

ST. JANE FRANCES S.S – MASAKA
SENIOR FIVE MID TERM EXAMINATION – 2025
PHYSICS (PAPER 1)
TIME: 2 Hours 30 Minutes

INSTRUCTIONS:

- Answer ALL items in Section A and ANY TWO items from Section B.
- Begin each item on a fresh page.
- Show all working clearly and neatly.
- Use of non-programmable calculators is allowed.
- All questions carry equal marks unless otherwise stated.

SECTION A (Compulsory – Attempt All)

ITEM 1 – Linear Motion and Friction

Scenario:

In the mountainous terrain of Kabale District, a health NGO uses motorcycles to deliver vaccines to rural health centres. One of the riders descends a sloped gravel road with a 300 kg motorbike. During the rainy season, he notices the motorbike takes longer to come to a halt when descending hills, even though he applies the same brake pressure. On this particular day, he's riding down a 20° incline at 54 km/h. Suddenly, he spots a herd of cattle crossing the road and brakes immediately, causing the tyres to skid slightly before stopping just in time.

He later discusses the experience with students from a local school, who are studying motion and friction. They are curious to know how the rider's speed, the incline of the road, and the nature of the surface influence stopping distance. They decide to analyze the event mathematically using physics concepts like work, energy, and the force of friction.

Tasks:

- a) Convert the speed to m/s and calculate the kinetic energy of the motorbike before braking.
- b) If the average braking force on a dry road is 1500 N, determine the minimum stopping distance.
- c) Explain the role of friction in this scenario and discuss two ways engineers can improve road safety in hilly areas.

ITEM 2 – Measurement, Precision, and Dimensional Analysis

Scenario:

A team of agricultural engineers in Lira are designing an irrigation system for a banana plantation. They need to connect narrow pipes to water tanks and must measure the internal diameter of the pipes to determine the appropriate connectors. Using three instruments — a meter rule, vernier calipers, and a micrometer screw gauge — they each take a measurement, but the results differ slightly. This raises concerns about the precision and accuracy of their readings.

To ensure proper fitting of the connectors, the engineers must decide which reading is most reliable. They also discuss how small measurement errors can affect water pressure and flow in the pipes, leading to crop loss. To minimize risks, they consider applying dimensional analysis when testing formulas to confirm whether calculated results are physically valid.

Tasks:

- a) If the three instruments give readings of 2.5 cm, 2.45 cm, and 2.47 cm, calculate the average internal diameter and state the absolute error for each reading.
- b) Find the percentage error of the meter rule reading based on the average diameter.
- c) Explain how dimensional analysis can help engineers verify formulae and prevent costly installation mistakes.

SECTION B (Answer Any TWO)

ITEM 3 – Projectile Motion and Sports Physics**Scenario:**

During a regional athletics championship in Mbale, students observe as one of their classmates competes in the javelin throw. The athlete launches the javelin at an angle of 35° to the horizontal. The crowd watches in awe as the spear arcs through the air and lands 60 meters away. Their physics teacher challenges them to estimate the throw's speed and the height the javelin reached, using what they've learned in class about projectile motion.

Later, the students meet the athlete, who explains how he trains by adjusting the angle and force of the throw. He reveals that knowing a bit of physics has helped him improve his technique. Intrigued, the students decide to use the javelin's path to apply kinematic equations and explore how gravity, air resistance, and launch angle determine its motion.

Tasks:

- a) Calculate the initial velocity of the javelin.
- b) Determine the maximum height reached by the javelin.
- c) Describe how understanding projectile motion can help athletes improve performance and how air resistance might affect real-life results.

ITEM 4 – Statics, Moments and Construction Safety

Scenario:

In Fort Portal, a construction team is building a wooden pedestrian bridge over a stream. The bridge deck is supported by beams resting on stone pillars. A student on site notices the structure swaying slightly when a person walks across. Concerned, he discusses it with a supervising engineer, who explains that the position of the load, the distribution of forces, and the center of gravity all influence the bridge's stability.

The engineer uses the scenario to teach the student about torque and moments. He places a 200 N bag of cement at different positions on a 3-meter plank supported at both ends and shows how one side can lift if the moment becomes unbalanced. They then test how the reactions at the supports change with varying loads, and how understanding statics ensures safety in bridges and buildings.

Tasks:

- a) If the 200 N bag is placed 1 m from the left support, calculate the reaction forces at each end of the plank.
- b) Determine the torque about the left support and explain whether the system is in equilibrium.
- c) Explain why knowledge of moments and centre of gravity is crucial in bridge design, especially in areas with frequent foot traffic.

ITEM 5 – Work, Energy, Power and Renewable Systems

Scenario:

At a rural health centre in Amudat District, clean water is pumped to a storage tank using solar power. The solar panel powers a motor that lifts 40 liters of water (approx. 40 kg) every 3 minutes to a height of 6 meters. The nurse in charge is worried about whether the system can serve more people, so she asks visiting science students to calculate its output and efficiency.

The students measure the panel's electrical output at 120 W. They discuss the process by which gravitational potential energy is stored in the elevated water and how any loss of energy indicates inefficiency in the system. They also explore how understanding energy transformations can guide decision-making in rural infrastructure planning.

Tasks:

- a) Calculate the power used to lift the water and compare it to the solar panel's output.
- b) Determine the efficiency of the system.

c) Explain how concepts of energy and power can help communities design better renewable systems, particularly in off-grid areas.

ITEM 6 – Relative Motion and Navigation

Scenario:

Two passenger ferries leave Entebbe dock at the same time to ferry goods across Lake Victoria. Ferry A heads north at 12 km/h, while Ferry B departs eastward at 9 km/h. Onboard, a student studying physics becomes curious about whether the two vessels are moving away from or toward each other, and how their paths relate from one ferry's point of view.

She sketches a diagram and uses vector addition to calculate the relative motion between the vessels. She also discusses with the captain how such analysis helps in avoiding collisions. The conversation opens her eyes to how abstract classroom topics like velocity vectors have life-saving applications in the transport industry.

Tasks:

- a) Determine the velocity of Ferry B relative to Ferry A.
- b) Calculate the distance between the ferries after 30 minutes.
- c) Describe the role of relative velocity in ensuring marine safety and how it is applied in real-time navigation.