P510/1
Physics
Paper 1
Theory
July – August 2026
**3 Hours**

UGANDA MUSLIM TEACHERS' ASSOCIATION
UMTA JOINT MOCK EXAMINATIONS – 2026
UGANDA ADVANCED CERTIFICATE OF EDUCATION

**Physics**

Paper 1

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## INSTRUCTIONS TO CANDIDATES

- *This examination paper consists of* **two** *sections;* **A** *and* **B**. *It has* **six** *items.*
- *Section* **A** *has* **two** *compulsory items.*
- *Section* **B** *has* **two** *parts;* **I** *and* **II**. *Respond to only* **one** *item from each part.*
- *Respond to* **four** *items in all.*
- *Any additional item(s)* **responded** *to, will not be scored.*
- *Responses to each item should start on a* **fresh page.**
- *Silent non-programmable scientific calculators may be used.*

## SECTION A

*Respond to* **all** *the items in this section.*

**Item 1.**

Cancer in Uganda is a growing public health crisis. A private hospital plans to establish a cancer treatment unit using a cost-effective cobalt teletherapy machine that emits gamma rays from cobalt decay to destroy tumors. Cobalt ($^{60}_{27}Co$) decays to nickel (Ni), emitting a beta particle and gamma rays. Before getting the machine, the project manager and health workers emphasized the need to understand stability of atoms using the binding energy per nucleon graph, the decay equation, the rate of disintegration, and the amount of energy the machine can possibly produce in the process. The available reference data indicates that an efficient teletherapy machine uses 20g of Cobalt at a rate of disintegration not more than $9x10^{14}$ Bq to produce at least $4.5X10^{23}$ MeV of energy. They were told to involve a student of advanced level physics for help if the best solutions were to be obtained.

The project manager asked the student to describe the structure and operation of a device that uses particles with properties similar to beta particles to produce radiation for scanning cancer patients.

They also experienced difficulty in completing the task because the machine emits particles that do not penetrate the body effectively, resulting in a low-intensity image. They therefore wish to be guided on how to adjust the machine settings to increase the penetration of the particles through the body and produce a more intense image.

**Support material:**

Half-life of $^{60}_{27}Co$. is 5.27 years, Mass of Co = 59.9338 U, Mass of Ni = 59.9308 U,

Mass of an electron = 0.0005 U, Avogadro's number = $6.02x10^{23}$ atoms.

1U = 931 MeV

**Task:**

**As a student of physics, you have been selected for help;**

**(a) Analyze the given data to address the concerns raised by the project manager.**

**(b) Propose the device and examine its operation to serve the purpose.**

**Item 2.**

Uganda has made significant strides in space technology, marked by the successful launch of its first satellite, Pearl Africa Sat-1, on 7th November 2022. As part of ongoing efforts to advance scientific research, communication, and environmental monitoring, the country is preparing for another satellite launch. On the day of the launch preparations, one of the engineers responsible had briefly returned to his home, located near the launch station. While at home, he received an urgent call from the project manager requiring him to report back to the station within 5 minutes.

The road from the engineer's home to the launch station consists of a straight section 0.8 km long, along which the car accelerates uniformly from rest at $2\ m/s^2$. This is followed by a banked circular bend of radius 60 m, arc length 0.2 km, and inclination $10°$ to the horizontal. After negotiating the bend, the car travels along a further straight section 0.3 km long, where it decelerates uniformly at $1 m/s^2$ before reaching the station. The coefficient of friction between the car tyres and the road is 0.3. The engineer wishes to determine whether the car will negotiate the circular bend safely without skidding, explain the purpose of banking the bend on the second section of the road, and establish whether he will arrive at the launch station within the required time.

Upon arriving at the station, the only available parking space is an inclined ramp that makes an angle of $15°$ with the horizontal. The mass of the car is 1.2 tones, and the coefficient of friction between the tyres and the ramp is 0.5. The engineer is



600

uncertain whether the parked car will remain at rest on the inclined ramp without sliding down.

At the station, preparations for the satellite launch continue. The engineers need to determine whether a speed of $1.0 \times 10^4$ m/s would be sufficient to launch the satellite so as to maintain it in an orbit at a height of $3.4 \times 10^7$ m above the Earth's surface. Since the satellite would be within the Earth's atmosphere, the engineers also wish to understand the effect of air resistance on the motion of the satellite.

**Support Material**

- Radius of the Earth, $r_e = 6.4 \times 10^6$ m.
- Gravitational field strength, $G = 6.67 \times 10^{-11}$ Nm$^2$kg$^{-2}$.
- Mass of the earth, $M_e = 6.0 \times 10^{24}$ kg

**Task:**

As a student of Advanced level Physics, analyze the information provided and assist in addressing the concerns raised.

## SECTION B

### Part I

*Respond to* **one** *item from this part*

**Item 3.**

A family is preparing for a large wedding the following day and several hundred guests are expected. Challenges had come up that the family members could not explain. So, they needed someone with a good knowledge of physics to help.

The first worry was whether the food would be ready in time. The organizing team pours **80 kg** of water into an aluminium pot of mass **12 kg** both at **25°C**, then adds **35 kg** of food from a cool store at **15°C**. Their stove supplies **6800 W** but only **72%** reach the pot. Everything must reach **100°C**, and about **3 kg** of water boils away as steam during this heating. The cook promises the team that the food will be ready in exactly **two hours** and the whole programme depends on this, so the supervisor needs to know if this is true and by how many minutes to adjust if not.

One of the relatives also brings an extra pot with a tight locking lid and a small valve on top and starts cooking. After a while, someone notices the valve releasing puffs of vapour and wonders how it is used to cook food differently from the ordinary ones.

Midway through, the team runs short of firewood. A neighbour brings a device with a large curved shiny surface that he uses to cook with sunlight. He places a pot in front of the surface and it begins to heat up, but no one can explain what the curved surface does to the sunlight to produce that much heat.

By evening, the music group had set up and were testing the sound. The coordinator, walking between two speakers placed facing each other, noticed that in some spots the sound was very loud while in others sound was soft, and when he asked the music group to explain it, none of them could. The musicians were also struggling to tune their instruments, as each string had to produce a specific frequency, but they could

not figure out the correct lengths to be used. One of them mentioned that a day before, while in the music laboratory, he had seen a device that could be used for tuning strings, but he did not know how it worked.

**Hint:**

- Specific heat capacity of water = **4200 J/kg/K**
- Specific heat capacity of the food mixture = **3400. J/Kg/k**
- Specific heat capacity of aluminium = **880 J/kg/k**
- Specific latent heat of vaporization of water = **$2.26 \times 10^6$ J/kg**

**Task:**

As a student of Physics,

(a) Help the wedding preparation coordinator to address the challenges the team is faced with.

(b) Provide clarity on the cooking devices advising them on which one would be the best choice for the purpose.

**Item 4.**

John and Peter are guitar makers designing a new instrument. During the process, they plucked the string mounted on a hollow box producing sound but John being a S.4 leaver would not explain why and how sound was produced. The string of a guitar was of length of **0.6m** and mass of **4.2g**. The string was tuned to fundamental frequency of **82.4Hz**. Both want to know how to tune the stringed instrument and understand how tension affects the pitch for the string.

To produce pleasant sound at its fundamental note, the tension in the string should not exceed **74.14Hz** but they were not sure with how to determine the tension in the string. After tiresome work, in the evening they went to cinema hall to relax and watch a movie. On entering the hall, they were given glasses to put on the eyes to enhance them visibility. They wondered how the images were appearing after

putting on the glasses. Peter told his friend that he had ever heard a device that is applied in the glasses but he was not aware with how that device works in normal adjustment. The device had a convex lens of focal length 60 cm arranged co-axially with a diverging lens of focal length 15 cm to view a distant object. In the normal adjustment, the magnifying power of the device should be at least 0.1 for good visibility. However, they could not verify this neither describe how the device works.

**Task:**

As a S.6 physics student,

(a) Analyze the information in the scenario and solve the arguments between John and Peter.

(b) Propose the device and help the guitar makers address their concerns.

## Part II

*Respond to* **one** *item from this part.*

**Item 5.**

A growing community market has expanded rapidly and now depends on electricity for lighting, refrigeration, charging their electronic devices, and other machinery operations. Electricity is supplied from a distant power station through transmission lines and some devices before reaching the market.

During a community awareness, David, Solomon and Kevin were among the vendors that learnt some devices in power transmission that are used to step up or step-down voltage. They were told that electricity is transmitted at high voltages and later stepped down for safe use in homes and businesses.

David and Solomon wondered why high voltage transmission is preferred and how the devices achieve the safe transmission of power. At the market, one of the machines owned by Kevin used for processing agricultural products is rated at **200W** and operates at **230V**. The resistance of the transmission line connecting the power station to this machine is **3.0Ω**. For the machine to operate efficiently, utmost **2.27W**

should be the power lost in the transmission line but Kevin could not easily tell if the machine could operate efficiently.

Meanwhile, the market recently experienced several fire outbreaks suspected to have been caused by overheating extension cables. An investigation reveals that a typical stall uses **25m** long copper extension cable with cross sectional area of **1.5mm$^2$**. The cable carries an average current of **12A** for **6** hours each day. The safety regulations state that the energy dissipated as heat in the cable should not exceed **882 kJ** per working day. Solomon suggested replacing the copper cable with an aluminum cable of the same dimensions. The vendors would like to know whether the aluminum would be a better replacement in this situation.

During the discussion, one vendor consulted from the mechanic to understand why whenever he charges his phone, it initially charges faster but slows down with time before getting a fully charged battery.

**Support material;**

*Resistivity of copper is* **$1.7 \times 10^{-8}$ Ωm.**

*Resistivity of aluminum is* **$2.8 \times 10^{-8}$ Ωm.**

**Task:**

(a) Analyze the scenario and examine the operational concerns of the device.

(b) Address the concerns and queries raised by the vendors.

Item 6.

A modern hospital organized wildlife conservation and community health outreach program in Queen Elizabeth national park.

A professional photographer was invited to document the activities including photographing nocturnal animals. His camera used a flash unit containing a 2200μF capacitor charged to p.d of 330V. Each flash lasted about 1.5ms, the flash tube and the capacitor was recharged by a current of 120mA before the next photograph could be taken. However, for next flash, the power dissipated should be at least 79kW so that the photograph is very clear but they were not certain with how to determine it.

During the program the photographer noticed that for each flash, the charging indicator on the camera responded rapidly at first but then slowed at least 6s before the capacitor becomes fully charged. Curious about this, he asked the laboratory physicist to determine the actual time it takes to fully charge so that they're not late for the next photograph.

The inspection team later visited the hospital's laboratory, where a device was used to supply charge. The device had a spherical dome of diameter 4.0m maintained at a potential of $5.0 \times 10^6$ V. It also had an insulating belt driven by a 240V electric motor drawing a current of 2.5A for 8.0s while charging the dome.

The inspectors requested the laboratory staff to explain to them how the device operates and how charge is distributed on it. Based on its operating manual, the device had to be at least 60% efficient to supply the required charge to run all machines in the hospital. The inspection team wanted to determine the efficiency of the device, know whether the device had a mechanical problem. This was all about the device not supplying enough charge to run the machines in the hospital. In case the mechanical problem wasn't there, what could have been the cause of low charge supply? As the inspection team prepared to leave, the engine of one of the hospital'

ambulances was difficult to start on the cold morning but started immediately later in the afternoon. The laboratory physicist was asked to explain the reason for this behavior but couldn't.

***Support material***

*Relative permittivity of free space is* $8.85 \times 10^{-12}\ Fm^{-1}$

***Task:***

*(a) As a physics student, analyze the information and address the inspection team concerns.*

*(b) Interpret the operation and a real-life application of the device.*

**END**