

**SAMPLE PAPER UACE
PRINCIPAL MATHEMATICS PAPER 2, SET 1
Time: 2HOURS AND 15 MINUTES**

INSTRUCTIONS TO CANDIDATES:

- *This paper consists of **two** sections; **A** and **B**. It has four examinations items.*
- *Sections **A** and **B** have two items each. Answer at least one item from each section*
- *Answer a total of **three** 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	
	ITEM 4	
	TOTAL	

SECTION A

ITEM 1

A non-governmental organisation (NGO), has been running a farmer support program in Masaka district aimed at improving coffee yields. They assume that increased fertilizer application leads to higher coffee production. To evaluate this, a random sample of 20 household farmers who participated in this program were interviewed, each using a different amount of fertilizer. For each farmer, they recorded the total fertilizer applied (in kg/acre) and their average coffee yield in bags per acre for the most recent harvest.

The NGO has set the following criteria for future action:

- **Support Plan:** If the assumption is true, the NGO will support the farmers with more fertilizers.
- **Expansion Condition:** The NGO plans to expand its program to a new group only if the chance of finding at least 4 selected farmers achieving a yield of 30 bags or more per acre is greater than 0.54.
- **Program Success Criterion:** The overall program is considered a success if the range of the middle 60% of the coffee yield data is less than 25 bags.

Farmer ID	Fertilizer Application (kg/acre)	Coffee yield (bags per acre)
1	10	15
2	25	30
3	15	18
4	30	35
5	20	25
6	5	12
7	35	40
8	12	16
9	28	32
10	18	20
11	40	45
12	8	14
13	22	28
14	32	38
15	17	22
16	29	34
17	11	17
18	38	42
19	6	13
20	55	48

You have been selected to take part in the analysis of the data above.

Help the NGO to;

- a) Ascertain whether it will support farmers with more fertilisers.
- b) Propose a framework for deciding whether to expand the programme. Based on this framework, what would your recommendation be?
- c) Determine whether the programme is a success and propose strategic recommendations for program enhancement. (hint use groups of 10 from the smallest coffee yield).

ITEM 2

The Ugandan Ministry of Health (MoH) is simultaneously managing two urgent public health issues that strain the national budget and healthcare resources: a community malaria outbreak and a high rate of Road Traffic Injuries (RTIs) on the Kampala northern by pass.

During a malaria outbreak, the MoH needs to treat children. Due to a financial constraint, the Ministry can only afford to purchase one of the two World Health Organization (WHO) recommended treatments.

The recommended drugs are Chloroquine (C) and Doxycycline (D) however Chloroquine represents a lower-cost treatment option.

The two drugs can be used independently. Preliminary data on a child's survival indicates that the chances of survival when both drugs C and D are used is $1/6$ and the chance of either C or D is $2/3$.

The MoH in partnership with the Traffic Police, is studying the high rate of Road Traffic Injuries (RTIs) on the major roads in the country. These injuries place a major burden on the national health system. The MoH assumes that controlling excessive speed is the most effective preventative measure.

Data collected on a random sample of 50 major roads indicate that the speeds of motorists are normally distributed with a mean of 80 km/h and a standard deviation of 15 km/h.

The (MoH) and Traffic Police need statistical insights to finalize their enforcement and safety policies.

- Identify Reckless Speed by only the top 5% of drivers exceed. This speed will define the most reckless group causing severe accidents.
- Determine Safe speed Interval required to contain at least 85% of all motorists, which will establish the bounds for safe driving speeds.
- Estimate True Mean Speed interval for all roads basing on 99.5% confidence to better inform future highway design and safety standards.

As a mathematician, advise;

- a) the Ministry of health to choose the single drug to be used, and justify the choice of the drug.

- b) the Ministry of health and the police address the three policy challenges under Road Traffic Injuries (RTIs) and make justifications.

SECTION B

ITEM 3

A local art gallery is preparing for a new exhibition and needs to move a marble sculpture on to a display platform. The sculpture is too heavy to lift manually, so the gallery staff has decided to use a pulley system with a counter weight.

The sculpture is of mass 450kg and is attached to one end of a strong cable that passes over a smooth fixed pulley mounted on the ceiling beam.

One end of the cable is tied to a crate filled with construction materials that acts as a counterweight. The crate rests on a rough plane inclined at an angle of 60° to horizontal concrete floor. The gallery crew would like know the crates weight sufficient to overcome the friction between the crate and the incline.

given:

- Coefficient of friction between crate and incline: 0.2
- Acceleration due to gravity: 9.8 m/s^2

- (a) Analyze the lifting system to determine if the minimum crate mass required to initiate the sculpture's movement is also sufficient to sustain its motion at a constant speed. In your response, provide the calculated minimum mass and a reasoned explanation based on the relevant mechanics principles.
- (b) As a safety measure, the crate's acceleration must be limited to a maximum of 0.874 m/s^2 . Propose a suitable mass for the crate that adheres to this safety constraint. In your response, justify how this specific mass value ensures a controlled acceleration and discuss one potential risk that is mitigated by imposing this acceleration limit.

ITEM 4

The Israel Ministry of Défense (IMOD) is tracking a cargo aircraft involved in a sensitive operation.

A cargo aircraft, flying horizontally at a constant velocity of 100ms^{-1} and at a constant altitude of 200 meters above the horizontal ground, releases a package of emergency supplies

At this exact instant IMOD radar spots the aircraft and communicates to their drone in space positioned 150 km away from the aircraft's current position on a bearing 150° relative to the cargo aircraft's position. The drone remains stationary at the altitude of the aircraft. The cargo aircraft maintains its velocity but changes the course to $N30^\circ E$ after the supplies are released.

If a missile is immediately fired from the drone at a maximum constant speed of 190ms^{-1} .

The IMOD is struggling to determine the emergency supplies' landing point a critical data point for the operation and the course the missile should take to intercept the cargo aircraft in the shortest time and range possible, thereby minimizing the extent of damage.

Task

Analyse the motion patterns in the context above and provide justified solutions to challenge the IMOD is facing.

END