

# ST KIZITO SS BUGOLOBI

UACE PRE-REGISTRATION EXAMINATION 2026

PHYSICS P510/1

Time: 2 Hr. 15 minutes

## **Instructions:**

*Attempt 4 items in total.*

*Item 1 in section A is made up of 2 scenarios, and all are compulsory*

*Attempt one Item from each Section B, C, and D*

## **SECTION A - PARTICLES**

### **Modern Physics [Compulsory]**

#### **Item 1**

#### **Scenario 1(a)**

In a physics laboratory at Makerere University, students are analyzing a graph of binding energy per nucleon against mass number. They discuss how this graph explains both nuclear fusion in stars and fission in nuclear reactions. The lecturers use the graph to explain why middle-mass nuclei are most stable and why energy is released when heavy nuclei split or very light nuclei combine.

#### **Task**

As a learner of physics

- Sketch a typical graph of binding energy per nucleon versus mass number and label the regions where nuclear fusion and fission are energy releasing processes.
- Use the graph above to explain what is meant by nuclear fission and nuclear fusion processes.
- Using the graph, explain why iron-56 is considered one of the most stable nuclei.
- The binding energy per nucleon for U-235 is about 7.6 MeV, while for middle mass – nuclei, it is about 8.5 MeV. Estimate the energy released when one U-235 nucleus fissions into two middle mass nuclei.
- Explain how the process of nuclear fission helps to generate electricity in a nuclear power plant.

### Scenario 1(b)

A severe storm has damaged a research centre in Jinja, leading to the rupture of sealed containers of Iodine-131 powder. Iodine-131 is a beta and gamma emitter with half life of 8 days. An emergency response team is dispatched from the ministry of Health to monitor radiation levels and assess the risk of contamination to the environment and nearby water sources.

#### Task

As a learner of physics

- Iodine-131 decays to Xenon-131. Identify the type of decay and write a balanced equation.
- The initial activity of the spilled source was  $3.2 \times 10^7$  Bq. Calculate the activity of the remaining Iodine-131 poses a significant external and internal hazards to humans.

### Item 2

### SECTION B - FORCE AND MOTION

#### Scenario 2(a)

During a basketball match, a player standing 7.0 m away from the hoop attempts a jump shot. The basketball is released from a height,  $h = 2$  m above the ground, with initial speed  $9 \text{ ms}^{-1}$  at an angle of  $52^\circ$  above the horizontal. The basketball hoop is 3.05 m above the horizontal ground and aligned directly in front of the player. Support:  $g = 9.8 \text{ ms}^{-2}$

#### Task

As a learner of physics

- Determine the horizontal and vertical components of the initial velocity with which the ball was projected.
- Calculate the time taken for the ball to reach the hoop horizontally.
- What is the height of the ball above the ground at the time in (b)? Does the ball reach the hoop?
- What is the maximum height reached by the ball during its flight.

#### Scenario 2(b)

Describe how static friction coefficient value can be determined in your school laboratory between a wooden block and a wooden plane surface.

### **Item 3: Fluid Mechanics**

The National Water and Sewerage Corporation is designing a new water tower for the growing town of Mbarara. Engineers need to calculate the pressure at the base of the proposed 25-meter high tank to ensure the pipeline system can handle the static pressure and deliver water effectively to elevated areas of the town. The design must account for seasonal temperature variations that affect water density and consequently the pressure distribution throughout the distribution network.

#### **Task**

As a learner of physics

- a) State the relationship between liquid pressure, depth and density.
- b) Calculate the pressure at the base of the water tower if the height is 25 m and water density is  $1000 \text{ kgm}^{-3}$ .
- c) Determine how the pressure would change if the tower contained diesel (density  $850 \text{ kgm}^{-3}$ ) instead of water.
- d) Explain why water towers are effective for maintaining consistent water pressure in municipal systems.

## **SECTION C - ENERGY**

### **Item 4: Optics**

An optical fiber installation company in Kampala is deploying internet infrastructure using principles of refraction and total internal reflection. Engineers must calculate the minimum angle for light to remain trapped within the fiber cores, ensuring efficient data transmission over long distances. This technology is crucial for expanding Uganda's digital infrastructure to rural areas, where traditional copper cables are impractical. The proper understanding of refraction has enabled the company to design networks that minimize signal loss, bringing reliable internet access to schools, hospitals and businesses across previously underserved regions.

#### **Task**

As a learner of physics

- a) Explain the conditions necessary for total internal reflection to occur.
- b) An optical fiber has a core refractive index of 1.48 and cladding index of 1.46. Calculate the critical angle for light guidance.

- c) Describe how total internal reflection is utilized in optical fibers.
- d) Why is refraction important in telecommunication technology?

### **Item 5: Waves**

A telecommunications company is expanding its 4G network across rural Uganda, and engineers are studying how radio waves (a type of progressive wave) propagate through different terrains. They need to understand fundamental wave properties like wavelength, frequency, and speed to optimize tower placement for maximum coverage. In the hilly regions of Kigezi, signals are affected by diffraction and reflection, while in the flat Karamoja plains, signal range is much greater. The company uses this understanding of wave behaviour to ensure that even remote communities can access mobile services, which is crucial for communication, mobile banking and accessing market information.

### **Task**

As a learner of physics

- a) Define the terms amplitude, wavelength, frequency and period for a progressive wave.
- b) A radio station broadcasts at a frequency of 100 MHz. Given that the speed of light is  $3 \times 10^8 \text{ ms}^{-1}$ , calculate the wavelength of these radio waves.
- c) Explain the relationship between wave speed, frequency and wavelength.
- d) Why is understanding wave propagation important for telecommunication planning in Uganda?

## **SECTION D - CHARGES AND FIELDS**

### **Item 6: Electrostatics**

A research laboratory at Makerere University is using an updated version of Coulomb's torsion balance experiment to precisely measure electrostatic forces. Physics students setup the apparatus with small, charged spheres and measure the force between them at varying distances. Their careful measurements verify the inverse-square law relationship that Coulomb first established. This hands-on experience helps students appreciate the foundational nature of Coulomb's work, which underpins much of modern electrical science and technology. The laboratory exercise also highlights the challenges of making precise physical measurements and the importance of controlling variables in experimental physics.

### **Task**

As a learner of physics

- a) State Coulomb's Law in both words and mathematical form.
- b) Two-point charges of  $+2\mu\text{C}$  and  $+3\mu\text{C}$  are placed 0.1 m apart in air. Calculate the electrostatic force between them.
- c) If the distance between the two charges in part (b) is doubled, what happens to the force between them?
- d) Explain why Coulomb's Law is described as an inverse-square law.

### **Item 7: Current Electricity**

A vocational school in Lira teaches electrical installation skills to students seeking employment in Uganda's growing construction sector. Students learn to measure current, voltage and resistance using multimeters and verify Ohm's Law through practical experiments. They also learn how different materials and wire thicknesses affect resistance, knowledge essential for safe and efficient electrical installations. This training provides valuable skills that support Uganda's infrastructure development while creating employment opportunities for technical graduates.

#### **Task**

As a learner of physics

- a) Describe an experiment to verify Ohm's Law.
- b) A copper wire of length 50 m and cross-sectional area  $2.5 \text{ mm}^2$  has resistivity  $1.7 \times 10^{-8} \Omega\text{m}$ . Calculate its resistance.
- c) Explain how resistance depends on the dimensions and materials of a conductor.
- d) Why are practical electrical skills important for Uganda's development?

**END**