P425/2
PRINCIPAL
MATHEMATICS
Paper 2
2026
3 hours

UGANDA NATIONAL EXAMINATIONS BOARD
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 $g = 9.8ms^{-2}$.

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

 Turn Over

SECTION A

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

Item 1

A District Headquarter does not have sufficient water supply and the District Council has resolved to obtain additional water from one of the rivers that is exactly 20m wide. The District Council has tasked the District Water Engineer to install a pump for pumping water from the river to the district headquarters.
To do this, the engineer has modeled the river's depth $H(x)$ in metres using the function;

$H(x) = 12 - 0.12(x-10)^2 ; 0 \le x \le 20$, where x is the distance from the river bank.
For the pump to work efficiently, it requires a minimum cross-sectional area of the river to be 145m^2, and according to the engineer the model conforms to that area.

The engineer has also informed the council that when he takes measurements at exactly 5m intervals from the river bank and uses the **approximate** method, he can easily prove that his model satisfies the condition of the minimum cross-sectional area required to install the pump.
He can also prove that his model satisfies the condition of the minimum cross-sectional area required to install the pump using the **exact** method.

According to the engineer, the base of the water pump requires a depth $H(x) =$ 8m and the engineer has assured the council that using a distance of 4m from the river bank as an initial approximation, he can easily determine the least distance and hence the suitable position with the depth required for a suitable installation of the pump with a tolerance error not exceeding 0.1m, for the pump to be stable.

However, the district council needs proof that using the two methods, the model yields the minimum area required, to inform decision about installation of the pump. The council also needs to know exactly how far from the bank, the pump shall be installed.

Task:
(a) Provide the proof needed by the council.
(b) Investigate and Inform the council, the exact position from the river bank, to install the pump.

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 teachers' association of a certain district conducted a physics examination. The association used a sample of 85 students to guide in the analysis of the students' performance.
The distribution of the scores is shown in the table below.

Scores (%)	**No. of students**
5- < 30	17
30- < 40	21
40- < 50	30
50- < 60	14
60- < 80	3

Basing on the association's standards, the performance is considered good when both the average mark and dominant mark are at least 45%, and the examination is considered reliable when the standard deviation is at most 10%.
The association would like to know if the performance was good or not and also establish the reliability of the examination.
In the whole district, 500 students sat for the physics examination and their scores were approximately normally distributed.
The officer in charge of physics is challenged with providing the analysis of all the results that include determining the:

(i) Cut off marks for a distinction and a fail basing on the condition that the top 15% of the students score a distinction and bottom 20% fail.
(ii) Number of students who passed the examination and those who got a distinction.
(iii) Range within which the average mark of all the students who sat the examination lies basing on 95% degree of confidence.

Task:

(a) Based on calculated results, report about;
  (i) The performance of students in physics.
  (ii) The reliability of the examination.

(b) Address the challenges of the officer in charge of physics.

Item 3

A District Education Officer (DEO) is monitoring the utilisation of sciences laboratories in his district. On visiting one of the schools that has both O and A-Level students, he has found out that the probability a student utilised a Physics, Chemistry and Biology laboratory is 0.3, 0.5 and 0.2 respectively.
The DEO has also discovered that the probability that a student is in A-Level given that he/she utilised a Physics, Chemistry and Biology laboratory is 0.65, 0.85 and 0.5 respectively.

The DEO wants to make a recommendation to the district council for construction of new laboratories if the proportion of students who utilised the Chemistry laboratory given that they are A-Level students exceeds 0.5 and the expected number of laboratories uutilised is 2.

Furthermore, the DEO has sampled 10 students from the school and would wish to establish the proportion of at least half of the number of students who utilised the Chemistry laboratory. If the proportion exceeds 70% then more equipment will be supplied.

Task:
Assist the DEO to;
(a) Make an informed recommendation to the district council about construction of new laboratories.
(b) Decide on the supply of equipment.

PART II.

Item 4

A construction company has been contracted to renovate a building in town.

To lift heavy crates to the service deck, the company's technical team has set up a pulley system, shown in **figure.1**, consisting of a light in-extensible cable attached to a ceiling beam.

The cable loops under a smooth movable pulley which holds a counter weight of 50kg and then runs over a smooth fixed pulley mounted on a service deck. A crate of 20kg to be moved to the deck is attached to the other end of the cable.

The cable sections remain in the vertical plane during operation.

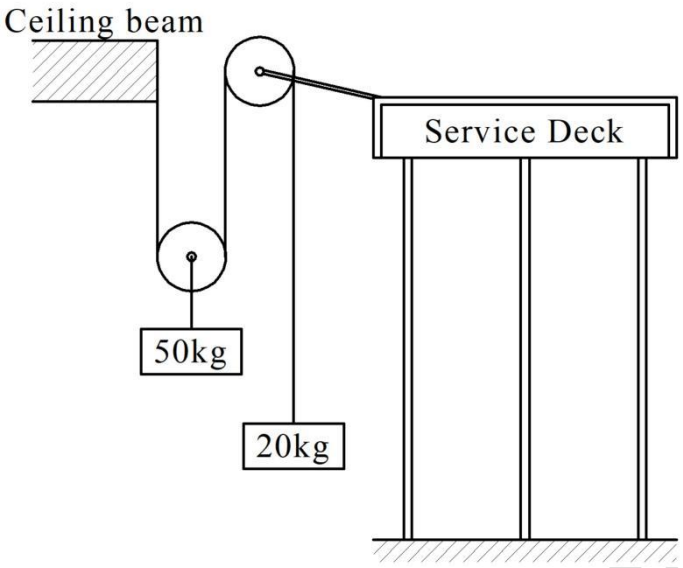

Fig.1

The system is currently held at rest but the engineer is about to release it.
For the safety of passersby, the engineer has set a safe ground zone of 5m from the service desk in case of any falling debris.
However, according to the engineering team the system must meet the following requirements before a system run is made:

i) For safety and stability, the acceleration should not exceed $2ms^{-2}$.
ii) The cable is designed to handle a maximum tension of 300N as a safety rating.
iii) If the system is released from rest, the team needs to know how far the movable pulley will travel after 5 seconds.

Immediately after setting the system, their tool box slides off the service deck horizontally at a speed of $2ms^{-1}$, falling from a height of 20m above the ground thus creating fear among the engineering team about the safety of the passersby near the site.

Task:

(a) Investigate whether the system will meet the requirements needed before the system run is made and provide an informed decision.

(b) Assess the safety of the passersby near the site.

Item 5

During a leavers' party, members of the organising committee want to move a box of decorations and a container of soda along two levels of a storeyed building using a pulley system.
The box is of mass 300kg and rests on a rough horizontal level with coefficient of friction being 0.3 while the container is 500kg and sits on a rough plane inclined at 30^{o} to the horizontal with coefficient of friction 0.1 as shown in **figure.2.**

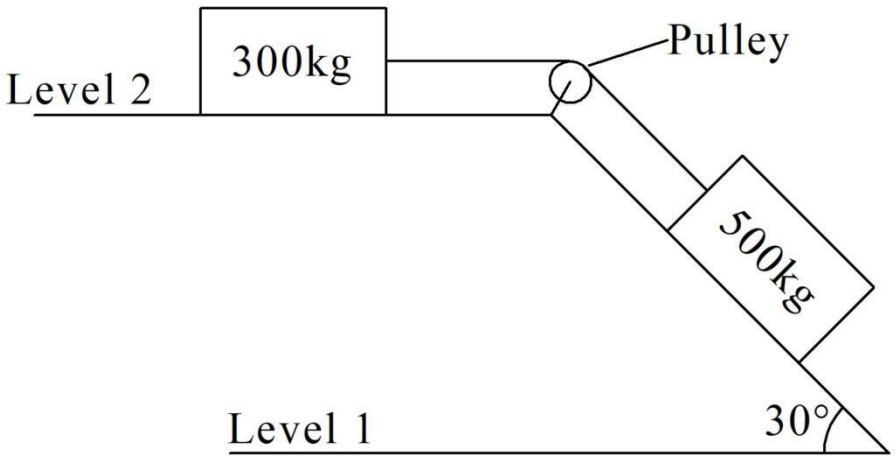

Fig.2

If the container is to be successfully lowered to level 1 without breaking the bottles of soda, its speed after 3s should not exceed $5ms^{-1}$and the magnitude of the reaction at the pulley should be at most 700N.

Task:

Determine whether the container will be delivered safely when the system is released from rest.

END