P510/1
PHYSICS
Paper 1
(Theory)
Nov./Dec. 2026
3 hours

UGANDA NATIONAL EXAMINATIONS BOARD

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.*

Respond to **four** *items* **in all**.

Any additional item(s) responded to, will **not** *be scored.*

All *responses* **must** *be written in the answer booklet(s) provided.*

Responses to **each** *item should start on a* **fresh** *page.*

Indicate the item number you are responding to, clearly at the top of the page.

Graph paper is provided.

Mathematical tables and silent non-programmable scientific calculators may be used.

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SECTION A

This section is **compulsory.**

Item 1

A teacher used a motorcycle to go to a Pharmacy to buy medicine for a patient at his home. He bought the medicine and on his way back, he received an emergency call to reach home in less than 5 minutes, if the patient's life was to be saved. At that instant, the motorcycle had power of 10 kW and was moving at 18 km h^{-1}. In order to respond to the emergency call, the teacher accelerated uniformly for 800 m in a straight road. He immediately proceeded to move at a uniform speed along a semi-circular section of the road whose radius is 500 m. At the end of the semi-circular part, the road is inclined at 30° to the horizontal. The teacher ascended under a constant driving force of 1.5 kN, to reach home at the top of the incline.

As the teacher was riding, he observed that the umbrella fixed on the motorcycle was being blown upwards instead of backwards. He also remembered that whenever the motorcycle started to move, the murram particles moved backwards.

The following information is provided:

I. Acceleration due to gravity, $g = 9.81$ m s^{-2}.
II. Total mass of the motorcycle and the teacher = 250 kg.
III. The average coefficient of friction at all road surfaces = 0.2.
IV. $\pi = 3.14$

Task:

(a) Assess whether the teacher reached home in time.

(b) Provide an explanation to;
  (i) the observations made by the teacher.
  (ii) any one real-life application of the effect the teacher observed on the umbrella.

Item 2

An oil company uses pipes manufactured by a reputable industry to transport oil over long distances. For the last few months, the quantity of oil they received at the out let has been less than what they expected. The oil company suspects that there must be some leakage point(s) along the pipe line.

In a bid to locate the leakage points or cracks, the oil company is considering buying of a Geiger Muller Tube (GMT) and two radioactive tracers, X and Y, which are emitters of gamma rays. Tracer X contains 10^{20} atoms and after 1 hour, 9.0×10^{19} atoms will remain un decayed. Tracer Y has a half-life of 5.04×10^{4} s. The tracer with a shorter half-life is preferred. However, the manager is not sure which of the two tracers to buy and how to use it to locate the exact position(s) of the leakage using the device they are to purchase.

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The oil company also thinks that the pipes must be having cracks due to factory production error. The Manager has shared the concern with the Director of the pipe production industry. The pipe production industry is planning to purchase a 15 kV X-ray which will be used to inspect all the newly produced pipes for any cracks before selling them out. The X-ray tube is considered to be effective if it produces X-ray radiation of minimum wave length of 4.1×10^{-10} m.

Support:

I. Planck's constant, $h = 6.6 \times 10^{-34}$ J s.
II. The speed of electromagnetic radiation, $c = 3.0 \times 10^{8}$ m s^{-1}.
III. Electronic charge, $e = 1.6 \times 10^{-19}$ C.

Task:

(a) Recommend, based on calculations, the tracer the oil company should buy.

(b) Describe how the device, the manager is expected to buy, will be used to trace the leakage point(s).

(c) Describe how the device the oil company is expected to buy, can be used to assess the state of the pipes.

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SECTION B

Part I

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

Item 3

During a Physics lesson, a teacher told the learners that it is possible to develop a device which can be used to amplify small voltage changes. As an illustration, the teacher drew the circuit diagram shown in figure **1**.

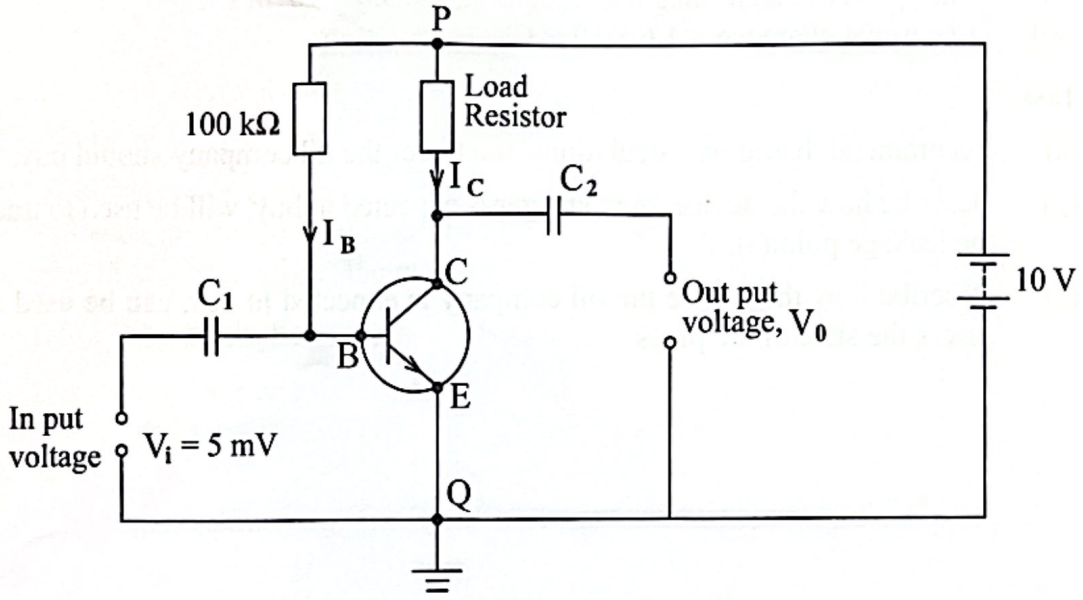


Fig. 1

Using the illustration in figure **1**, the teacher informed the learners that such a device can produce a voltage amplification of 400. However, the teacher neither explained how the device works nor determined the value of the load resistor, but provided the following information: V_{BE} = 0.7 V and current gain = 150.

Task:

(a) Explain how the device works.

(b) Recommend, based on calculations, the size of the load resistor required to produce the voltage amplification provided.

Item 4

Senior five Physics class was divided into two groups. Group **1** was taken to the laboratory, given a specimen on a slide. Their teacher told them to observe the specimen using a compound microscope that was set in normal adjustment. The students observed that the image was magnified by a reasonable factor. They wondered how the microscope in that setting was able to produce such a magnified image.

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Group **2** students were expected to design an optical device in which light is incident on the first face of a triangular glass prism of refracting angle 60 ° and refractive index 1.5. One of the key conditions was that, the light ray grazes the second face of the prism. The students did not know how the required angle of incidence at the first face is obtained, in order to direct the incident ray accordingly.

Task:

(a) Using a ray diagram,

(i) illustrate how the optical instrument is able to produce the magnification observed.

(ii) derive the formula for the magnification produced by the instrument.

(b) Determine the value of angle of incidence needed by students of group 2.

Part II

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

Item 5

Petrol engines run on a mixture of compressed petrol vapour and air, which gets ignited at a spark gap by an electric spark from an induction coil, when starting a car. A mechanic owns a garage and trains recruits on different systems of the car, including the ignition system shown in figure **2**.

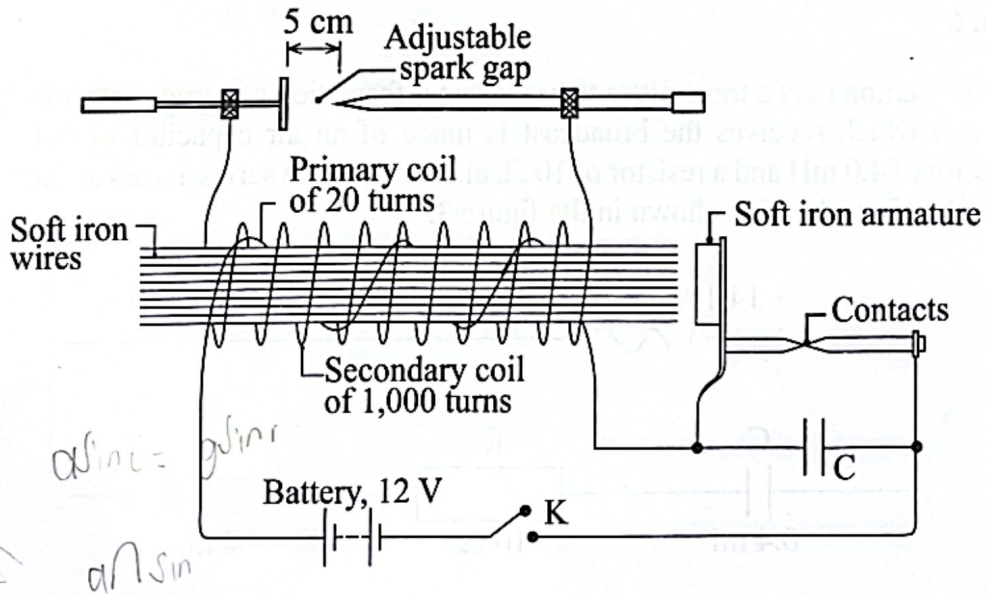


Fig. 2

The mechanic often uses the diagram in figure **2** to show the trainees the circuit of the induction coil used in the ignition start-switch of the car.

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After thorough discussion and analysis of the circuit, the mechanic tasks the trainees to establish whether a 12 V battery can produce an electric field intensity at the spark gap, large enough to cause an ignition spark, given that the dielectric field strength for the mixture of petrol vapour and air at the gap is 10 kV m^{-1} and permittivity of free space, ε_o, is 8.85×10^{-12} F m^{-1}.

At the garage, there is a system that uses a capacitor to store electric charge. The capacitor used has parallel plates, each of area 0.12 m^2, placed 2 mm apart with a plastic material of dielectric constant 5, between the plates and a p.d of 12 V across the plates. Available information indicates that for the capacitor to be effective, it should store at least 3×10^{-8} C of charge.

The mechanic has acquired a new appliance that runs on an a.c voltage of 120 V. However, the sockets at the garage have an a.c voltage of 240 V and the mechanic has to acquire another device for the appliance to work effectively.

Task:

(a) Assess whether the 12 V battery can produce an electric field intensity that is large enough to cause an ignition spark.

(b) (i) Evaluate the effectiveness of the capacitor.
(ii) Explain the effect of the plastic material.

(c) Describe the mode of operation of the device the mechanic should acquire for the appliance to work effectively

Item 6

A radio station uses a transmitter to broadcast information at a frequency of 42.0 Hz. A radio which receives the broadcast is made of an air capacitor of 0.4 mF, an inductor of 4.0 mH and a resistor of 10 Ω, all connected in series across an a.c voltage of peak value 14.1 V as shown in the figure **3**.

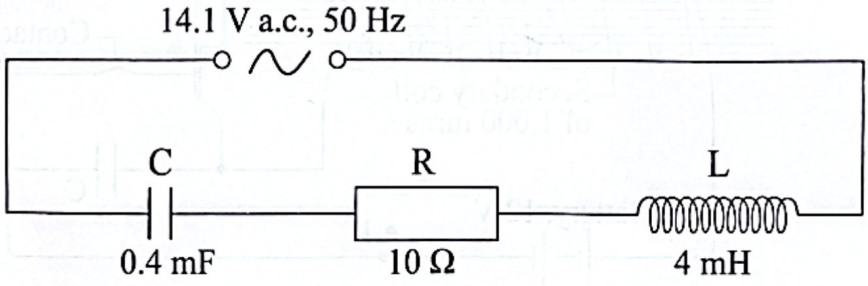


Fig. 3

A student acquired such a radio to use in her room. When the student switched on the radio, the signal was not clear and she thought the cause of the poor signal was due to high consumption of power. The student sought advice of a technician, who

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told her that the average power consumed by such type of radios is less than 8.5W, when working normally. The technician added that the capacitor in the circuit of the radio behaves in such a way that it blocks d.c but passes a.c. The technician proposed to the student that the circuit of the radio required a modification if it were to receive clear signals.

Task:

(a) Explain, based on calculations, why the signals received were not clear.

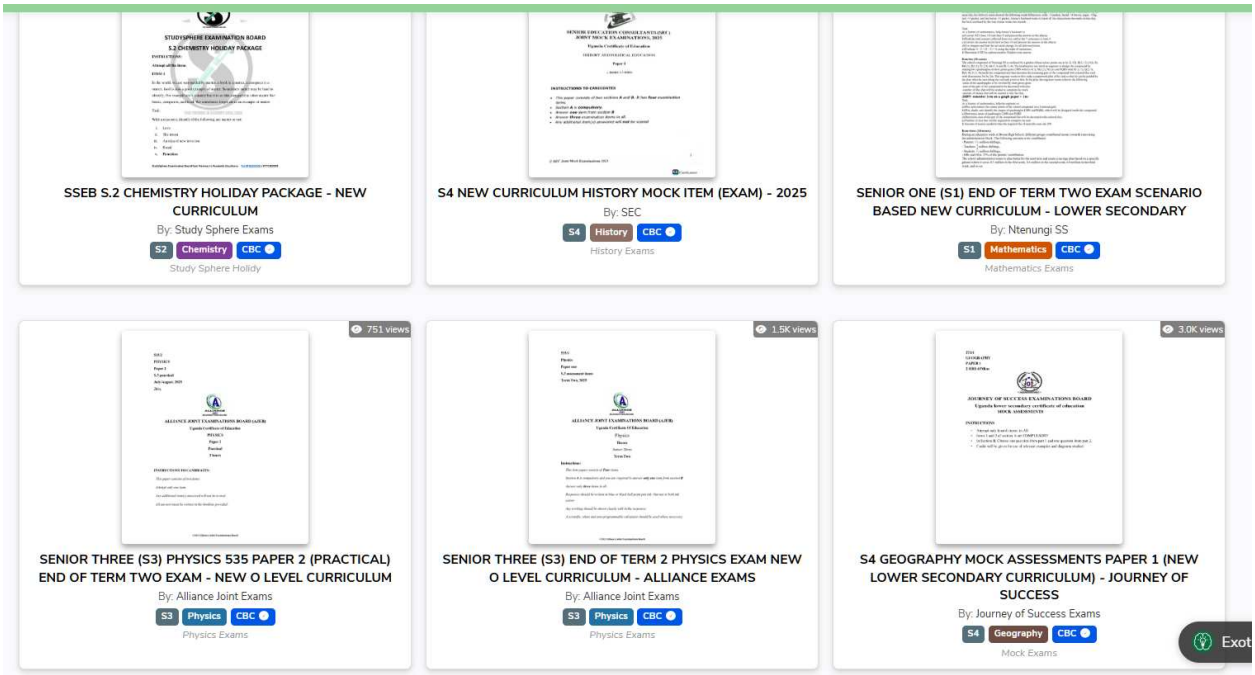
(b) Assess whether the average power consumption of the radio was high.

(c) Explain;
  (i) the behaviour of the capacitor as stated by the technician.
  (ii) based on calculations, the modification required to receive clear signals.

END

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