**TORORO MIXED SECONDARY SCHOOL**

# Uganda Advanced Certificate of Education

# MIDTERM II EXAMINATIONS,2025

**S.5 PHYSICS PAPER 1**

# TIME:2HOURS

# INSTRUCTION:

# Attempt all items

# Unclear work may lead to loss of marks

# Item 1

In a laboratory, a student is tasked with determining the specific heat capacity of a solid material. The student uses a copper calorimeter of mass 150 g, containing 200 g of water at 20.0°C. A 300 g sample of the unknown solid, initially heated to 120.0°C, is quickly transferred into the calorimeter. After stirring, the final steady temperature is 25.0°C.

Assume:

No heat is lost to the surroundings.

The specific heat capacity of water is 4.18 J g⁻¹ °C⁻¹.

The specific heat capacity of copper is 0.39 J g⁻¹ °C⁻¹.

Question:

(a) State the principle of calorimetry that applies to this experiment.

(b) Write an energy balance equation based on the principle stated.

(c) Calculate the total heat gained by the calorimeter and the water.

(d) Using your result in (c), calculate the specific heat capacity of the solid material.

(e) Discuss two assumptions made in the experiment and how they could affect the accuracy of the results.

(f) Suggest one modification to the experimental setup to reduce heat loss and improve accuracy.

**Item2**

A delivery company is designing a ramp system for loading packages into their trucks. The ramp is inclined and made of a metal surface. Heavy wooden crates are pushed up the ramp by workers. Each crate has a weight of approximately 200 N. The company is concerned about safety and wants to ensure that crates do not slip back when the workers take a brief pause while pushing the crates.

You have been consulted as a physics student to analyze the situation.

**Further details**

The ramp makes an angle of 30° with the horizontal.

The coefficient of static friction between the wooden crates and the metal ramp is 0.4.

A crate is at rest on the ramp as the worker takes a break.

The crate is modeled as a uniform rigid body.

Air resistance is negligible.

**Tasks:**

i). Draw a free-body diagram for the crate on the inclined ramp.

ii). Determine the maximum static friction force available.

iii). Determine whether the crate will remain at rest or start sliding.

iv). If the crate does not move, calculate the actual frictional force acting on it.

v). Discuss how increasing or decreasing the angle of inclination affects the situation.

vi). Propose design recommendations for the company to prevent crates from sliding, using your understanding of statics and friction.

**Item 3**

During a rescue operation in a flooded region, a team needs to ferry supplies across a river. The river has a current flowing eastward, while the team wants to cross directly north to reach a stranded village. They must analyze and adjust the direction of the canoe to counteract the river’s current using vector principles.

This real-world scenario requires applying vector addition and resolution to determine the required heading and resultant velocity of a boat crossing a flowing river.

**Problem Description:**

A rescue canoe moves through water at a speed of 5 m/s relative to the water. The river is 150 meters wide and flows eastward with a speed of 3 m/s.

The team wants to land directly across from their starting point (i.e., due north).

Student Tasks:

1. Determine the angle at which the canoe must be steered (relative to the north) to compensate for the river current.
2. Calculate the time it takes to cross the river.
3. Find the resultant velocity of the canoe (magnitude and direction).
4. Discuss what would happen if the canoe were pointed directly north.

**Item4**

A rural community in the hilly region of Kabale is setting up a gravity-fed water supply system. To do this, they construct a 10,000-litre water tank on a hill that is 25 metres above the village level. The water is pumped from a stream at the bottom of the hill using an electric water pump powered by a diesel generator.

The generator produces a constant power output of 2.5 kW, and the efficiency of the pump and generator system combined is 65%. The tank is filled from empty to full in 2 hours.

Water has a density of 1000 kg/m³.

**Task:**

1. Determine the gravitational potential energy gained by the water when the tank is full.
2. Using the efficiency, verify the energy loss in the system.
3. Verify if the generator's rated power is sufficient to perform this task in the given time. If not, what minimum power would be needed to complete the task in 2 hours?
4. If 1 litre of diesel produces 10 MJ of energy, estimate how much diesel fuel is consumed during the operation.

**END**