

P510/1
PHYSICS
Paper 1
(Theory)
2026
3 hours



UGANDA NATIONAL EXAMINATIONS BOARD
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.

SECTION A

Respond to all the items in this section.

Item 1

There is a construction site within the same premises with a multi-storey building. Within the multi-storey building, there is a lift installed to transport people.

The site engineer of the construction site was at the 5th floor of the multi-storey building, handling some. A new worker at the construction site urgently wished to meet the site engineer. They decided to use the lift to ascend there. As the lift just started to ascend, the new worker felt heavier than before, normal weight as the journey progressed and lighter as the lift came to a stop. She could not understand her experience in the lift.

The sight engineer had briefed the workers at the site on two wooden planks that can be used to transport blocks of concrete from the ground floor to the first. He told them to incline the plank at 45° to the horizontal and pull each block at a time with a force of 160 N along the plane. Additionally, he mentioned that the acceleration due to gravity is 9.81 m s^{-2} . Finally, he told them to select the board having coefficient of friction less than 0.2. He advised them to select the efficient board experimentally.

At the construction site, there is a single room that was not demolished. It was assigned to serve as a kitchen for at least two years; the projected construction period. Cooks complained about too much smoke that is affecting their eyes. There is a visitor who said that a solution can be crafted without major structural changes on the kitchen wall.

Your teacher of Physics took you to the construction site to learn about structures and you were briefed on the challenges faced.

Task:

- a) Analyse the information provided and use it to educate the new worker on her experience and guide the workers to experimentally select the required board.
- b) Design a solution that uses Bernoulli's principle to address the problem experienced by the cooks.

Item 2

Your teacher organized a tour to a facility which has all the apparatus needed for demonstration of concepts learnt. To help them appreciate the concepts, an expert assembled apparatus and demarcated the tube into three sections; P, Q and R, as shown in figure 1:

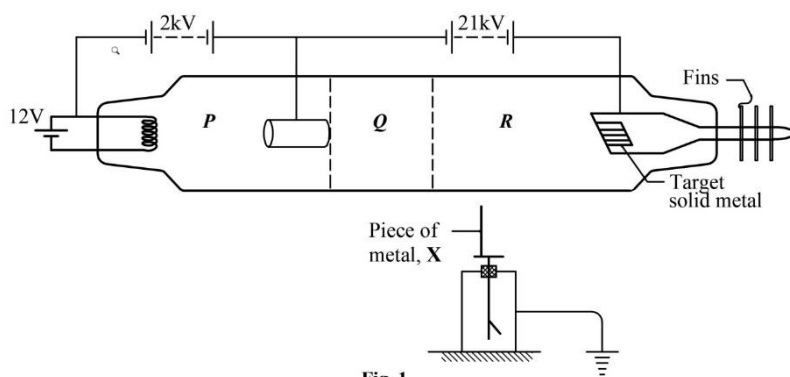


Fig. 1

Between the coil and the cylinder, she set up a potential difference of 2 kV, with the cylinder at positive potential relative to the coil. In section Q, she set up perpendicular electric (E) and magnetic (B) fields. Where, $E = 7.2 \times 10^4 \text{ V m}^{-1}$ and $B = 3.0 \times 10^{-3} \text{ T}$. The target solid metal in Section R was connected to a positive potential of 21 kV. The expert mentioned that the target metal absorbs 99% of any energy incident on it.

When a piece of metal, X, of work function 0.1 keV was placed near the tube as in figure 1, the gold-leaf diverged from the metal plate and this surprised the learners. They also wondered about processes taking place in sections and whether the effect that occurred on the piece of metal, X, had any real-life application.

The following facts were provided:

- Electron charge, $e = 1.6 \times 10^{-19} \text{ C}$.
- Mass of an electron = $9.11 \times 10^{-31} \text{ kg}$.
- One electron volt, $\text{eV} = 1.6 \times 10^{-19} \text{ J}$.

As much as the expert carried out the demonstration, majority of the learners could not explain the observations made and feared to ask the expert. One of the learners in the group recorded the whole demonstration and shared it with you.

Task:

- a) Analyse the concepts that were demonstrated in the different sections of the glass tube plus the observation made on the gold-leaf, and use it to educate the group.
- b) Analyse the application of the effect that occurred on X in modern technology, explaining how the effect enables the application to function.

SECTION B

PART I

Respond to one item from this part

Item 3

Uganda, just like any other African country, is facing the challenge of deforestation due to many households depending on the use of firewood and charcoal. Several projects and initiatives across Africa utilize concave/parabolic reflectors for solar cooking. In a bid to help nearby villages that are off-grid, a group of students were tasked with a project of designing a system that can help the villages to cook using concave/parabolic reflectors.

The following information was provided:

- Stefan's Constant, $\delta = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$.
- Heat Capacity of the thermometer bulb = 70 J K^{-1} .
- Effective cooking system should generate at least 20 kJ of heat energy.

One group designed a system which employs a digital thermometer with a blackened spherical bulb of diameter 10 mm, initially at 20°C that has to be placed at the focus of a concave reflector of diameter 0.2 m. The reflector is directed towards the Sun and the Solar Power incident on the reflector is 100 W m^{-2} . The group members were not sure whether this system will be effective and they also needed to understand another aspect in which renewable energy is used apart from the use of concave reflector.

Task:

- a) Evaluate the effectiveness of the system designed by the group.
- b) Propose, with justification, a real-life application of another aspect the group members were interested in.

Item 4

A manager of a fishing company would like to buy an 8.0 m long fishing boat to safely operate on a lake where there has been a challenge of boats capsizing due to strong winds. Sometimes, thieves/pirates operating on the lake, when not spotted from a far can also cause panic and making it hard to escape. Meteorologist informed the manager that the lake experiences periodic water waves generated by strong winds. The waves approximate progressive sinusoidal waves moving across the water surface. However, the manager has no idea about such kind of waves.

Records show that during a storm, the waves follow the model represented by an equation:

$$y = 1.5 \sin \frac{\pi}{3} \left(t - \frac{2x}{6} \right)$$

Where, y , is the vertical displacement of water from the lake surface, x is the distance moved by the wave in time, t . Note that, y and x are in metres, while t is in seconds.

Boat safety guidelines require that the wave height should not exceed 50% of boat length, the velocity of water waves should not exceed 6.0 m s^{-1} ; and the maximum vertical acceleration experienced by a point on water surface should be less than 1.7 m s^{-2} . The manager would like to know if such a boat is safe for navigation during windy conditions.

The boat crew is expected to have one dedicated member with an optical instrument to help in constant surveillance to avoid attacks from thieves. The manager is not sure of the appropriate instrument and its functionality.

Task:

- a) Evaluate whether the boat is safe for navigation during windy conditions.
- b) Analyse the operation of the instrument needed by the crew member.

Part II

Respond to one item from this part

Item 5

In one of the projects of Electronics Club, the members decided to design a radio tuning system consisting of a variable air capacitor connected in series with a small coil of 200 turns. The Club members did not know the inductance and the length of the coil they were supposed to use. The capacitor was made of 10 identical pairs of parallel plates connected in parallel. Each pair of capacitor plates has an overlapping area of $1.5 \times 10^{-3} \text{ m}^2$ and the separation between the plates is 0.50 mm. The Club members received a signal from one of the radio stations that broadcasts at a frequency of 62.0 MHz. The current in the tuning circuit was 0.20 A, and the coil produced magnetic flux density of $1.0 \times 10^{-3} \text{ T}$.

The circuit was disconnected, and the capacitor charged with a d.c supply. The charged capacitor was then connected in series with the coil and an instrument that detects both **a.c** and **d.c** currents. They did not know why the measuring instrument gave a constant reading. A small piece of solid soft iron was inserted in the coil to see how such an action affects the circuit. The members wondered why the coil became hot.

The following information was provided:

- Permeability of free space, $\mu_0 = 4.0\pi \times 10^{-7} \text{ H m}^{-1}$.
- Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$.

The teacher tasked the Club members to find out how such a heating effect is used in modern science.

Task:

- a) Analyse the information provided and address the challenges faced by the Club members.
- b) Examine the cause of the heating effect observed by the Club members and guide them to respond to their teacher.

Item 6

Your class was taken to one of the battery companies in town. Of late, customers are complaining about the quality of the batteries produced. This prompted the company manager to design an investigation to verify customers' complaints using two quality checks.

In the first check, a battery is connected in series with two resistors of resistances $10\ \Omega$ and $25\ \Omega$. The potential difference across the $10\ \Omega$ resistor was balanced against the potential drop across 715 mm of a uniform potential wire carrying a steady current. The $25\ \Omega$ resistor was then replaced with $33\ \Omega$ resistor while keeping the $10\ \Omega$ resistor unchanged. The length of the same potentiometer wire carrying the same amount of current required to balance the potential difference across the $10\ \Omega$ resistor was found to be 582 mm.

In the second check, an ammeter is connected to a $50\ \Omega$ resistor and a setup which has a soft iron ring with two coils A and B. The battery is to be connected to an inverter which changes d.c voltage to a.c voltage of r.m.s value equal to the e.m.f of the battery. Coil B has turns four times that of coil A. Coil A is to be connected across the inverter while B is to be connected in series with the ammeter and the resistor. The ammeter reading of 0.96 A is expected. The manager told the learners that he anticipates that the resistor will heat up after some time.

The manager further guided that for their type of battery to be pronounced to be good, it should have an internal resistance not exceeding $1.0\ \Omega$ and its e.m.f should be in the range of 11.0 – 13.0 V.

The manager shared this information with the learners as a way of challenging them to see if they mastered the concepts they had already learnt in classroom.

Task:

- a) Analyse the information provided to verify customers' complaints.
- b) Interpret the operation and a real-life application of the device (having A and B)