The flight must depart at exactly $2{:}00\ PM$. The destination airstrip has a strict closing time of exactly $4{:}30PM$, after which no landings are permitted. According to the operations mandate, the inspection team's mission is authorized to proceed only if: the calculated flight time ensures the aircraft arrives and lands before the airstrip's closing deadline.

Task
Critically analyze three distinct engineering challenges for the Uganda National Roads Authority (UNRA) and justify all operational decisions using rigorous mathematical evidence.

Item 5

An aquaculture project on Lake Victoria uses a floating rectangular cage, $\boldsymbol{ABCD}$, submerged near the harbor. The cage measures $12\ m$ along sides $\boldsymbol{AB}$ and $\boldsymbol{CD}$, and $5\ m$ along sides $\boldsymbol{BC}$ and $\boldsymbol{DA}$. To secure the cage against strong lake currents, six underwater forces act simultaneously along its boundaries and diagonal cross-cables. These forces are: $80\ N$ along side $\boldsymbol{AB}$, $60\ N$ along side $\boldsymbol{BC}$, 40 N along side $\boldsymbol{CD}$, $20\ N$ along side $\boldsymbol{DA}$, $130\ N$ along diagonal $\boldsymbol{AC}$, and $65\ N$ along diagonal $\boldsymbol{BD}$. To prevent the net from tearing, the station supervisor needs to determine the net resultant force acting on the cage structure, the current setup will only be maintained if the magnitude of the net resultant force is less than $155\ N$ and its direction angle is between 45^0 and 50^0; otherwise, an emergency anchor must be deployed.

To protect the cage from further underwater current damage, a large overhead rope-and-pulley system is installed directly above the water. This frictionless pulley system is designed to raise the cage closer to the surface or lower it deeper by adjusting weights on the opposite end. Currently, the weight of the rectangular cage and the water resistance sum to $500\ N$ on one side of the pulley, counterbalanced by a heavy $60\ kg$ concrete weight block on the other side. Initially, the system is held stationary with both the cage and the weight block suspended exactly $30\ cm$ above the lake bottom. The supervisor releases the system from rest, allowing the heavier weight block to fall and pull the cage upward towards the surface. Once the weight block hits the lake bottom, the rope goes slack, but the cage will continue moving upward due to inertia. Directly above the rising cage is a rigid steel docking point located exactly $35\ cm$ above the cage's initial starting position. The supervisor needs to determine if the docking point is safe and will not be hit by the cage.

With the cage positioning assessed, a heavy storm rapidly brews over Lake Victoria near Entebbe, and the supervisor and his crew needs to leave the site immediately on a small motorboat. Before navigating back to the mainland, they must determine the true velocity of the wind to ensure a safe crossing. The supervisor's motorboat moves at $12\ kmh^{-1}$ in the direction $S30^0W$, and his crew observes the wind appearing to blow from

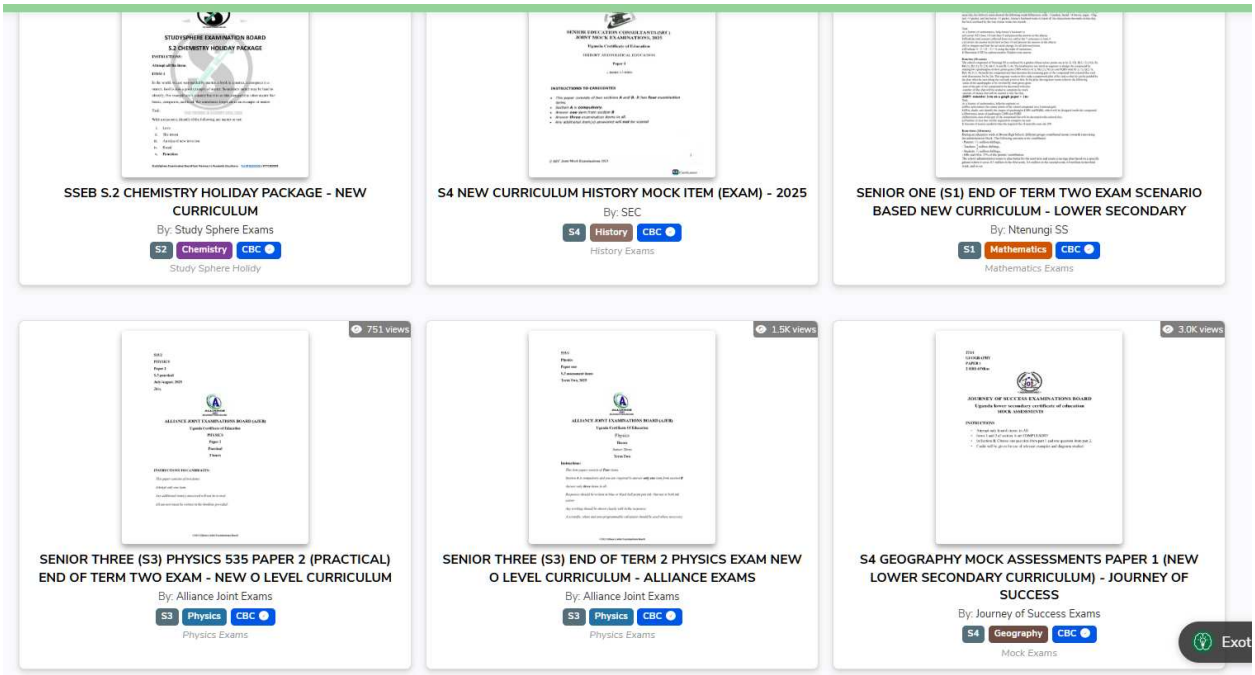
$N60^0W$. Meanwhile, a nearby Passenger Ferry navigating the same waters is moving at $15\ kmh^{-1}$ in the direction $S80^0E$, and its captain observes the wind appearing to blow directly from the North. Ministry of Water and Transport safety guidelines state that small fishing vessels must immediately return to the landing site if the true wind speed exceeds $25\ kmh^{-1}$.

Task:
As a student of Mathematics, assist the supervisor to determine whether:

a) they need to deploy the emergency anchor.
b) the cage will collide with and damage the rigid steel docking point, and decide whether this lifting operation is safe.
c) the fishing trawler must immediately return to the landing site or if it is safe to continue the journey.

END

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