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PHYSICS
Paper 1
July - August, 2024
2 ½ hours

UGANDA MUSLIM TEACHERS' ASSOCIATION

UMTA JOINT MOCK EXAMINATIONS - 2024

Uganda Certificate of Education

PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

- *This paper consists of* **two** *sections;* **A** *and* **B**. *It has* **seven** *examination items.*
- *Section* **A** *has* **three** *compulsory items.*
- *Section* **B** *has* **two** *parts;* **I** *and* **II**. *Answer* **one** *item from each part.*
- *Answer* **five** *items in all.*
- *Any additional item(s) answered will* **not** *be scored.*

SECTION A

(All items in this section are compulsory)

Item 1.

Consider your school to be organizing an annual Music, Dance, and Drama (MDD) event. To accommodate the large number of spectators, the MDD committee has been tasked with building a stage in the school compound. The MDD stage is to be positioned adjacent to the main hall, to minimize interference of echoes. To ensure optimal stage location, the committee is advised to use a parabolic mirror to focus a laser beam from the proposed stage position to the main hall wall to check for echoes. Additionally, they need to decorate the stage with unique sources of light. However, the committee members are not familiar with some of these tasks and seek your assistance.

Task:

As a physics student, help the committee;

(a) Explain how echoes are formed and why it's important to avoid them during such performances.

(b) To avoid interference of echoes, guide the committee on whether the selected position is a perfect spot for the stage.

(c) Explain why a laser beam should be preferred to the ordinary light in determining distance for the most appropriate echo free stage position.

(d) Describe the setup of a parabolic mirror and how it is used to focus a laser beam.

(e) Explain how a yellow dress with blue spots will appear while on stage when the red light is shone on it.

Hint:

(i) Speed of sound in air = 330 ms^{-1}

*(ii) During the testing, sound from the laser source took **0.16s** to make **one** roundtrip.*

(iii) Stage has been decorated with a source of red light.

Item 2.

Recently, your female friend enrolled in an Astrophysics course in one of the outside countries. After a few days of settling in, she called her parents in Uganda by 9am local time in that country. However, in Uganda, it was 8pm. Her parents had just received the news that the crescent moon had been sighted using the satellite communication, indicating the start of fasting of the holy month. During the phone conversation, she mentioned that her first lecture was about the life cycle of a star. This interested the parents who wondered how a star could have a life cycle and were also curious about the significant time difference between the two countries. The parents seek your explanation about these events.

Task:

As a physics student, help the parents to understand;

(a) What causes the differences in time such that in the country of study is 9am (day time) and Uganda is 8pm (night time).

(b) The crescent moon sighted is believed to have phases; Explain the phases regarding the new moon to full moon.

(c) Briefly describe the life cycle of a star.

(d) During satellite's communication, a combination of logic gates are used to encode and decode messages. For example, an **OR** gate combines two signals, **A** and **B**. If the output of the **OR** gate is true, the satellite transmits a signal back to the Earth otherwise, it does not. Basing on the conditions described, explain whether the satellite will transmit a signal back to the Earth if **A** is false (logic **0**) and **B** is true (logic **1**)?

Hint:

*(Include a truth table for the **OR** gate in your response.)*

Item 3.

It is established that a dairy company produces regular pasteurized milk that contains harmful bacteria. To ensure the effectiveness of the pasteurization process and monitor bacterial growth, the company adds a radioactive isotope tracer, Phosphorus-32 (P-32) to the milk. The tracer helps in tracking and ensuring that the bacterias are destroyed during pasteurization process. However, P-32 is harmful for human consumption until its activity is reduced to a safe level. To monitor the activity of P-32 in the milk to safe levels, the company uses a Geiger-Muller (**GM**) tube to measure the activity over time. The results obtained from the **GM** tube measurements are given in **table 1**.

Table 1: GM tube measurements.

Activity / counts per minute	22000	16000	11400	8200	5800	4000	3000	2400
Time (days)	0	2	4	6	8	10	12	14

Task:

As a physics student;

(a) Help the company by calculating the period to determine when the milk will be safe for human consumption.

(b) Write an advisory note to educate the company on the dangers of exposing themselves to radioactive substances and suggest any safety precautions that should be put into consideration.

(c) Traces of radiations are still found in the milk even though there is no source. This is attributed to background radiations. Explain the concept of background radiations and suggest their common sources.

(d) The **GM** tube can efficiently detect cathode rays but fails to accurately detect X-rays. Explain any **three** differences between Cathode rays and X rays.

Hint:

*(i) Phosphorus becomes inactive after its activity goes below **6000** counts per minute.*

SECTION B.

Part I

Attempt one item from this part.

Item 4.

A community leader who owns a popular village video cinema, is preparing for the upcoming power blackouts during the scheduled maintainace of the area transformer. To ensure uninterrupted entertainment for the villagers, the leader has invested in a diesel-powered AC generator **(Figure 1)** as a reliable backup power source.

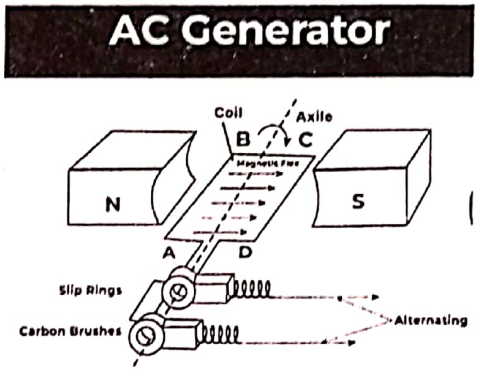

Figure 1: AC Generator

The cinema hall's equipment and the duration at which they will be switched on is given in **table 2.**

Table 2: Cinema Equipment.

Equipment	Power (watts)	Duration (hours / day)
TV	300	14
Refrigerator	3000	5
5 Energy saving bulbs	15 each	12
Loudspeaker	50	8
Automatic electric fan	75	14

Task:

As a physics student;

(a) Regarding the current flow through the sides **ABCD** of the rectangular coil of the **AC** generator as shown in **Figure 1.** Explain how an **AC** generator works.

(b) Use a circuit diagram to explain to the community leader how the automatic electric fan that depends on temperature installed in the hall works.

(c) If the community leader has a budget for fuel less than Shs 100,000 for five days. Comment whether the leader will be able to run the generator for the five days.

(d) Discuss any dangers associated with electricity and suggest the safety precautions.

Hint:

(i) *For every 0.4 litres of diesel consumed, the generator produces approximately* ***1.8 kWh*** *of electric energy.*

(ii) *1 litre of diesel costs Shs 4950*

Item 5.

In the previous rainy season, there was a powerful lightning that was observed striking severely damaging an area transformer causing a power shutdown. The team found out that lightning strike led to a voltage increase in the transformer's secondary coils well above the standard **240V** that is required by the households. **Figure 2** shows the winding of coils in the secondary and primary coils.

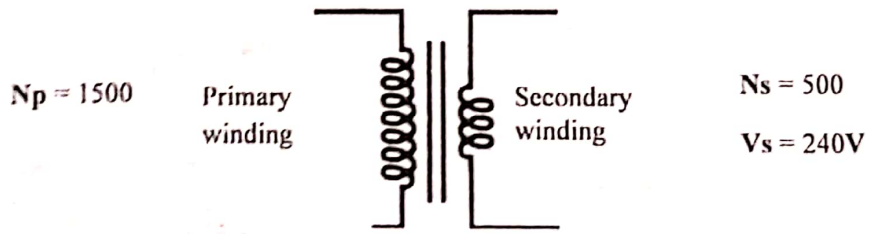

Figure 2: Transformer

This unexpected event led to widespread damage, burning out numerous home appliances and resulting in significant financial losses for the residents. Upon investigating the incident, the team from the local area electricity distribution company discovered a critical electricity anomaly. The homes that suffered the most damage had poorly connected or inadequate earthing systems. Therefore, the team has organised a sensitization program for the citizens and you as a physics student you are invited to be part of the facilitators.

Task: .

As a physics student sensitize the area citizens on;

(a) Suggesting ways on how area citizens can safeguard themselves from such dangers of lightning.

(b) Explain the purpose of earthing in their household electrical system?

(c) Several households wish to install automatic electric bulbs that depend on intensity of light, explain how such bulbs work.

(d) A transformer to be replaced is expected to deliver an output of 20 KW with a primary current of 28.7 **A**. Comment whether such a transformer can be recommended as a good one for use.

(e) Discuss any **two** factors that might affect the efficiency of the transformer and suggest ways to minimize each of them.

Hint: .

(i) A good ideal transformer should operate at an efficiency of between 95% - 99%

Part II

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

Item 6.

An investor seeking to establish a ceramics company requires guidance on using a hydraulic press to manufacture concrete pavers, blocks and bricks. The hydraulic press supplier contacted, provided a manual booklet with a sketch drawing to help the investor understand the technical aspects. The manual has instructions for the hydraulic press to be operated effectively. One of the instructions given, is that the temperature of the hydraulic fluid in it should not rise beyond 20^0C.This is crucial to ensure the press's efficiency and longevity. The investor who is not a physicist seeks guidance to venture into this business.

Task:

As a physics student;

(a) Explain to the investor the working principle of a hydraulic press.

(b) Explain why oil is used instead of air in the hydraulic press.

(c) If 340000 J of heat in the fluid is generated by the hydraulic press during operations. Determine whether it will remain effective if the entire system contains 10 litres of the fluid.

(d) If the hydraulic press has an efficiency of 80% and needs to press concrete requiring an output work of 2000 J. Advise whether it will be in position to start operating.

(e) Explain the main components of concrete and why it is preferred as an effective constructional material.

Hint:

(i) *Specific heat capacity of the hydraulic fluid is 1750* $Jkg^{-1}K^{-1}$

(ii) *The minimum energy input for the press to start working is 1600 J*

(iii) *1 litre =* $0.001\ m^3$

(iv) *Density of hydraulic fluid =* $800\ kgm^{-3}$

Item 7.

After driving for 8 minutes on a slippery road at a constant speed in a busy town, the driver of a fully loaded passenger bus notices a boda-boda rider suddenly crossing the road to pick up a customer. The driver immediately applies the brakes and decelerates but still slightly hits the rider causing damages to both the bus and motorcycle. It takes the bus 80 seconds from the moment the brakes are applied to come to a complete stop. During this time, it is noted that most passengers hit their heads on the seats infront of them. However, during the incident of the accident several boda-boda riders convene and threatened to beat the bus driver for damaging their colleague's motorcycle. However, officers from the police and the bus's insurance company were called upon to come to the scene to access the situation and also calm down the rowdy riders. Upon assessment, the following points were noted:

- Passengers were not wearing seat belts
- Bus tyres were worn out
- A significant amount of heat had been generated due to braking.
- The police officers inquired if the driver had not sighted the road marking signs shown in **figure 3**

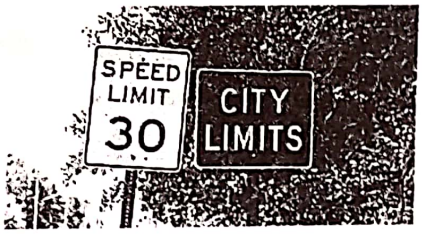

Figure 3: Road marking signs.

Task:

As a physics student respond to the following;

(a) The bus had travelled a total distance of **5.3 km** from when it started the constant speed to when it uniformly decelerated to rest. Determine whether the insurance company will be in position to compensate for the damages.

(b) Suggest reasons why the loaded bus took long to come to rest.

(c) The police was also interested in investigating whether the brakes were in good condition. If the bus was using steel brakes of mass **25 kg** on each wheel, and **7000 kJ** of heat was generated at each wheel, help to determine whether these brakes were appropriate for use.

(d) Discuss any **three** safety precautions that should be followed to minimize road accidents.

Hint:

(i) *The Insurance company only pays back its customers if they are driving within the required speed limits.*

(ii) *Specific heat capacity of steel brakes is* $470\ Jkg^{-1}K^{-1}$ *and their initial temperature is* 20^0C

(iii) *Maximum temperature range for efficient brakes is* $600^0\ C - 700^0C$

END