Uganda Advanced Certificate of Education
INTERNAL MOCK EXAMINATION 2026
PHYSICS
Paper 1
3 hours

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

At a military airbase, a fighter jet is preparing for an emergency training mission. The runway is 900 m long, and beyond the end of the runway is a protective barrier designed to stop aircraft that fail to take off in time. To maintain flight safety, the control tower allows only one minute for each aircraft to accelerate and take off before the next aircraft is cleared to line up on the runway.

For a safe take-off, the fighter jet must reach a speed greater than $65\,ms^{-1}$. The pilot confidently states that if the aircraft starts from rest and accelerates uniformly at $4.3\,ms^{-2}$, it will safely take off after 18.4 s. However, a junior pilot is not convinced. He wonders whether the aircraft will actually have reached the required take-off speed by then, and whether it will still be within the 900 m runway or risk crashing into the barrier.

At the designated drop zone, elite paratroopers jump from the aircraft. They initially accelerate under gravity before deploying their parachutes. A junior pilot observes that, after the parachutes open, the soldiers descend at an almost constant speed instead of continuing to accelerate. The flight instructor explains that air resistance (drag) increases with the square of the soldier's speed. For illustration, he considers a soldier of mass 80 kg notes that a parachute should be deployed when the soldier's speed is between 20 ms^{-1} and 45 ms^{-1} to ensure a safe descent.

The junior pilot then asked how the military could accurately determine the exact drop-off point for the paratroopers, especially when flying over unfamiliar terrain. The flight instructor informed him that military aircraft rely on Satellite Systems

HINT

Take $g = 9.8\,ms^{-2}$

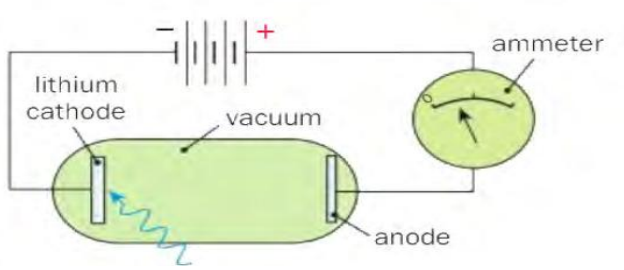
Drag constant $= 0.85$ kgm^{-1}

Task

a) Analyse the information to address the Junior pilots' concerns.
b) Explain how the satellite system is used by the military.

ITEM 2

James works in the packaging department of a company that manufactures laser torch lights. Before each torch is packaged, it undergoes a quality control test in which a beam of light is directed onto a lithium cathode, and the resulting deflection on an ammeter is observed.



During the test, James notices that a dim blue light produces only a small deflection on the ammeter, while a brighter blue light produces a much larger deflection. However, a red light that is just as bright as the bright blue light produces no deflection at all. This leaves James confused and unable to explain the observations.

The following week, James develops chest complications and visits a hospital. The doctor requests an X-ray examination, which is carried out by an assistant. After receiving the X-ray image, James asks the assistant to explain how the image is formed and how its quality can be improved. The assistant is unable to provide a clear explanation beyond stating that the image is produced when electrons strike a metal target. She also mentions that the quality of the X-ray image depends on the voltage applied to the X-ray tube, but James does not understand how the voltage affects image quality.

After examining the X-ray results, the doctor prescribes tablets, each containing 1.49μ g of pure ${}^{13}_{7}N$ James is instructed to purchase the tablets from a pharmacy. Unfortunately, the doctor forgets to explain the dosage. However, the package indicates that another tablet should be swallowed only after the activity of the previous tablet has fallen below one disintegration per second.

HINT
Blue light has a frequency of 7.7×10^{14} Hz.
Red light has a frequency of 4.3×10^{14} Hz.
work function of lithium = 2.4 eV
Planck's constant, $h = 6.6 \times 10^{-34}$ Js
half-life of ${}^{13}_{7}N$ =10.0 min
Avogadro's number = 6.02×10^{23} atoms

Task

a) As a physics student, analyse the information provided and use it to educate the James on his experience at the company and the hospital.
b) Help James to find out how long he has to swallow another tablet.

SECTION B

PART I

Respond to one item from this part

ITEM 3

The National Meteorological Centre plans to install an automated storm warning system along the shoreline of a large lake.

The warning system will use two siren towers, A and B, which emit sound waves of the same wavelength. Members of the nearby community have raised concerns that the combined sound from the two sirens could pose health risks due to its intensity. A sound engineer was consulted and made the following observations: the sound from source A travels a distance $d$to an observation point, while the sound from source B travels a distance of 3λ, where $\lambda$is the wavelength of the sound. The engineer needs to determine the largest value of the wavelength, expressed in terms of d, that will produce maximum sound intensity at the observation point.

To minimise prolonged exposure to the siren sound, it was decided that the siren towers would be installed 10.0 m away from the nearest human settlement. The community chairman then asked whether the sound emitted by the sirens would fall within the audible range of human hearing.

During one storm, the water waves on the lake were found to obey the equation

$$y = 0.2\sin(346t + 78.8x),$$

where $y$is the vertical displacement of the water surface (m), $x$is the horizontal distance (m), and $t$is the time (s).

The warning sirens are programmed to switch on automatically whenever the speed of the water waves exceeds $3.0\ \text{m s}^{-1}$.

While responding to an emergency, an ambulance with a siren emitting a frequency of 1600 Hz overtakes a cyclist travelling at $2.44\ \text{m s}^{-1}$. After the ambulance passes, the cyclist hears a frequency of 1590 Hz. This makes the cyclist curious about the speed at which the ambulance was travelling.

HINT

- Speed of sound in air = $340\ \text{m s}^{-1}$
- Audible frequency range = 20 Hz to 20,000 Hz

Tasks

a) Analyse the information provided and use it to educate the community and the chairman by

b) Justify the need for an ambulance and how fast it over took the cyclist.

ITEM 4

You visit a newly opened sports and rehabilitation centre where you friend Brian works. The centre has a cafeteria and an outdoor swimming pool. To reduce electricity costs, the management relies on solar energy to heat the swimming pool during the day. Cold drinks are stored in a refrigerator located inside a well-insulated room.

During an inspection, Brian, notices that although the refrigerator keeps its contents cold, the room gradually becomes warmer whenever the refrigerator has been operating for

several hours. The centre manager asks Brian to explain this observation using the First Law of Thermodynamics, indicating the direction of heat flow, the work done and the change in internal energy for both the refrigerator and the air in the room.

Brian is asked to assess how long after sun rise will the pool temperature change by 3.0K. The pool has a surface area of 60 m^2 and a uniform depth of 1.5 m. The average intensity of solar radiation reaching the water surface is 800 W m^{-2}. Measurements show that 20% of the incident solar energy is reflected while the remaining energy is absorbed by the water.

The centre manager wonders why the pool never becomes comfortably warm during the cold season, even on sunny days, and asks Brian to explain the possible reasons. Brian has requested for your assistance.

Hint

Specific heat capacity of water = 4200 J kg^{-1} K^{-1}

Density of water = 1000 kg m^{-3}.

Task

a) Analyse the information provided and explain the observations in the refrigerator room.

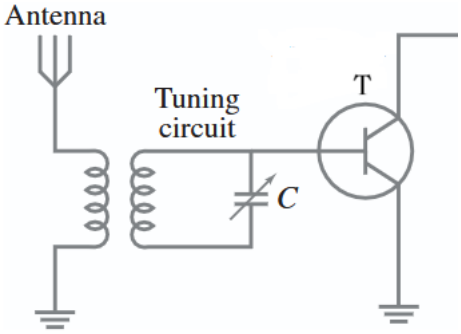
b) Perform the necessary data analysis regarding the swimming pool and address the manager's concern.

PART II

Respond to one item from this part

ITEM 5

Lydia's radio stopped working, so she took it to the village mechanic for repair. When the mechanic opened the radio, he showed her part of the tuning circuit, as illustrated in the figure.



Lydia identified component T in the tuning circuit and asked the mechanic what it was made of, how it performed its function in the radio and any other application of T and C

The mechanic replaced the variable capacitor C with one of 2500 pF, allowing the radio to be tuned to a station broadcasting at 550 kHz. However, Lydia's favourite radio station broadcasts at 1610 kHz, so the mechanic needed to replace the capacitor with one of a different capacitance.

The mechanic knew that the capacitance required for tuning is inversely proportional to the square of the frequency. Unfortunately, the capacitance values on all the spare capacitors available in his workshop had faded, making it impossible to identify them by inspection. As a result, he had to determine the correct capacitor experimentally before installing it in the radio.

Task

a) Analyze the information provided and offer guidance how best the mechanic will achieve the favorite Station.
b) Explain Lydias inquiry and give real-life applications of the components T and C

ITEM 6

A patient was admitted to a hospital with suspected heart complications. The doctor suspected that the condition could be related to reduced blood circulation and requested a test to determine the velocity of blood flow in one of the patient's arteries.

The hospital uses a Hall-effect blood flow sensor to measure blood velocity. During the test, the sensor recorded the following data:

- Diameter of the artery: 3.3 mm
- Magnetic field strength: 0.070 T
- Measured Hall voltage: 0.13 mV

The device was programmed to print the patient's blood-flow report. However, the printer failed to produce the report because of an electrical fault.

The doctor asked the nurse, who had a good background in physics, to manually verify whether the patient's blood velocity was within the normal range. The patient was surprised that the doctors could determine the blood flow without performing a surgical operation, and this left him wondering how the device worked.

When the printer was taken to a technician for repair, a burnt resistor was discovered. The technician explained that the printer uses a mechanism, in which negatively charged toner particles are attracted to a positively charged rotating drum. Each toner particle has a mass of 9.0×10^{-16} kg and carries 20 extra electrons. To ensure that the toner particles are attracted firmly to the drum, the electric force acting on each particle must be at least twice its weight.

The technician also determined that the burnt resistor had prevented the drum from reaching its required operating potential. To restore normal operation, the resistor had to be replaced so that the drum could operate at a potential difference of at least 25 V.

HINT

- Normal blood velocity range: 0.80 ms^{-1} to 1.20 ms^{-1}
- Radius of the printer drum: 5 mm
- Operating current supplied to the printer drum: 150 mA

Task

(a) Analyse the patient's blood-flow measurements and comment on the findings.
(b) Analyse the printer's electrostatic charging system to determine whether it can operate correctly.

END

Marking Guide Available at a FEE
Khalid M754857296