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

PROVINCIAL EXAMINATIONS AGENCY (PEA)
COUHEIA 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 m s^{-1} at an angle of 30° 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 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:

a. 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.

b. 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:

a. Analyse the information provided and use it to educate the visitors on the observations made at Station A.
b. 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°C. A mercury-in-glass thermometer, initially at 18°C and having a heat capacity of 30 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 J kg^{-1} 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 2.0×10^{-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;

a. Analyse the information provided and use it to educate the client on the optical and wave phenomena demonstrated in the workshop.
b. Help the parent in discovering the focal length of the convex mirror and the fundamental frequency of vibration of the stretched wire.
c. 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°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 μF 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:

a. Analyse the information provided and use it to educate the trainees on the electronic components and charging system demonstrated at the Solar Tech Hub.
b. 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 Ω 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° 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:

a. Analyse the issues of resistance with temperature, the meter bridge experiment, and the magnetic effects including torque on the coil.

b. Interpret the purpose and operation of the copper rod installation at the warehouse.

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