

**P510/1**  
**PHYSICS**  
**Paper 1**  
**(Theory)**  
**Jul/Aug, 2026**  
**3 hours**



**ALLIANCE JOINT EXAMINATIONS BOARD**

Uganda Advanced Certificate of Education

**PHYSICS**

**(Theory)**

**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.*

**TURN OVER**

## SECTION A

*Respond to all items in this section*

### ITEM 1.

Uganda has made significant strides in space technology marked by the successful launch of its first Satellite-Pearl AfricaSat-1 on November 7, 2022. The project manager is intensifying mechanisms to develop more infrastructure to enable a second satellite launch before 2028. At Mpoma East station- Mukono, a satellite of mass 200kg is to be launched in a parking orbit and Project Manager needed to establish the height of the parking orbit, the mechanical energy of this satellite and get understanding the effect of reducing the mechanical energy of the satellite on its safety.

This information was necessary to establish safety precautions of the satellite in the orbit. The satellite is considered safe if its mechanical energy does not exceed  $-9.0 \times 10^9 \text{J}$ . The project manager called one of the space Engineers in charge who had gone back to his nearby home to rush and return not later than 5 minutes to do the necessary calculations and deliver information. The engineer had parked his car on a road which was a straight stretch up to the station. He wants to start the engine of the car and give it a power of 22kW for a driving force of 1.1kN to be developed so as to uniformly accelerate for the first 1.2km just before applying brakes for the remaining 0.5km to decelerate uniformly to rest at the station.

The project supervisor also had tasked the engineer to explain how he can utilize some locally made materials to design a device that can produce a lift force with a mounted camera to capture aerial photos at the station. As the engineer had may other pressing issues at hand to solve.

#### **Hint:**

*Coefficient of friction on the used road is 0.025*

*Mass of the car = 2 tones*

*Acceleration due to gravity  $g = 9.81 \text{ms}^{-2}$*

*Radius of the Earth  $R$ ,  $E = 6.4 \times 10^6 \text{m}$*

#### **Task:**

You have been selected to help;

- (a) Analyze the data to provide the necessary information needed by the project manager and the establish if the engineer can reach in time to deliver it.
- (b) Explain how the device needed by the supervisor can be made and able to serve the purpose.

### ITEM 2

Cancer in Uganda is a major, increasing public health crisis. One of the Privately owned Hospital wants to start a cancer treatment department. The proposed cost effective method is the use of an efficient Cobalt ( $^{60}_{27}\text{Co}$ ) teletherapy machine which utilizes gamma rays from radioactive cobalt decay to destroy tumors. The radioactive isotope

$^{60}_{27}\text{Co}$  decays to Nickel (**Ni**) producing a beta particle and the gamma rays. The project manager sat with some health workers who suggested that before the machine is bought, there should be a clear understanding of the stability of atoms using binding energy per nucleon graph, an equation showing the decay, a determined rate of disintegration and the amount of energy the machine can possibly produce on the process.

The available reference data indicate that an efficient teletherapy machine exploits 20g of the Cobalt at a rate of disintegration not more than  $9 \times 10^{14}$  Bq to produce at least  $5.5 \times 10^{20}$  MeV energy. They told the manager to involve a student of Senior Six advanced level physics for help if the best solutions were to be obtained.

The project manager was told that the student should help in describing the structure and operation of a device which uses particles of same properties like the beta particle to produce radiations for use in scanning whether cancer patients who always complain of painful bones have fractures.

**Hint:**

*Half-life of  $^{60}_{27}\text{Co}$  is 5.27 years*

*Mass of  $^{60}_{27}\text{Co}$  = 59.93381U*

*Mass of Ni = 59.93079U*

*Mass of an electron = 0.0005U where 1U = 931MeV*

**Task:**

You have been selected for help

- (a) analyze the given data to address the concerns raised by health workers
- (b) Explain how the device suggested by the manager can work to serve the desired purpose

**SECTION B**

**Part I**

*Attempt **one** item from this part*

**ITEM 3.**

Students in a certain secondary school complained of too much heat in the classroom. They claimed that this could be due to much light which entered through the door which would remain open when one entered or the quality of the newly installed windows. The head teacher convened a meeting with the class and invited some S.6 physics students, their teacher of physics and the supplier of the windows to address the issues raised. The supplier said that the windows supplied are of good quality and each window had a double-glazed glass consisting of two Sheets of glass 5mm thick separated by a layer of air 10mm thick.

The cross-sectional area of the window was  $2\text{m}^2$  and absorbed 5% of radiation from the sun of solar constant  $1100\text{Wm}^{-2}$ . He also said that the thermal conductivity of the used materials were  $0.025\text{Wm}^{-1}\text{K}^{-1}$  for air and  $0.8\text{Wm}^{-1}\text{K}^{-1}$ . He said that all this ensures that even when the outside surface of the window was at  $35^\circ\text{C}$ , the inside temperature in the classroom would be maintained at most  $20^\circ\text{C}$  which is good enough for the conducive atmosphere.

The physics teacher raised doubt on whether said inside temperature in the classroom and the thermal conductivity of the glass are accurate. The teacher requested one of the physics students to explain how an experiment can be done using a piece of glass material used to confirm the value and also establish whether the inner class room temperature was at most  $20^\circ\text{C}$ .

The teacher also requested the same student to explain how the outer surface of the window can be made in order to reduce the amount of energy absorbed from light falling on it. The head teacher remembered that there is a simple device which when installed on the door, it enables it to slowly close automatically after it is opened.

**Task:**

You have been selected by the physics teacher,

- (a) Analyze the data to address the requests put forward to calm down the class members about window quality.
- (b) Assess the information given to explain is mode of operation of the said device.

**ITEM 4.**

Musical instruments such as guitars are widely used in Uganda for music to serve as instrument of performance, education and entertainment. Ojok is a famous business man selling Musical instruments in town. Of recent past, his customers have been complaining of the effect of heating in strings of the guitars. Ojok sent his S.6 physics child who had come to help him on the weekend at the shop to call the Luthier (guitar repairer) to check if customers claims were right. The luthier tested a fixed string of length  $40\text{cm}$  and mass  $1.2 \times 10^{-3}\text{kg}$  on one of the guitars. He tuned the string to produce a third harmonic of Frequency  $750\text{Hz}$ . The Luthier requested the S.6 candidate to determine tension which was developed in the string to address customer concerns and explain the effect in the string experienced.

Luthier also tasked the candidate to derive the equation of the wave generated in fixed strings relating to amplitude and wave displacement such that future string properties can be studied. As the Luthier was busy fixing the guitar problems, Ojok moved at the



Balcony viewing the day moon using a refracting device in normal adjustments. The device was a gift to him and he was excited at his observation. Meanwhile Ojok was taking a cold soda in a glass bottle and by the time he picked the bottle for another sip of a soda, some liquid had collected outside the bottle which kept him wondering whether the glass had pores. He immediately called his S.6 candidate to provide explanations.

**Hint:** *The guitar string breaks if its tension exceeds 100N.*

**Task:**

You are the selected student;

- (a) Help the luthier to address customer concerns and obtain the desired expression for future use and explain what happened on the outside the soda bottle
- (b) Describe to Mr Ojok the structure and operation of the device he received as a gift.

**Part II**

*Attempt one item from this part*

**ITEM 5.**

Some schools in Uganda are faced with challenges of ineffective communication especially on assemblies due to lack of address systems. The head teacher in one of the Secondary Schools bought a portable speaker address system. This speaker could however, work for a short time and stop. The head teacher claimed that the problem of the speaker could be a high internal resistance of the battery used for charging.

Some learners claimed that it was the charging time which was short. The recommended charging time for the power bank to be full should be at least 15 minutes. One S.5 student approached the head teacher and requested to test the battery and establish if it was indeed the problem. The student connected the battery in series with a variable resistor and an ammeter. When the resistor was set  $21\Omega$ , the current through it was 0.48A and when it was set to  $36\Omega$  the current was 0.30A. The power bank in the speaker was made up of two super capacitors each of capacitance 1.0F in series. The head teacher further intervened and asked how the capacitors got charged by the battery and the time one needed to wait before the speaker is fully charged.

The Deputy head teacher on the other hand asked the student to explain how he could change the a.c from other sources into d.c for use in powering some other school gadgets. The S.5 student tried but could not succeed in addressing any of the matters raised. He went to S.6 physics students for assistance.

TURN OVER

**Hint:** A good battery for charging has internal resistance not more than  $20\Omega$ .

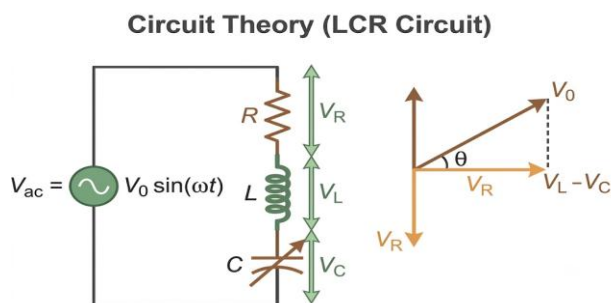
**Task:**

You have been selected to help:

- analyze the information given in the scenario and address the claims and concerns of the head teacher.
- Address the response of the deputy head teacher.

**ITEM 6.**

Listening to religious radios is highly advisable for older adults to promote emotional comfort and mental stimulation. Opio visited his parent with his child who was doing physics in S.6. The parent complained to Opio of the challenge they had with their radio set which often failed to tune in their favorable religious program. The radio operated at a frequency of 61.2MHz. Opio opened the radio and found its tuning circuit as indicated in *figure 6(i)* very weak.



**Figure 6 (i): Resonance circuit for tuning radio.**

Opio decided to install a new stronger variable capacitor, C and a pure inductor, L. He purchased materials and made the two smaller capacitors each of plate separation 2cm and maximum area of overlap  $5.0 \times 10^{-4} \text{ m}^2$  filled with a material of dielectric constant 4. The two capacitors were joined in series and connected with a rotor for tuning.

He made L from a 1.0cm air-cored solenoid of 10 turns and  $1.2 \times 10^{-3} \text{ m}^2$  cross sectional area. Opio requested his child to explain the effect of a dielectric in the capacitors, determine the magnetic field density developed by L and perform necessary calculations to establish whether the new circuit can tune to the desired religious channel

Opio's Parent also took advantage of the presence of the grand child and requested to make them understand the structure and operation of a device used by used in charging the radio because, this parent had always wondered how the charger can be connected in the socket which supplies 240V to charge a radio which operates at only 12V.

**Hint:**

*Permeability in free space  $\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$*

*Permittivity of free space  $\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$*

**Task:** As a S.6 physics student:

- (a) analyze the information in the scenario to answer the requests made by Opio
- (b) Provide the solution made by Opio's parent.

**END**

P510/1  
PHYSICS  
(Theory)  
PAPER 1  
July/August, 2026  
3 hours



**LUGAZI DIOCESE MOCK EXAMINATIONS BOARD**

**Uganda Advanced Certificate of Education**

**PHYSICS THEORY**

**Paper 1**

**3 HOURS**

**INSTRUCTIONS TO CANDIDATES:**

*The paper has Six Items. Attempt ONLY FOUR questions.*

*There are TWO sections; Section A and section B.*

*Section A is COMPULSORY and Section B has two parts (i) and (ii).*

*Attempt NOT MORE THAN ONE ITEM from each of the Parts (i) and (ii).*

*Start each Item on a fresh page.*

*Use the provided data and support materials to guide your solutions.*

*Clearly show all calculations and assumptions.*

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@LUDISSEB2026

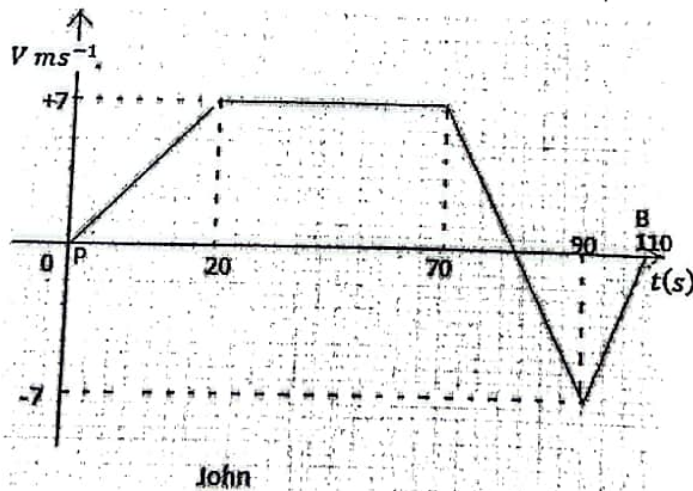
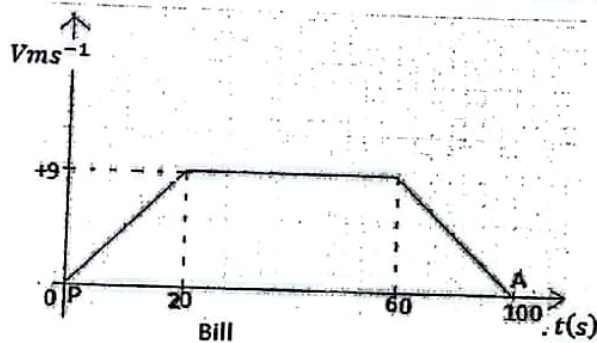
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## SECTION A (COMPULSORY)

### ITEM 1

Athletics in Ugandan schools are utilized to promote holistic education, competition management, physical fitness, and talent identification to foster life skills, social cohesion, and health. In one of the secondary schools, the school coach subjected trial tests to identify various athletes who can represent the school effectively. In running, two boys, Bill and John, started from rest at the same place **P** and each ran respectively to one of the two positions marked **A** and **B**. The distances are marked on the graphs of velocity,  $V$  against time,  $t$  from their start as shown below.

The School Nurse was among the spectators and demanded that the boys put on helmets which had a caution on the inside for their safety in case of a fall.





Another competition involved selecting a participant in a darts game. Two girls Jane and Sofia trained by firing darts at a target  $2\text{m}$  high above the horizontal. Jane released a dart at  $45^\circ$  to the horizontal at  $16\text{ms}^{-1}$  and Sofia at  $30^\circ$  to the horizontal at the same speed like Jane. The target was located  $3\text{m}$  from the throwing point.

The Coach kept wondering why darts were designed with flight (wings). One student told him that the streamlined wings (flights) at the tail end of darts is to provide stability and produce a more lift force and that this effect has many real life applications which were disclosed.

The team required a physics student to provide technical assistance.

Hint:

An average speed not less than  $6.0\text{ms}^{-1}$  was needed for one to qualify.

Acceleration due to gravity is  $9.81\text{ms}^{-2}$

**Task:**

You have been chosen:

- (a) Explain motion of the boys and the demand made by the nurse hence select the boy and the girl that will be able to represent the school in competitions.
- (b) Explain any two of the real – life applications disclosed to the coach.

## ITEM 2

Cancer in Uganda is a major, increasing public health crisis. One of the Privately owned Hospital wants to start a cancer treatment department. The proposed cost effective method is the use of an efficient Cobalt ( $^{60}_{27}\text{Co}$ ) teletherapy machine which utilizes gamma rays from radioactive cobalt decay to destroy tumors. The radioactive isotope  $^{60}_{27}\text{Co}$  decays to Nickel ( $\text{Ni}$ ) producing a beta particle and the gamma rays. The project manager sat with some health workers who suggested that before the machine is bought, there should be a clear understanding of the stability of atoms using binding energy per nucleon graph, an equation showing the decay, a determined rate of disintegration and the amount of energy the machine can possibly produce on the process.

The available reference data indicate that an efficient teletherapy machine exploits  $20\text{g}$  of the Cobalt at a rate of disintegration not more than  $9 \times 10^{14}\text{Bq}$  to produce at least  $5.5 \times 10^{20}\text{MeV}$  energy.

@LUDISSEB2026

3

They told the manager to involve a student of Senior Six advanced level physics for help if the best solutions were to be obtained.

The project manager was told that the student should help in describing the structure and operation of a device which uses particles of same properties like the beta particle to produce radiations for use in scanning whether cancer patients who always complain of painful bones have fractures.

**Hint:**

Half life of  ${}^{60}_{27}\text{Co}$  is 5.27 years

Mass of  ${}^{60}_{27}\text{Co} = 59.93381U$

Mass of  $\text{Ni} = 59.93079U$

Mass of an electron =  $0.0005U$  where  $1U = 931\text{MeV}$

**Task:**

You have been selected for help

- analyze the given data to address the concerns raised by health workers
- Explain how the device suggested by the manager can work to serve the desired purpose

## SECTION B (PART I)

### ITEM 3

Students in a certain secondary school complained of too much heat in the classroom.

They claimed that this could be due to much light which entered through the door which would remain open when one entered or the quality of the newly installed windows.

The head teacher convened a meeting with the class and invited some S.6 physics students, their teacher of physics and the supplier of the windows to address the issues raised.

The supplier said that the windows supplied are of good quality and each window had a double glazed glass consisting of two Sheets of glass  $5\text{mm}$  thick separated by a layer of air  $10\text{mm}$  thick. The cross sectional area of the window was  $2\text{m}^2$  and absorbed 5% of radiation from the sun of solar constant  $1100\text{Wm}^{-2}$ . He also said that the thermal conductivity of the used materials were  $0.025\text{Wm}^{-1}\text{K}^{-1}$  for air and  $0.8\text{Wm}^{-1}\text{K}^{-1}$ . He said that all this ensures that even when the outside surface



of the window was at  $35^{\circ}\text{C}$ , the inside temperature in the classroom would be maintained at most  $20^{\circ}\text{C}$  which is good enough for the conducive atmosphere. The physics teacher raised doubt on whether said inside temperature in the classroom and the thermal conductivity of the glass are accurate. The teacher requested one of the physics students to obtain a small piece of glass material similar to that used in the windows and use it to establish whether it has the accurate thermal conductivity as compared to the standard value known from the market and also establish whether the inner class room temperature was at most  $20^{\circ}\text{C}$ .

The teacher also requested the same student to explain how the outer surface of the window can be made in order to reduce the amount of energy absorbed from light falling on it.

The head teacher remembered that there's a simple device which when installed on the door, it enables it to slowly close automatically after it is opened.

**Task:**

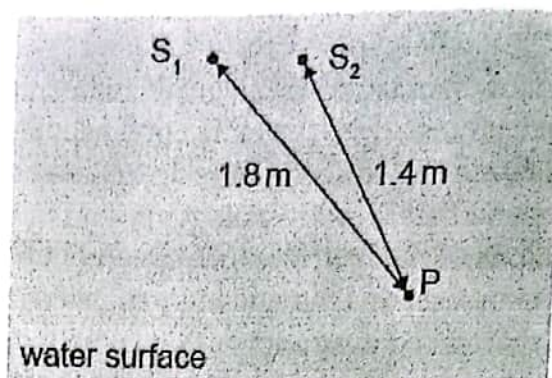
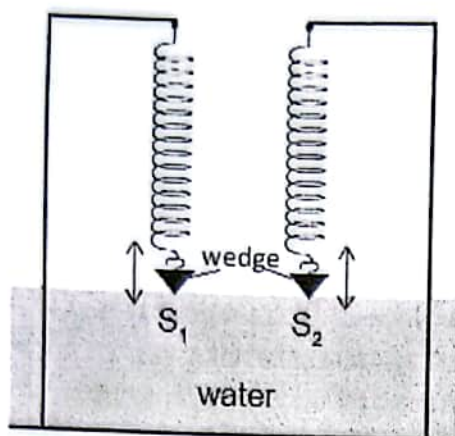
You have been selected by the physics teacher,

- (a) analyze the data to address the requests put forward to calm down the class members about window quality.
- (b) Assess the information given to explain its mode of operation of the said device.

**ITEM 4**

Energy is a fundamental property of nature that cannot be created or destroyed, only transformed from one form to another for various life applications. A group of S.6 Physics students decided to perform some experiments to enable them understand concepts on energy better. Okello, one of the group members used two identical wedges attached to two identical vertical springs. The wedges touch a water surface at S1 and S2. As the wedges oscillate, they create travelling waves on the water surface. The wedges oscillate in phase with the same amplitude. P is a point on the surface of the water.





The mass of each wedge is  $0.200\text{ kg}$  and the spring constant is  $504\text{ N m}^{-1}$ . Damping is negligible. The speed of the water waves is  $1.6\text{ m s}^{-1}$ . Okello was tasked by the group to find the frequency of the water wave and make them understand the observations made at point P and slightly after.

The head teacher also had a newly purchased a  $2.352\text{ kW}$  power Kettle made of a material of heat capacity of  $420\text{ J K}^{-1}$  and he was assured by the shop owner that the kettle was so genuine and can boil water within  $6\text{ minutes}$ . The head teacher gave it to the group to test whether it was truly genuine. They heated  $2\text{ litres}$  of water initially at  $20^\circ\text{C}$  until it boiled at  $100^\circ$ . Okello observed that the steam produced had energy and was almost lifting off the cover. The discussion leader asked the group to heat the water for extra  $4\text{ minutes}$  and establish the work done by the water against a constant atmospheric pressure of  $1.0 \times 10^5\text{ Pa}$ . The head teacher came back and asked them to give the molecular account of all the heating processes.

Rose entered the room and found a great science group. She requested them to recommend a device which can help her vision. She was always complaining of her failure to see far writings clearly.

HINT

Density of water is  $1000\text{ kg m}^{-3}$  while that of steam is  $0.6272\text{ kg m}^{-3}$ .

Specific heat capacity of water is  $4200\text{ J kg}^{-1}\text{ K}^{-1}$

Specific latent heat of vaporization of steam is  $2.25 \times 10^6\text{ J kg}^{-1}$

## Task

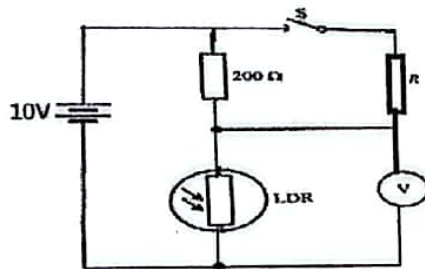
As a student of physics;

- Analyze the scenario to address the concerns raised in the discussion group.
- Recommend the device for Rose and make her understand how it will be of help.

## ITEM 5

Automatic light systems in farming are often powered by off-grid sources. They have sensors and are commonly used for **livestock management, greenhouse horticulture, and farm security**. These systems help optimize animal growth, regulate crop photoperiods, and reduce energy costs.

Uganda Young Tech LTD is a company that specializes in automated garden lighting have been contacted by Musa a famous farmer to check the effectiveness of his new sensor system to enable it behave consistently whether it's under the faint glow of moonlight or the bright glare of the sun according to the circuit diagram below.



V represents a control unit that operates at a specific voltage,  $V_m$ . The resistor R has been damaged and needs replacement. It is known that the **Sensors: The Light-Dependent Resistor (LDR)** is the heart of the system. Its resistance is  $800\Omega$  in moonlight and drops to  $160\Omega$  in daylight. With the override switch S open, the control unit which operates perfectly well when the LDR is exposed to moonlight and when the override switch S is closed, the control unit still works perfectly when the LDR is exposed to daylight but  $V_m$  value remains unchanged. Ndugu works for Uganda Young Tech LTD and was sent by the company to fix the system. He needs to establish if  $V_m > 9V$  as required for normal operation of the control unit of the lighting system and the value of the resistance R to be bought



Musa could not let Ndugu return before checking his water pump system because its efficiency was getting weak. Ndugu found out that its motor contains a coil with 500 turns and when running, its magnetic flux changes from  $0.05\text{Wb}$  to  $0.02\text{Wb}$  in  $0.2\text{s}$ . This coil further worked as an inductor of inductance  $0.5\text{H}$  and resistance  $30\Omega$  connected in series with a start-up capacitor of capacitance  $1000\mu\text{F}$  to provide an initial powerful jolt of energy for the motor coil to overcome resting inertia and balance motor current. It is connected to a  $200\text{V}$  (RMS) supply alternating at  $\frac{50}{\pi}\text{Hz}$ . Ndugu wants to check if this coil can withstand at least  $70\text{V}$  of induced e.m.f and if the system can supply the necessary  $8\text{A}$  peak current required for efficient use or else the pump be replaced. Musa however asked Ndugu to tell him whether the Motor was A.C or D.C. Ndugu said that this Motor should be A.C but Musa insisted that he should be made to understand how the D.C Motor Works for him to make a clear distinction of what was being used for his pump.

Jane is Musa's farm manager and she advised Musa to procure a device which can boost the a.c voltage supply from  $200\text{V}$  to at least  $240\text{V}$  for the efficiency of the Pump to improve.

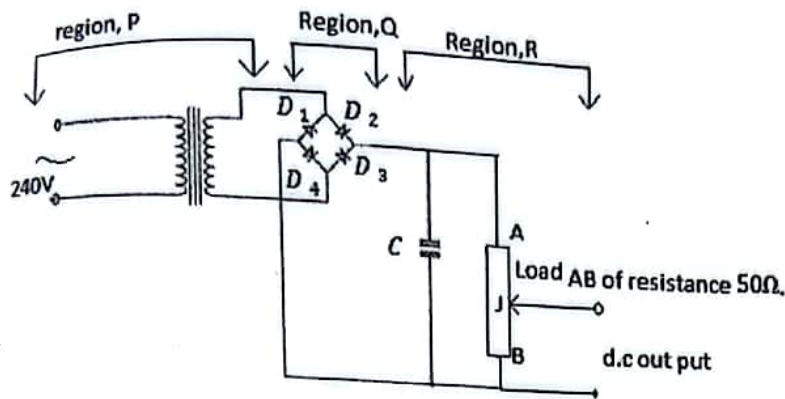
#### Task:

As a student of physics, you have been approached for help

- (a) provide the solutions needed by Ndugu to satisfy Musa's demands
- (b) assess the design and operation of the suggested device to serve its purpose.

#### ITEM 6

Most electronic devices which use semiconductors, microprocessors and batteries require d.c voltages converted from a.c source. Okot bought a smart phone but he got challenges with its charger. A typical set-up in figure 5 below is a circuit which is used to charge his phone using a  $240\text{V}$  a.c voltage source. The charger not working is attributed to various factors but the major ones zero down to charging levels of the capacitor and the value of output voltage.



The set-up used in region P has primary to secondary turn ratio of 8 : 1 and the load AB is of length 100cm with the potential divider tapped at point J where  $AJ = 30\text{cm}$ . The capacitor,  $C$  used has plate dimensions 10cm by 10cm separated by a dielectric material of constant 3 and thickness 6mm. The required capacitor should be able to store charge not less than 3.0nC and the best charging system should have a power output not less than 5W.

Okot was told by his visitor that set-up in region P has many applications in everyday life devices.

**HINT:**

Permittivity of air  $\epsilon_0 = 8.85 \times 10^{-12} \text{Fm}^{-1}$

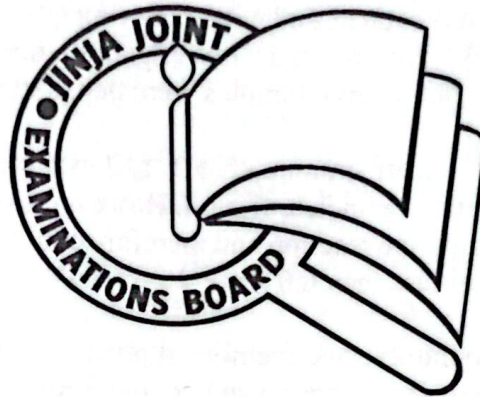
### Task

You have been contacted by Okot for assistance,

- Explain actions in regions P, Q and R. Hence, establish the problem of the smart phone charger.
- Describe the structure and operation of a device which uses the principle of the set up in region P.

**END**

**P510/1**  
**PHYSICS**  
**Paper 1**  
**AUGUST, 2026**  
**2½ hours**



## **JINJA JOINT EXAMINATIONS BOARD**

*Uganda Advanced Certificate of Education*

**MOCK EXAMINATIONS – AUGUST, 2026**

**PHYSICS**

**Paper 1**

**2 hours 30 minutes**

### **INSTRUCTIONS TO CANDIDATES:**

Attempt only **four** items

Section A is compulsory. Section B has two parts (I) and (II). Attempt not more than one item from each of the Parts (I) and (II).

Use the provided data and supporting materials to guide your solutions.

Clearly show all calculations and assumptions.

Responses to each item should start on a fresh page

Silent non-programmable scientific calculators may be used.

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Turn Over  
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## SECTION A

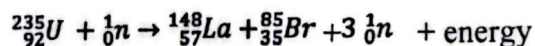
## ITEM 1

Uganda is facing challenges of high electricity costs and frequent power fluctuations. A team from the Ministry of Energy has been tasked with exploring alternative sources of energy to help address these challenges. As part of their investigation, the team visited the Kyambogo University laboratory, where radioactive samples were being studied.

During a trial experiment, 1 kg of uranium-235 ( $^{235}_{92}\text{U}$ ) was placed in a nuclear reactor and bombarded with neutrons to initiate nuclear fission. However, the team did not know how much energy would be released during the reaction and therefore could not complete their report. Their target is to produce energy not less than  $6.0 \times 10^{13}\text{J}$

As they were leaving the laboratory, one member slipped on a staircase and was rushed to the hospital. A medical imaging device was used to determine whether any bones had been fractured. On that very day, a group of Senior Six students who had come for a study tour were asked to help the medical team understand how the device works and how bone fractures can be detected; however, they could not provide sufficient information.

A few days later, some members of the team began experiencing symptoms such as skin irritation and burns. After a medical examination, a student pursuing a medical radiography course was selected to give a medical report on what could have caused the symptoms experienced by the team members. He found that during the investigation in the laboratory, the team did not observe adequate safety precautions while handling radioactive samples, thereby exposing themselves to the harmful effects of radiation.

**Support information:**

Mass of  $^{235}\text{U} = 235.1 \text{ u}$

Mass of  $^{148}\text{La} = 148.0 \text{ u}$

Mass of neutron =  $1.009 \text{ u}$

Mass of  $^{85}\text{Br} = 84.9 \text{ u}$

$1\text{U} = 931\text{MeV}$

**Task:** You have been selected as a Senior Six Physics student to:

- Examine the information provided and help the Senior Six students who attended the tour, as well as the radiography student, to compile their report.
- Analyse the scenario and help the Ministry of Energy team complete their report by providing the missing information.



**ITEM 2**

During the transportation of construction materials to a bridge construction site in a rural district of Uganda, a truck driver noticed that one of the wheel rims became very hot after repeatedly applying the brakes while descending a steep hill. He suspected that the heating was due to overloading of the truck. However, the conductor explained that the heating resulted from the frictional force between the brake pads and the wheel rim. Although his explanation was partly correct, he was unable to describe the origin of this force using the molecular theory of matter.

When the pedestrian bridge was being constructed, engineers observed that although the bridge appeared stable and safe for use, many residents, including learners, could not explain how the bridge remained in equilibrium. In particular, they were unable to identify the forces acting on the beam or determine the reaction exerted by the hinge.

To ensure long-term safety of the structure, the engineers decided to test the elastic properties of the steel wires used to reinforce the bridge. They intended to determine the Young's modulus of the wires before installation. However, the available technicians were unable to set up and explain the required experiment. The students were therefore requested to demonstrate the experiment using suitable laboratory apparatus and state the necessary precautions.

**Hint**

- Length of the beam = 4.0 m
- Weight of the beam = 50 N

**Task**

- a) **Analyse** the information provided and explain, using the molecular theory of matter, the origin of the opposing force between the brake pads and the wheel rim that causes the wheel rim to become hot, identify all the forces acting on the bridge beam and determine the magnitude of the reaction at the hinge.
- b) **Design the experimental set up** and explain to students to carry out the demonstration.



## SECTION B

## Part (I)

## ITEM 3

Due to the increasing threat of Ebola outbreaks in Uganda, many residents have become anxious whenever they experience minor symptoms such as headaches and fever. As a result, the number of people seeking medical examination at health facilities has increased significantly. However, several concerns have arisen among hospital workers, patients, and visitors.

In the hospital laboratory, a technician uses a **device that uses pressure of a fixed mass of the gas at a constant volume** to monitor the temperature of the room where medicines are stored. Some workers are concerned about how the device operates and how it can accurately measure temperature.

One of the admitted patients complained of a severe toothache. During examination, the dentist used a curved mirror to inspect the affected tooth before prescribing medication. The patient noticed that the image of the tooth appeared larger than normal and became curious about the type of mirror being used and how it produces such an image.

Meanwhile, students from a nearby school visited the hospital's science outreach centre during an astronomy exhibition. They observed the Moon using an optical instrument made of two convex lenses. The final image of the Moon was formed at infinity.

One student informed the others that a good viewing instrument should have a magnifying power of at least 6 to enable clear observation of distant objects. However, the students were unable to identify the type of instrument being used and derive the expression used to determine whether the instrument met the required standard. Their teacher later instructed them to prepare a written report based on their observations. Unfortunately, they were unable to complete the task and decided to seek assistance from a Senior Six Physics student from a nearby school.

## Hint

Focal length of objective = 300 cm

Focal length of eyepiece = 25 cm

## Task

- Analyse the concepts demonstrated and address the concerns raised by the hospital workers and the patient.
- Analyze the information given and help the student with all information that is required in their report.



**ITEM 4**

During the annual secondary school inter-class Music, Dance and Drama (MDD) competitions, the school band acquired several new guitars to improve their performance. However, during rehearsals, the house patrons noticed that some guitars were producing notes that were not properly in tune.

To address the issue, members of the Physics Club were requested to investigate and determine the frequencies of the notes produced by the guitar strings. Some students were unsure how this could be done and requested clarification, but the explanations given did not fully satisfy them, leaving the issue unresolved.

One guitar string of length **0.80 m** was selected for investigation. When plucked, the string vibrated in its **fundamental mode**, forming a stationary wave with a single loop between fixed ends. The frequency of vibration was measured to be **200 Hz**.

Further investigation raised additional concerns:

- Some students wanted to understand how stationary waves are formed on a stretched string.
- The mass per unit length of the string was found to be  $2.0 \times 10^{-3} \text{ kg m}^{-1}$ , but the students could not determine the tension in the string.
- Students were informed that well-tuned guitars operate at tensions of at least **204.8 N**, but they were unsure how to use this information to select suitable guitars.

At the same time, in the school canteen, the attendant was preparing a sugar solution for refreshments during the festival. However, there was uncertainty about whether the correct concentration of the sugar solution had been achieved. The attendant could not clearly explain how concentration can be determined, leading to concerns among the students.

**TASK**

(a) Analyse the information provided and provide the necessary information to help the students address the challenges arising from their investigation.

(b) Examine the canteen attendant concerns in preparing and measuring the concentration of sugar.



**Part (II)****ITEM 5**

A rural district in Uganda has established a **Renewable Energy and Technical Innovation Centre** to improve access to electricity for schools, health centres, and small industries. The centre has installed electronic equipment, including solar power systems, communication devices, and a high-voltage laboratory for training technicians.

During routine maintenance, several challenges arose. The backup energy storage unit in one of the electronic control systems failed, and many trainee technicians could not explain how the electrical component responsible for storing electric charge is charged and discharged. They were also unable to sketch the graphs that describe the charging and discharging processes.

To improve energy efficiency, an engineer proposed storing electrical energy in a **200  $\mu\text{F}$  energy-storage device** charged by a **12.0 V battery** and later using the stored energy to power a small electric heating coil immersed in **2 litres of water** for a laboratory demonstration. Before purchasing a new heating coil, the technicians needed to determine whether the energy stored in the device would produce the required increase in the water temperature. According to the manufacturer's specification, a suitable heating coil should produce a temperature rise of **at least  $1.71 \times 10^{-6} \text{ }^\circ\text{C}$**  when connected to the charged device. However, the trainees were unable to perform the necessary calculations or determine whether the heating coil met the required specification.

The centre also plans to demonstrate the production of very high voltages using an **electrostatic machine to run the factory**. However, many workers could neither explain how the machine builds up high voltages nor illustrate its operation using a labelled diagram.

Hint

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

**Tasks**

- Analyse** the concepts and address the challenges faced by the trainees.
- Examine** the information provided and explain whether the heating coil will meet the required specification and hence address the concerns of the workers.



**ITEM 6**

John woke up very early in the morning to prepare for work. He wanted to iron his clothes, but the electricity supply was too low to operate the electric flat iron. Although some light bulbs were glowing, they were very dim, and several electrical appliances could not function properly. Wondering why this was happening, John contacted his son, who was studying Physics in Senior Six. His son suggested that a device capable of stepping up an alternating voltage to the required value should be installed. John became curious and asked his son to explain how the device works. He also requested his son to explain the most likely causes of energy losses in the device and how such losses can be minimized.

As John was about to leave for work, his car failed to start. He contacted a nearby mechanic who, after inspecting the vehicle, concluded that the battery's performance was too low. The battery was disconnected so that its maximum power output could be investigated. However, the mechanic could not derive the expression for the maximum power delivered by the battery in terms of its electromotive force (e.m.f.) and internal resistance. He also failed to sketch the graph of power output against load resistance.

To determine the battery's e.m.f., the mechanic connected an ammeter in series with the battery and a  $2\ \Omega$  resistor. The ammeter read  $0.50\ \text{A}$ . When the  $2\ \Omega$  resistor was replaced with a  $5\ \Omega$  resistor, the ammeter reading dropped to  $0.25\ \text{A}$ . However, the mechanic was unable to calculate the e.m.f. and determine whether the battery was suitable for starting the car. The minimum e.m.f. required for the battery to start the car is  $1.5\ \text{V}$ .

**Tasks**

- a) Design the device and help John understand the concerns he raised with his son.
- b) Analyze the information and help the mechanic address all the challenges encountered during the battery test.

**END**

P510/1  
PHYSICS THEORY  
PAPER 1  
JULY 2026  
3 Hours



ACEITEKA JOINT MOCK EXAMINATIONS 2026

Uganda Advanced Certificate of Education

Physics

Paper 1

Theory

Time: 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*

*Indicate the items responded to on the first page of the answer booklet*



SECTION A  
(PARTICLES)

ITEM 1

In the factory, a worker found some sealed object left in one of the rooms some time ago. The sealed object was taken in their laboratory for investigation and it emitted entirely beta particles. Plato one of the intern and the engineer used a Geiger counter and measured an activity of 1600 counts per minute, and its half-life was 20 days from the last moment. After some time, the engineer and Plato found that the counter had reduced to 40 counts per minute, and the mass of the radioactive substance had not reduced. They wondered why and how the reading reduced and also how the count rate can be determined.

The manager found Plato asking the engineer why the emitted beta particles come from the nucleus even though the nucleus contains no electrons before decay, but she did not get a clear explanation. Near the sealed radioactive source there was a metal strip. Plato wanted to know its ability to emit radiations, so she performed a photoelectric effect experiment using a charged gold leaf electroscope which had a clean zinc plate placed on its cap. When a lamp was made to face the zinc plate, he made some observations which he failed to explain, and also wanted to know the work function of zinc metal such that he can tell other forms light which cause the same effect.

When the intensity of the light was increased, the stopping potential could not increase. Plato wondered why this was so, and when the laser pointer was directed to zinc, no observation was made, which confused Plato the more.

When Plato was moving he found students from one of the schools which had come to tour the factory talking about Rutherford's model how it's confusing to explain, and the model that makes electrons to be in specific energy levels. When Patricia heard them she asked them how the specific charge of ions that entered a magnetic field was determined and if there is any application of the effect that occurred in the scenario.

**Support Material**

Planck's constant  $h = 6.63 \times 10^{-34} \text{ Js}$

Wavelength of light = 200 nm

Stopping potential = 2.5 V

Accelerating potential (voltage) = 400 V

Magnetic field = 0.02 T

Radius of the electron = 3 cm

**Task:**

As a learner of physics at a level of senior six.

- (a) Carefully analyze the scenario and help Plato to address all her concerns.
- (b) Examine Patricia's concern.

**ITEM 2 (MOTION AND FORCE)**

In certain school, a group of students went for a tour by bus. One of the learners told a friend that the tires of the bus had flattened and he did not know why. The turn boy worked on them and they continued with the journey.

On their way to Entebbe airport, the bus moved over a hump which made them to move up and down and a learner wondered why it happened like that. When they reached the airport another learner saw an areophane and imagined how it's able to fly. He could also not tell the amount of force that can lift it, however when he asked the guide about it. He said the airplane can only fly if the lift force is 6.9kN and above.

When they were coming back to school the bus slid into a trench, the driver brought a tow car to pull it. The learners were amused on seeing the tow car pulling the bus and one asked why the tow car was not sliding. A friend said may be due to friction. One of the Students said their teacher talked about molecular explanation of friction however he could not just explain to the colleagues.

The driver said that for the tow car to be efficient, its engine should have a force of 9.7kN but he did not know how to calculate. A learner told the driver that to calculate it, he also needs to know the coefficient of friction which confused the driver the more. Since he could not tell how to determine its value. After towing, the driver opened the bus and told the students to enter, one learner who was near him heard the door making noise and he asked how that noise can be stopped but the driver could not give an answer. When they reached school, their teacher briefed them about what they had learnt and he asked Muzafaru a learner to explain any other application that uses the same principle like that of the airplane when starting to fly but he could not.

**Support material**

|                                               |                        |
|-----------------------------------------------|------------------------|
| Speed of air above the wings of the areophane | = $81\text{ms}^{-1}$   |
| Speed of air below the wings of the areophane | = $57\text{ms}^{-1}$   |
| Total area of the wings of the aero plane     | = $3.2\text{m}^2$      |
| Density of air                                | = $1.3\text{kgm}^{-3}$ |
| Mass of the bus                               | = $2000\text{kg}$      |
| Mass of the tow car                           | = $1000\text{kg}$      |



The tow accelerates at rate of

$$=0.8\text{ms}^{-2}$$

Coefficient of friction

$$= 0.25$$

Acceleration due to gravity

$$=9.81\text{ms}^{-2}$$

Task:

As a learner of physics;

- a) Analyze the scenario and address the challenges.
- b) Examine Muzafaru's worry.

## SECTION B

### PART I (ENERGY)

#### ITEM 3

At a rural health centre in Kuwero, Dr. Anna and her intern Peter are struggling with a damaged solar-powered vaccine refrigerator. The refrigerator uses a thermodynamic cycle to remove heat from the vaccine compartment (maintained at  $2^{\circ}\text{C}$ ) and releases it to the outside air at  $27^{\circ}\text{C}$ . The compressor does 500 J of work per cycle, and the refrigerator absorbs 1500 J of heat from the cold compartment each cycle. Peter wonders, "How much heat is released to the room" and "whether this is working as efficiently as it should" He calculates the coefficient of performance but worries because the actual performance is lower than the ideal coefficient value.

Nearby, a broken window allows humid outside air (relative humidity 80% at  $27^{\circ}\text{C}$ ) to enter. The doctor explains that water vapour in the air condenses on the cold evaporator coils, forming ice. Peter could not explain why ice forms even when the air temperature is above freezing. She reminds him of latent heat of vaporization and condensation, which Peter could not determine.

To check the vaccine vials, Peter uses a compound microscope in normal adjustment but could not tell the magnification of the system. The doctor told him to use a small refracting telescope (objective 80 cm, eyepiece 10 cm focal length) to spot a distant ambulance across the valley. Peter could not tell whether the telescope produces an upright or inverted image in normal adjustment.

Later, Peter helps fix a solar panel that powers the refrigerator. The panel provides 150 W of power for 6 hours of sunlight per day, but he wanted to know whether the power it produces is enough for the refrigerator. The compressor runs 30% of the time. When Musa saw Peter, he asked how the device can be operated, which Peter failed to explain.



### Support Material

Specific Latent heat of vaporisation  $L = 2.26 \times 10^6 \text{ J/kg}$

Ideal gas constant for water vapour  $R = 461.53 \text{ J/kg} \cdot \text{K}$

Compound microscope of object lens focal length = 1.5 cm

Compound microscope of eye piece of focal length = 5.0 cm

Tube length = 18.0 cm

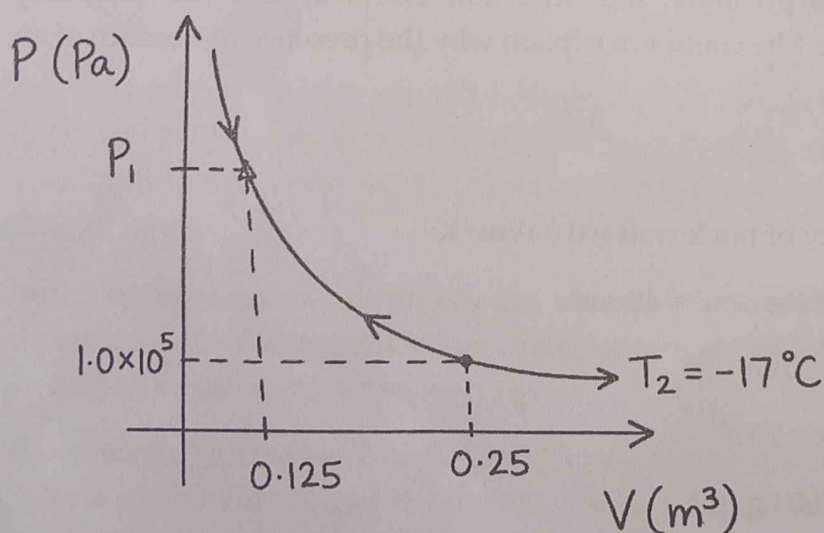
### Tasks:

As a learner of Physics at Senior Six level:

- Analyze the scenario to help Peter solve his puzzles.
- Address Musa's concern.

### ITEM 4

In a mountainous area of Uganda, community members face challenges leading to nose bleeding due to high air currents. A group of researchers went to this area to study the changes in atmospheric pressure and volume of the air current. The findings were plotted on a graph showing the variation of pressure with volume at a temperature of  $17^\circ\text{C}$ .



The graph helped the researchers understand the variation of pressure and volume of the air current in the community. They noted that the energy carried by the air current at a given temperature of  $-17^\circ\text{C}$  forces community members to enter their rooms for 9 hours for safety. The members were forced to stay indoors such that the temperature

difference between the surroundings and the inner room should be  $28.1^{\circ}\text{C}$  for them to be safe from nose bleeding.

The researcher asked the community leader about the material of the bricks used to construct the houses and their thermal conductivity, but the leader failed to determine it.

When the researcher entered one of the members' rooms, he found them playing music using an instrument that uses a string to produce sound. He wondered how sweet the music was. Musa, the person playing the instrument, told the researcher that for the music to be nice, the string should be under tension and vibrating at a frequency of 300 Hz and above, which was the third harmonic. This confused the researcher. When Musa touched the string, it was hot, which made him wonder how heat energy is generated in the string.

Joan, one of the researchers, observed that the sound pitch produced by the string instrument depends on the variation of frequency in the string and the tension. She wanted to know how this variation can be determined.

Later, in a separate laboratory experiment, a researcher set up a sonometer to investigate the relationship between frequency and tension. A paper rider was placed on the string. The string was plucked, and the rider vibrated. When she increased the tension, the rider still vibrated but at a different frequency. She was confused because she expected a simple relationship, but the results seemed inconsistent. She also wanted to determine the speed of the wave in the string when the tension was 20 N and the linear density was  $0.5\text{ Kg m}^{-1}$ . To understand further, she placed the sonometer in a vacuum chamber. Surprisingly, the rider still vibrated, and the frequency remained the same as in air. She could not explain why the presence or absence of air did not affect the frequency.

### Support Material

- Thermal conductivity of brick wall =  $0.6\text{ W m}^{-1}\text{K}^{-1}$
- Cross-section area of the wall =  $40\text{ cm}^2$
- Thickness of brick = 10 cm
- Tension in the string = 20 N
- Density of string =  $600\text{ kg/m}^3$
- Length of string = 1 m
- Diameter of the string =  $1.03 \times 10^{-3}\text{ m}$



Task:

- Analyze the scenario and help the researcher address their challenges.
- Examine Joan's task.

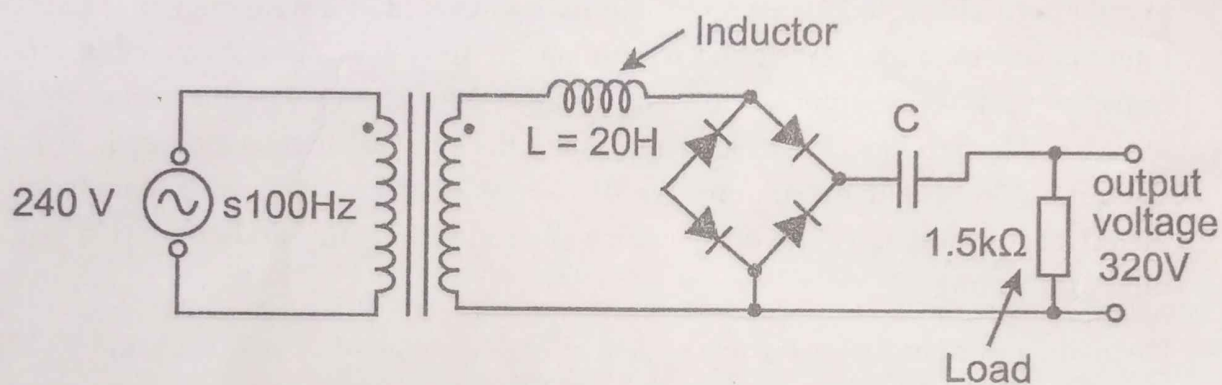
## PART II

### (FIELDS AND CHARGES)

#### ITEM 5

A certain school has a challenge of electricity fluctuations. The school management is planning to design a system which will solve the problem. To achieve this, their technician told them that they need a switch which can turn the generator on and off in case of power fluctuation, but the technician lacked the knowledge of how it works.

The circuit board of the school electricity distribution was shown in a diagram.



The technician consulted the engineer on how the circuit should be done to solve the electricity fluctuation. The engineer told him that the voltage should be improved since the hospital had many electric devices, but the technician could not explain how this can be done.

In the technician's circuit board, the technician was told to include a capacitor of capacitance  $50 \mu\text{F}$  and an inductor of inductance  $2\text{H}$ , but the capacitor was to act as a smoother, which he failed to understand.

When the technician went to the electronics shop, he wanted to buy a transformer but had no specifications, and the hospital devices required an output voltage of  $400\text{ V}$ , but could not carry out calculations to determine it.

Marth told the technician that at the school, they had devices which could also use d.c voltage, she wondered how this could be adjusted to work on them.



### Support material

Transformer should be of output voltage of 400v and more

#### Task:

- (a) Analyze the scenario and help the technician to address the challenges.
- (b) Examine Marth' challenge.

### ITEM 6

In our communities people listen to radios for many reasons among them are to promote emotional comfort, mental stimulation and to be informed of what is going on. John visited his parents with his child who was doing physics in s6. The parent complained to John of the challenge they had with radio set which often failed to tune in their favorable religious program the radio operated at a frequency of 0.755MHz John opened the radio and found it's tuning circuit consisting of a capacitor and an inductor very weak. John decided to install a new strong variable capacitor and inductor. He purchased materials and made the two small capacitor each of plate separation 2mm and maximum area of overlap  $0.005\text{m}^2$  filled with a material of dielectric constant 4. The two capacitor were found in series and connected with a motor for tuning.

He made a pure inductor L from a 15cm air-cored solenoid of 100 turns and  $0.012\text{m}^2$  cross sectional area John requested his child to perform the necessary calculation to establish whether the new circuit can tune in to desired channel.

John's parent also took the presence of their grandchild and asked for the explanation of the structure and mode of operation of radio charging device being used, because the grandparent had always wondered how the charger can be connected in the socket which was labeled 240 V to charge a radio whose input required only 12V

### Support Material

Permittivity of free space  $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$

Dielectric strength of air =  $3.0 \times 10^6 \text{ V/m}$

#### Task:

As a Physics student at Senior six level:

- a) Analyze the scenario and help John to address the challenges.
- b) Assess the concern of the grandparent about the structure of the device.

END

P510/1  
PHYSICS  
Paper 1  
July/Aug, 2026  
3HOURS



**PROVINCIAL EXAMINATIONS AGENCY (PEA)**  
**COUHELA MOCK EXAMINATIONS 2026**

**Uganda Advanced Certificate Of Education**

**Physics**

**Paper 1 (Theory)**

**Time: 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 calculator may be used.



## SECTION A

*Respond to all the items in this section.*

### Item 1

A research team working in a remote region was developing a high-speed launch system to study atmospheric effects using small projectiles. Before carrying out the experiment, the engineers had to analyse the motion of the projectile and ensure the safety of people working around the test site.

The prototype launcher projected a small object with an initial speed of  $330 \text{ m s}^{-1}$  at an angle of  $30^\circ$  to the horizontal. Some observers were positioned 100 m from the launcher, and the engineers wanted to determine whether this distance was safe. During the planning stage, members of the team discussed the physical quantities involved in the investigation and the importance of dimensional analysis in checking the validity of equations used to predict the projectile's motion. They also reviewed the equations describing uniformly accelerated motion before carrying out the test.

Later, one of the engineers travelled by vehicle from the research centre to inspect the test area. He left the station at 6:45 a.m. and travelled at a constant speed of  $108 \text{ km h}^{-1}$  until 7:45 a.m. At that point, he gradually slowed down and came to rest at 8:00 a.m. near the only underground well to refill the radiator. As the vehicle was stopping, he noticed that his body jerked forward and wondered why this happened.

### Task:

- Analyse the information provided and use it to educate the research team on the observations made during the launch experiment and the incident experienced by the driver.
- Determine whether the observers were safe and how far the research center was from the underground well.

### Item 2

During a university open day, the Department of Physics organized an exhibition to demonstrate concepts in radioactivity and atomic structure. Visitors, including secondary school students, moved through different stations to observe a variety of experiments and historical models.

At Station A, a cloud chamber was used to observe the tracks produced by radiation from a thoron gas sample obtained from a thorium hydroxide source. The demonstrator explained that the source had a half-life of 56 seconds and an initial count rate of 800 counts per minute. As the demonstration progressed, the tracks became less frequent, prompting discussions about radioactive decay, the different types of nuclear emissions and how the activity of a radioactive



source changes with time. They are also interested in knowing the count rate after 2 minutes 48 seconds.

At Station B, students observed a cathode ray tube and a canal ray tube operating side by side. The demonstrator explained how J. J. Thomson used cathode rays to determine the charge-to-mass ratio of the electron, while Goldstein's canal rays provided evidence for positively charged particles. The learners also observed the behaviour of the rays in electric and magnetic fields and discussed what the deflections revealed about their charge and mass.

At Station C, a model of Rutherford's gold foil experiment was displayed. The demonstrator used it to explain how the results of the experiment led to the nuclear model of the atom and why it replaced Thomson's plum pudding model.

Although many visitors enjoyed the demonstrations, they could not fully explain the observations or relate them to the underlying principles. The demonstrator requested you, as an advanced Physics learner, to help the visitors understand the concepts.

**Task:**

- Analyse the information provided and use it to educate the visitors on the observations made at Station A.
- Analyse the demonstrations at Stations B and C and use them to explain the development of the modern atomic model.

**SECTION B**

**Part I**

*Respond to only one item from this part.*

**Item 3**

In a certain secondary school in Kanungu District, a Physics teacher organized a practical lesson to help learners understand heat transfer, temperature measurement and entropy. The class was taken to the laboratory where they observed two experimental setups.

In the first setup, a beaker contained 120 g of water at  $60^{\circ}\text{C}$ . A mercury-in-glass thermometer, initially at  $18^{\circ}\text{C}$  and having a heat capacity of  $30 \text{ J K}^{-1}$ , was placed in the water to measure its temperature. The students noticed that the thermometer reading increased gradually before becoming steady, leading to a discussion about thermal equilibrium and the response of different thermometers. Some learners suggested using a thermocouple instead, claiming it would give a quicker reading. The teacher asked the learners to use the observations and the given data to determine the temperature indicated by the thermometer after equilibrium was reached. The specific heat capacity of water is  $4200 \text{ J kg}^{-1} \text{ K}^{-1}$ .

In the second setup, an electrical resistor operating at a constant power of 200 W was immersed in a stream of cooling water. The water maintained the resistor at a constant temperature of 27°C while carrying away the heat produced. The teacher challenged the learners to use the observations to explain the entropy changes taking place in the resistor-water system over a period of 1 minute and to judge whether the process complied with the second law of thermodynamics.

Many learners observed the demonstrations but could not fully explain the phenomena they had seen.

**Task:**

- a. Analyse the information provided and use it to educate the learners on the observations made in Setup One.
- b. Analyse the entropy changes occurring in Setup Two and comment on the process.

**Item 4**

Your parents operate an optical workshop that manufactures custom mirrors, lenses and other optical equipment for educational institutions. Recently, the security cameras installed around the workshop developed faults and could no longer monitor activities beyond the perimeter fence. Your parents began looking for an alternative optical device that could solve the challenge.

Meanwhile, a client visited the workshop requesting guidance on the design and testing of optical devices. The client wanted to understand the laws of reflection and refraction, the relationship between object distance, image distance and focal length in mirrors, and the behaviour of transverse waves on stretched strings, which are used in calibrating some optical testing equipment.

To demonstrate the optical system, an illuminated wire gauze was placed 40 cm in front of a convex lens of focal length 15 cm, producing an image on a screen. A convex mirror was then positioned 4 cm from the lens, between the lens and the screen, causing the final image to be formed beside the illuminated wire gauze. The client asked your parents to use this arrangement to determine an unknown property of the mirror.

For the wave demonstration, a uniform wire of length 1.00 m and mass  $2.0 \times 10^{-2}$  kg was stretched between two fixed supports under a tension of 200 N. The wire was plucked at its midpoint and allowed to vibrate. Some visitors observed the demonstration but could not explain the motion of the waves or relate it to the production of sound.

**Task:** As a physics student;



- Analyse the information provided and use it to educate the client on the optical and wave phenomena demonstrated in the workshop.
- Help the parent in discovering the focal length of the convex mirror and the fundamental frequency of vibration of the stretched wire.
- Design an optical solution that can be used to address the security challenge at the workshop.

## Part II

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

### Item 5

In May 2026, the Katabi Solar Tech Hub in Wakiso District commissioned a new off-grid solar power system to supply electricity to a community ICT centre and a nearby health clinic. The system consisted of solar panels, rechargeable batteries, charge controllers and an inverter. During the commissioning exercise, the lead engineer explained how different electronic components ensured that the system operated safely, efficiently and reliably.

As the trainees inspected the solar panels, they noticed small black electronic components mounted at the back of each panel and were told that they prevented reverse current during the night. They also observed that the inverter remained cool even while delivering high power to the loads, prompting a discussion on the role of semiconductor devices in power regulation. In the control room, the engineer explained that the battery charging circuit was designed so that charging would occur only when the solar panel voltage exceeded the battery voltage, the battery temperature was below  $45^{\circ}\text{C}$ , and the main switch was turned on. The trainees were asked to represent these charging conditions using an appropriate logical circuit.

The engineer later demonstrated an electrical experiment using a 240 V, 1 kHz a.c. supply connected in series with a  $4.6\ \mu\text{F}$  capacitor and an inductor of negligible resistance. The circuit drew a current of 3.0 A from the supply. To illustrate energy transfer in capacitors, he charged a capacitor of capacitance  $C_1$  using a battery of e.m.f.  $V_0$ , disconnected the battery and then connected the charged capacitor to another uncharged capacitor of capacitance  $C_2$ . The trainees observed that some of the stored energy was lost during the transfer but could not explain why.

Collaborate with the lead engineer to help the trainees on the following tasks.

### Task:

- Analyse the information provided and use it to educate the trainees on the electronic components and charging system demonstrated at the Solar Tech Hub.
- Analyse the electrical demonstrations and determine the inductance of the inductor and the energy lost during the transfer of charge between the capacitors.



#### Item 6

Technicians at Uganda Electricity Distribution Company Limited were troubleshooting faults in rural power distribution networks. During a safety briefing, the lead engineer discussed why aluminum cables on transmission poles expand and lose tension on hot days, and asked the team to explain why the resistance of a conductor increases with increase in temperature.

The team then analyzed a damaged cable using a meter bridge. A 110 cm length of the cable with diameter 0.85 mm was placed in the left-hand gap, while a  $10\ \Omega$  standard resistor was placed in the right-hand gap. The balance point was found at 46.7 cm from the left end of the bridge. The engineers were expected to derive the balance condition of the meter bridge and use it to determine the resistivity of the cable.

In the workshop, the engineer used a bar magnet and a soft iron core to illustrate how magnetic domains align in ferromagnetic materials. He also tested a small device: a vertical square coil of side 5 cm with 100 turns carrying 1 A was positioned in a horizontal magnetic field of 0.2 T, with the coil's plane set at  $30^\circ$  to the field direction. The coil twisted when current flowed. The technicians were asked to explain the molecular (domain) theory of magnetism, derive the expression for the force on a straight conductor carrying current perpendicular to a magnetic field, determine the torque acting on the coil, and state two possible ways to increase this torque.

Before closing, the team inspected the main warehouse. A tall copper rod was installed on the roof, running down the wall to an earth pit. The engineer asked the technicians to explain how this installation works.

#### Task:

- Analyse the issues of resistance with temperature, the meter bridge experiment, and the magnetic effects including torque on the coil.
- Interpret the purpose and operation of the copper rod installation at the warehouse.

**END**





## UGANDA TEACHERS' EDUCATION CONSULT (UTEC)

### Uganda Advanced Certificate of Education

#### 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.*



### Item 1

An art fact piece from a long-ago site was being observed at the museum by a scientist, he uses carbon-14 dating which made the intern he was working with amused, on how the process operates. A **200 g** sample of the artifact showed an activity of **0.085 Bq** of carbon using a certain device but the people around wondered how the device used, worked to establish that activity of the detected radiation. Modern carbon has an activity of **0.255 Bq** per gram. Carbon-14 has a half-life of **5,730 years** and decays by beta particle emission to nitrogen-14.

Before dating, the scientist demonstrates the photoelectric effect, by charging a zinc plate negatively on a gold-leaf electroscope and observed that under ultraviolet light (of wavelength 254 nm), the leaf falls and under red light (of wavelength 600nm), nothing happens. He measured a stopping potential of **1.2 V** for zinc whose electrons have to be ejected with a minimum speed of  $6.4 \times 10^5 \text{ ms}^{-1}$ , which made him puzzled. He later explains that this effect led to Bohr's atomic model. The intern recalls Rutherford's gold foil experiment, which showed a tiny, dense nucleus, but failed to explain the observations witnessed.

### Support material

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

$$\text{Mass of an electron, } m = 9.11 \times 10^{-31} \text{ kg}$$

$$\text{Speed of light in a vacuum, } c = 3.0 \times 10^8 \text{ ms}^{-1}$$

$$\text{Plank's constant, } h = 6.6 \times 10^{-34} \text{ Js}$$

$$\text{Work function of the zinc plate} = 3.0 \text{ eV}$$

### Tasks:

- Analyze the Information given above,
- Address the Concern by explaining to the intern how the device works

### Item 2

During a study tour, the school hired a car for transporting students. The driver of the car was driving at **108 kmhr<sup>-1</sup>** and unfortunately the car burst a tyre due to high temperatures, went off the road, and hit a tree by the roadside. In due course the driver brakes suddenly and whoever in the car jerks forward and the driver, who had not put on a seatbelt, hit his chest to the steering wheel and got injured. His turn boy, who had put



on a seatbelt, was also thrown forward and sustained injuries. While his turn boy who put on a seat belt took  $0.1\text{ s}$  to bring him to rest and sustained minimum injuries a force of  $24000\text{ N}$  the seat belt should exert on him and maximum energy of the belt absorbed being  $3.6 \times 10^4\text{ J}$  for minimum injuries. Nevertheless, one curious student asked colleagues to explain why they were jerked forward when the car stopped suddenly and the major cause of the tyre bursting in the area. Car owners and mechanics were also blamed for not installing safety devices in the car which led to more injuries sustained by the driver.

*Support material:*

- Mass of car = 1.1 metric tonnes
- Acceleration due to gravity,  $g = 9.81\text{ ms}^{-2}$
- Mass of turn boy =  $80\text{ kg}$

**Task:**

*As a learner of Physics:*

- Analyze the data to give t help.
- Examine the concern about blaming the car owners.

**SECTION B**

**PART I**

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

**Item 3**

The husband organized with his wife to have Christmas celebrations with his family members in the village. Very early in the morning together with the family, he set off for the village. The day was bright and sunny. On their way, his children sighted a pool of water ahead of them; on reaching it, it disappeared, which surprised them and brought a debate in the car. He challenged the eldest son to explain to his siblings and he failed to convince them.

Then they branched off from the tarmac road to a dusty one leading to their home with two telecommunication masts, and while driving between them as he made phone calls with his family members while still on the way, the network bars on his phone kept dropping and increasing, making communication difficult which again brought back the debate in the car about the cause of clear and poor network connections.



After the celebrations, the husband visited a friend who is a telecom engineer and narrated the challenges he and his family faced. The engineer replied that even a certain hospital had raised a similar concern and was finding it difficult to keep patients' data and communication within the hospital. The engineer informed him that they were designing a light-based communication system to overcome the challenge in which its effectiveness is based on the angle of incidence of light signals entering the glass core and the critical angle with the cladding inner layer, not exceeding  $31^\circ$  and  $73^\circ$  respectively.

**Support material:**

Refractive indices of glass core, cladding material and air being 1.60, 1.52 and 1.00 respectively.

**Task:**

*As a learner of Physics:*

- (a) Analyse the data to settle the debate.
- (b) Examine the engineer's concern.

**Item 4**

A grandfather was celebrating his 80<sup>th</sup> birthday and invited many relatives and friends to a garden party. His age-mate played his favourite music. During the process, they plucked the string in the middle that was mounted on a hollow box, which produced sound. However, when one of the visitors got excited and also pulled out his violin to play the same song sung by all the guests, one curious visitor asked his neighbour how harmonics are produced and how they affect the timbre. He also wondered about the effect on pitch if the tension in the string exceeds 700 N, the set tension in the string. As the afternoon became hotter, guests requested a cold drink. Grandfather had prepared 80 kg of juice at  $30^\circ\text{C}$  but wanted to cool it to  $10^\circ\text{C}$  before serving, using ice at  $0^\circ\text{C}$ . The family needed to determine the minimum mass of ice required so that enough ice could be supplied. The supplier cautions that if the required mass exceeded 25 kg, an additional container of ice would be necessary.

Later, Grandfather tried to read birthday messages printed on a decorative poster on the wall near where he was standing. Although the writing was large, he struggled to read it clearly, while some younger guests could read it easily. One of the family members after the party wanted to know whether this problem can be solved medically and with which device and had to pay a visit to a medical doctor for guidance.



*Support material:*

- Specific length of guitar string = 0.65 m
- Fundamental frequency of a note = 82.4 Hz
- Mass of the string = 42.0 g
- Specific heat capacity of juice =  $4.2 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
- Specific latent heat of fusion of ice =  $3.36 \times 10^5 \text{ J kg}^{-1}$

**Task:**

*As a learner of Physics:*

- Analyze the information and all the concerns.
- Examine the doctor's concern.

**Part II**

*Respond to one item from this part*

✓ **Item 5**

Some schools in Uganda are faced with challenges of ineffective communication especially on assemblies due to a lack of address systems. The head teacher in one of the secondary schools bought a portable speaker address system. This speaker could, however, work for a short time and stop. The head teacher claimed that the problem could be the high internal resistance or EMF of the battery used for charging. The battery could be the power bank of 15 V in the speaker and takes at least 9 seconds to get fully charged.

One S.5 student approached the head teacher and requested to test the battery and establish if it was indeed the problem. The student opened the speaker and connected the battery in series with a variable resistor and an ammeter, and two capacitors of the same capacitance in series. The student had observed faint bluish glows and crackling sounds around the high voltage transmission cables near the antenna mast and asked why such glowing discharges appeared around the conductors during wet weather and how the shapes of the conductors could influence the distribution of electric charge on them.

The school warden asked the student, as he was testing the circuit, how a power bank of 15 V could be charged by a charger inserted in a socket labelled 240 V. The S.5 student tried but could not succeed in addressing any of the matters raised. He went to S.6 Physics students for assistance.



**Support information:**

- Capacitance of each capacitor in the speaker =  $1.0 \text{ F}$
- Resistors of  $21 \Omega$  and  $36 \Omega$  were set for currents of  $0.48 \text{ A}$  and  $0.30 \text{ A}$  flowing respectively.

**Task:**

- Analyze the data to give the necessary assistance.
- Address the concern of the warden.

**Item 6**

Listening to religious radios is highly advisable for people to promote emotional comfort and mental stimulation. A Reverend visited his parent with a friend who was doing Physics in S.6. The parent complained to the Reverend of the challenges they had with their radio channel which often failed to tune in to their favourable religious program. The radio operated at a frequency of  $159 \text{ Hz}$ . The Reverend opened the radio and found its tuning resonance circuit (as indicated in Figure 1). When it rained in the evening, sparks appeared around the aerial antenna, which puzzled the parent.

The Reverend tasked his friend to identify the device in Figure 1. The signal was found to be very weak. Then the Reverend replaced the resistor with a straight wire and adjusted the current flowing in the circuit to a maximum value and their favourable religious program was captured, bringing joy to the parent. The Reverend challenged his friend to explain the physics behind capturing the radio station, for which the current in the wire exceeds  $1.9 \text{ A}$  and a frequency of  $159 \text{ Hz}$  is obtained. Also when it rained in the evening as they were listening, sparks appeared around the aerial antenna which further puzzled the parent. The Reverend tasked his friend to identify the device in Figure 1 and explain how it works.

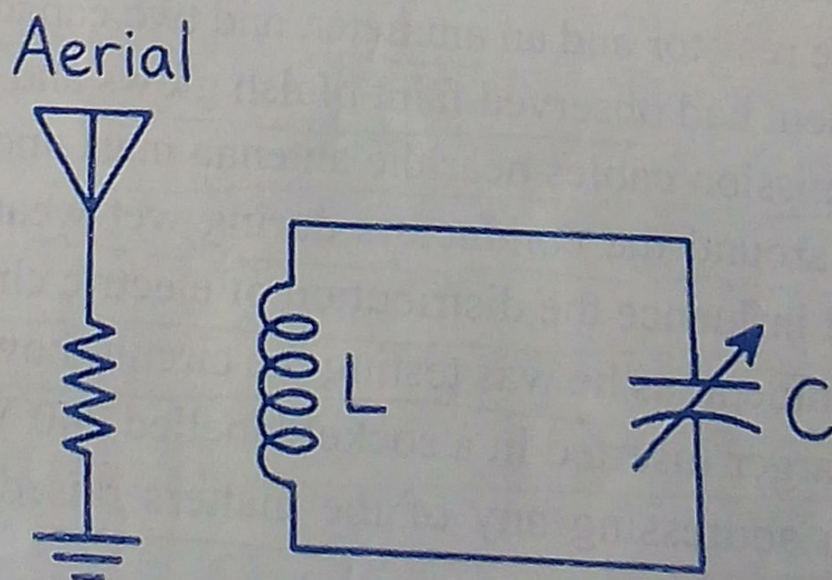


fig. 1



**Given data:**

- Length of straight wire = 5.0 cm
- Mass of straight wire = 2.0 g
- Magnetic field around the straight wire due to current causes magnetic flux density  $B = 0.20 \text{ T}$
- Capacitance of the variable capacitor  $C = 2.0 \times 10^{-6} \text{ F}$
- Inductance of the inductor  $L = 0.5 \text{ H}$

**Task:**

*You have been approached by the Reverend's friend:*

- a) Analyse the data to give the necessary assistance.
- b) Address the concern of the Reverend about **Fig. 1**.

**END**



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  
Theory  
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.*
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- *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 ( $^{60}_{27}\text{Co}$ ) 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  $9 \times 10^{14}$  Bq to produce at least  $4.5 \times 10^{23}$  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  $^{60}_{27}\text{Co}$  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 =  $6.02 \times 10^{23}$  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  $2 \text{ m/s}^2$ . This is followed by a banked circular bend of radius 60 m, arc length 0.2 km, and inclination  $10^\circ$  to the horizontal. After negotiating the bend, the car travels along a further straight section 0.3 km long, where it decelerates uniformly at  $1 \text{ m/s}^2$  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  $15^\circ$  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

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,  $G = 6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-1}$ .
- 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  $25^{\circ}\text{C}$ , then adds 35 kg of food from a cool store at  $15^{\circ}\text{C}$ . Their stove supplies 6800 W but only 72% reach the pot. Everything must reach  $100^{\circ}\text{C}$ , 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 =  $4200 \text{ J/kg/K}$
- Specific heat capacity of the food mixture =  $3400 \text{ J/Kg/k}$
- Specific heat capacity of aluminium =  $880 \text{ J/kg/k}$
- Specific latent heat of vaporization of water =  $2.26 \times 10^6 \text{ J/kg}$ .

**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  $0.6\text{m}$  and mass of  $4.2\text{g}$ . The string was tuned to fundamental frequency of  $82.4\text{Hz}$ . 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  $74.14\text{Hz}$  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 their 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  $3.0\Omega$ . 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  $1.5\text{mm}^2$ . 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  $1.7 \times 10^{-8} \Omega\text{m}$ .

Resistivity of aluminum is  $2.8 \times 10^{-8} \Omega\text{m}$ .

**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  $2200\mu\text{F}$  capacitor charged to p.d of  $330\text{V}$ . Each flash lasted about  $1.5\text{ms}$ , the flash tube and the capacitor was recharged by a current of  $120\text{mA}$  before the next photograph could be taken. However, for next flash, the power dissipated should be at least  $79\text{kW}$  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  $6\text{s}$  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  $4.0\text{m}$  maintained at a potential of  $5.0 \times 10^6\text{V}$ . It also had an insulating belt driven by a  $240\text{V}$  electric motor drawing a current of  $2.5\text{A}$  for  $8.0\text{s}$  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's

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  $8.85 \times 10^{-12} \text{ Fm}^{-1}$

**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**



510/1  
PHYSICS  
Paper 1  
3 hours

BUSHENYI MOCK EXAMINATIONS 2026  
UGANDA ADVANCED CERTIFICATE OF EDUCATION

PHYSICS

Paper One

(Theory)

3 Hours

**INSTRUCTIONS TO CANDIDATES:**

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## SECTION A

*Respond to all the items from this section*

1. A produce depot at a rural trading centre had been receiving complaints of delays at the loading bay and a rising electricity bill. The manager invited an engineer to spend the day at the depot, and asked a Senior Six student on internship to walk with him.

At the loading bay a loaded trolley of mass 150 kg was released from the storeroom and ran at  $4 \text{ ms}^{-1}$  along the level track. It locked with a stationary empty trolley of mass 50 kg at the truck, and the pair moved off together and struck the buffer wall at the far end. The wall had cracked from repeated impacts, and the engineer said the speed of the pair at the wall had to be known before a spring buffer of the right stiffness could be ordered.

Beyond the track was a wooden ramp inclined at  $25^\circ$ , up which the workers pushed 80 kg sacks of maize onto the truck. The workers had complained that the sacks felt much heavier on the ramp than on flat ground, and the manager was considering replacing the wooden ramp with a smoother metal one. The engineer found the coefficient of friction between a sack and the ramp to be 0.35, and asked the student to work out the force needed to push a sack up at steady speed so that the two ramps could be fairly compared.

At the electric hoist, rated 2.5 kW, which raised feed sacks to the upper store, the engineer timed a lift and found it took 10 s to raise a 200 kg load through 8 m. He said the rising electricity bill was partly explained here, and asked the student to check whether the hoist was still giving the manufacturer's claimed performance.

The steel cable on the hoist had frayed and was to be replaced. The engineer warned that a wrong grade of steel would stretch too much or snap under load, and that the Young's modulus of any new sample had to be measured before ordering. The manager had never seen this done, and asked the student to describe an experiment for the Young's modulus of the steel using only a long wire, a scale and standard loads.

At the landing site behind the depot, a wooden boat ferried sacks across the river. When empty it rode high on the water, but as sacks were loaded it sank deeper, though it always stayed afloat. Two boatmen had recently overloaded it and nearly capsized, and the manager wanted a clear explanation of what kept it up under load so that a safe loading limit could be set.

**Hint:**



- Acceleration due to gravity  $g = 9.8 \text{ ms}^{-2}$

**Task:** As a student of Physics,

- help the manager settle the matters at the loading bay, the ramp and the hoist.
  - describe the experiment for the Young's modulus of the steel and explain what keeps the loaded boat afloat.
2. A mobile health team had visited a rural community with a chest imaging machine and materials for an afternoon public health talk. A parent had brought his elderly mother for a chest examination in the morning and stayed on for the talk. Several things he saw during the day left him unable to answer his family's questions at home.

At the imaging station a technician passed his mother through a large machine that produced a picture of her chest showing the bones and lungs. He explained that a special radiation, made when fast-moving electrons were driven onto a metal target inside the machine, formed the picture, and warned that his mother should not be brought back more than twice a month. The parent wanted to know how this radiation was produced, why it could pass through flesh yet be stopped by bones, and why the visits had to be so limited.

On the way to his mother's ward, he noticed a small doorway that opened on its own whenever anyone approached, with no switch touched. He was told that a beam of light fell on a small metal plate hidden inside the doorframe, and when the beam was cut the door opened. He could not see how a beam of light on a plate could pull open a heavy door.

In the afternoon a health worker demonstrated the flame test used to check water samples for traces of certain metals. Sodium gave a bright yellow, copper green and lithium a deep red. She said each metal had its own set of colours, always the same wherever it was found, and this was how contaminated water sources were quickly identified. The parent could not see how the colour of a pinch of salt in a flame could tell anyone what metal was inside.

She then explained why the hospital preferred solar panels to the national grid, saying that the Sun's heat came from hydrogen nuclei joining to form helium, and that the helium formed had slightly less mass than the hydrogen that went in. She gave the mass of four hydrogen nuclei as  $6.6905 \times 10^{-27} \text{ kg}$  and that of the helium nucleus formed as  $6.6447 \times 10^{-27} \text{ kg}$ , and claimed that a single such joining released a very large amount of energy for its size. The parent wanted to check this claim for himself.

At the end of the day another speaker showed a wooden carving said to be many centuries old, whose age had been worked out from the small amount of a radioactive form of carbon still in the wood. He said that after 5730 years half was left, and after another 5730 years only a quarter. The parent could not follow how the age of the carving could be read from what remained inside it.

**Hint:**

- Speed of light  $c = 3.0 \times 10^8 \text{ ms}^{-1}$

- $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$

**Task:** As a student of Physics,

- (a) help the parent understand and check the claims he heard during the day.
- (b) explain to him the safety of the imaging machine and how a decaying substance can be used as a clock.

## SECTION B

### PART I

*Respond to one item from this part*

3. A shopkeeper who ran a small hardware store in a rural trading centre found himself, on a busy market morning, being asked by several customers to explain matters he could not fully understand.

The first was a young cyclist who had returned a bicycle pump bought the day before. He said that when he pumped air quickly into the tyre, the lower part of the pump became hot after only a few strokes, and he feared it would burst. He asked whether the pump was faulty or whether the pumping itself was the cause.

Soon after, a lorry driver came in with a related worry. He had inflated his tyres in the morning to  $2.0 \times 10^5 \text{ Pa}$  at  $22^\circ\text{C}$ , but after driving on a hot road all afternoon they were now at  $57^\circ\text{C}$  and much firmer. Before continuing, he wanted the shopkeeper to work out the new pressure, assuming the volume had stayed the same, so he could decide whether to release some air.

A tenant came in about a new water heater whose inner tank held water at  $80^\circ\text{C}$  in a room at a steady  $25^\circ\text{C}$ . He had noticed the water cooled quickly at first and much more slowly later, and wanted to know how the time at which it would fall to a temperature safe for bathing a baby could be estimated.



A telephone technician then arrived for a thin glass strand used to carry telephone signals. He said light entering one end travelled along the strand for many kilometres, bouncing along the inside walls without escaping. The shopkeeper's son had asked the previous evening why the company had switched from copper to this glass, and he could not see how light could survive such a long journey without leaking out.

A schoolteacher came in with two lenses of focal lengths 80 cm and 5 cm to be fixed at the ends of a tube. He was preparing a class demonstration for viewing distant objects with the final image at infinity, and wanted the correct tube length to pass to the school carpenter.

Late in the afternoon two young men brought guitars in for tuning. When both were played together, a slow throbbing rise and fall of loudness was heard even though the notes sounded almost the same. They also asked why shortening the vibrating length of a string raised its pitch, since they needed the string length that would give each required note for the evening concert.

**Task:** As a student of Physics,

- (a) help the shopkeeper settle the matters raised by his customers.
- (b) explain to the telephone technician how the thin glass strand carries the signals.

4. A community leader was putting up a new house in his village and had invited a builder to help with materials and layout. Several matters arose that neither of them could explain.

The kitchen was being fitted with a tall chimney rising above the roof. The builder said it would draw smoke away from the fire without a fan. The leader was worried smoke might fall back into the kitchen at night when the fire went out, and wanted to know what kept the hot air rising in the first place.

At the well outside, the leader looked down at the water surface. The well was truly 3.0 m deep, full of water of refractive index 1.33, yet from above the water appeared only about 2.3 m below the ground. He was about to buy rope for the bucket and did not want to buy too little for the true depth.

His wife then complained about a new pair of sunglasses. When she looked through them at the shiny bonnet of the car in the sunshine, most of the glare disappeared, but as she tilted her head sideways it returned. She was going to be driving in the afternoons and wanted to know whether the sunglasses were faulty before returning them.

A fisherman friend also dropped by. He had bought a small instrument for his boat that measured water depth by sending a sound pulse downwards and listening for the echo. Fishing in a part of the lake known from the map to be 150 m deep, he wanted the leader to work out how many seconds after the pulse the echo should return, so as to check whether the instrument was reading correctly.

In the afternoon the builder pointed at the iron roof and said it reached very high temperatures on a hot day because it took in radiation from the Sun. He mentioned that the Sun's surface was at about 5800 K, and that this set how much energy fell on the roof each second. The leader was deciding whether to fit an under-roof insulation layer, and wanted to know how anyone could work out the Sun's temperature when no instrument had ever been sent close to it.

Later in the evening he smelt food cooking from the kitchen moments after the pot had been uncovered, though he was sitting far away in the sitting room, and wondered how the smell could travel so quickly through still air.

**Hint:**

- Speed of sound in water  $\approx 1500 \text{ ms}^{-1}$

**Task:** As a student of Physics,

- (a) help the community leader settle the matters raised during the day.
- (b) explain to the fisherman how the depth-measuring instrument works.

## **PART II**

*Respond to one item from this part*

5. After a busy holiday season, a hotel owner in a rural trading centre had called in a technician for a whole-day inspection of the lodge's electrical installations. The technician used the visit to explain several things to the owner, who had never studied how his own equipment worked.

The old kitchen refrigerator had been drawing too much current, and the technician suspected a faulty heating element. He set up a metre bridge on the workbench to compare the good element with the faulty one, connecting them as opposite arms and sliding a contact along a uniform resistance wire until a centre-zero meter read zero. He said the contact position would give the resistance of the faulty element, but the owner could not see how sliding along a wire could measure a resistance.



The dining hall ran off the 240 V mains, but a display cabinet used small 12 V lamps. The technician had fitted a small transformer between the two, said to be 95% efficient. The display was drawing 8.0 A on the secondary side, and he asked the owner to work out the current on the primary side, since the mains fuse had to match this current or the display would keep tripping.

The next stop was an old electric fan whose motor had stopped turning. When it was opened, the owner saw only a coil between the poles of two magnets, connected through a split ring to the supply. The technician said that when current flowed in the coil, the coil turned and drove the blades. The owner asked how passing electricity through a coil between magnets could make it rotate on its own.

At the reception, a battery bank was being charged from the mains through a small circuit of diodes. The technician said the alternating current from the wall could not charge a battery directly, and the diodes turned it into a one-directional current first. A guest the previous week had asked whether the battery would be damaged by the mains cable, and the owner wanted a clear explanation for future guests.

Outside the lodge, two isolated point charges of  $+3.0 \mu\text{C}$  and  $-2.0 \mu\text{C}$  had been fixed 30 cm apart on a demonstration board for the primary school next door. A visiting teacher had left a note asking the owner to work out the resultant electric field at the midpoint between them before the pupils arrived, but the owner had no idea how to begin.

The security guard finally complained that the alarm bell at the gate no longer rang loudly. When the casing was opened, the owner saw a soft-iron core wound with a coil, which pulled a small hammer against a gong whenever current flowed. He wanted to know why the iron inside the coil could suddenly pull the hammer, so that he could describe the fault when ordering a new bell.

**Hint:**

- Coulomb's constant  $\frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$

**Task:** As a student of Physics,

- help the hotel owner settle the matters raised during the inspection.
  - explain to the security guard how the bell is supposed to work.
6. A small printing press in a rural trading centre had been suffering frequent equipment failures, and the owner had called in a technician for a whole-day inspection. As they went round the workshop,

the technician explained what each piece of equipment did, and the owner recorded the discussion in his notebook.

They stopped first at the main press, where the technician set up a small hand-held instrument he called a "field probe." He held it near the cable feeding the press motor and a reading appeared on the screen. He said a thin slice of a special material inside developed a small voltage across its width whenever it was placed in a magnetic field, and this voltage was what the screen showed. The owner could not see how a slice of solid material could develop a voltage on its own simply by being near a current-carrying cable.

They then moved to the scrap-metal store at the back, where a large electromagnet lifted metal offcuts. As the technician opened the switch to shut it off, a bright bluish spark jumped across the contacts, even though the supply was only 24 V. The owner had feared this spark would burn the contacts, and asked how such a small supply could give such a bright spark, and why the spark appeared only on opening the switch and not on closing it.

At the shop entrance, an outside lamp switched itself on as soon as the sun went down. The technician said a small light-sensitive resistor and a transistor inside a box did the switching, with no one touching anything. The owner had been thinking of installing similar switches at the store gate to save on night watchman wages, and wanted to know how a change in the light on a small piece of material could turn a whole lamp on or off.

Inside the office was an inkjet printer, and the technician explained what happened inside it. Tiny charged ink drops were guided by two parallel plates; when the plates were switched on, the drops bent as they passed through and landed at different points on the moving paper, forming letters. The owner had recently been getting blurred letters and suspected the plates were failing. The technician asked him to work out the sideways deflection of a drop of mass  $1.5 \times 10^{-11}$  kg and charge  $3.0 \times 10^{-13}$  C, moving at  $20 \text{ ms}^{-1}$  and spending 2.0 ms between plates producing a field of  $8.0 \times 10^4 \text{ N C}^{-1}$ , so that it could be compared with the manufacturer's specification.

At lunchtime the technician set up a demonstration for the apprentice in which a  $500 \mu\text{F}$  capacitor was discharged through a  $20 \text{ k}\Omega$  resistor to dim a small lamp slowly. He said the time for the voltage to fall to any chosen fraction of the starting value depended only on the two components, and asked the owner to work out how long after the switch closed the voltage would have fallen to about one third of the starting value. A similar arrangement was to be fitted to the delay circuit on the main press for a soft start.



Their last stop was the fluorescent tube that lit the office in the evening. The technician pointed out a small coil in series with the tube and said this coil, which he called a "choke," was what lit the tube on switching on and later kept the current steady. The owner had wondered whether the choke could be removed to save on materials, and the technician warned that this would ruin the tube. The owner wanted a clear explanation before passing the warning on to the apprentice.

**Task:** As a student of Physics,

- (a) help the owner settle the matters discussed during the inspection.
- (b) explain to him the role of the choke in the fluorescent tube circuit.

**END**