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PHYSICS
Paper 1
Jul./Aug. 2024
2½ hours

WAKISO-KAMPALA TEACHERS' ASSOCIATION (WAKATA)

WAKATA MOCK EXAMINATIONS 2024

Uganda Certificate of Education

PHYSICS

Paper 1
(Theory)

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.

All answers **must** *be written in the booklets provided.*

SECTION A

Answer **all** *the items from this section*

1. At a major airport, X–ray machines are used to screen luggage and check for weapons and other prohibited items. Recently, a suspicious item was detected in a passenger's bag, but the X–ray image was unclear, causing confusion among security personnel. Further investigation revealed that the X–ray machine's performance was affected by a nearby source of unknown radiation from a shipment containing isotopes of uranium with a known half-life. The security team was concerned about the incidence but couldn't understand how the machine operates, the type of radiation being produced by the radioactive substance, and the likely impact on their health and environment.

Hint:

- The nearby shipment contains isotopes of Uranium of half-life 4.5 billion years.
- The radioactive decay equation for Uranium atom is:

$$^{238}_{92}U \longrightarrow ^{238}_{90}Th + ^{A}_{Z}X$$

Task:

Using the knowledge of physics, help the airport security team understand;

(a) The principle of X-ray imaging and why it is used for checking weapons at the airport.

(b) Which radiation was being produced and what percentage of the radioactive substance will remain after 22.5 billion years.

(c) How to mitigate the impact of the radioactive material on the X-ray machine's operation and ensure accurate luggage screening.

2. A night swimming pool cleaner accidentally dropped his torch into the pool while on duty after a heavy rain that left the whole place logged with storm water and attempted to retrieve it as he was seeing light from the torch appearing closer to the water surface. Unfortunately, he fell into the water in an attempt to remove the torch as his hands couldn't reach the bottom of the pool. He screamed for help when about to drown in water but was surprised to hear his own voice after drowning in water 0.5 s later. After getting out of the water he tried to understand why he heard his own voice by shouting again but this time round the sound came little a bit later than while drowned in water after 0.16 s later and ended up getting confused the more.

Supporting Information:

- Sound travels at different rate in air and water
- The swimming pool is surrounded with a perimeter wall at a distance of 54 m in all directions.
- The distance from where he fell to the tall boundary wall of the swimming pool is

Task:

As a student of physics, help the cleaner;

(a) Understand why he was unable to reach his phone with his hand, even though it seemed close to the water's surface.

(b) (i) Understand why he heard himself at different time intervals after screaming.
(ii) Explain how he was able to hear the while drowned in water

(c) Compare the rate at which sound waves travel in air and water.

3. Learners of a certain school were watching a documentary video by NASA who had recently launched the stellar surveyor mission to the ISS to study the solar system, life cycle of stars, as well as energy they evolve. The crew in the mission was equipped with the Hubble telescope and other equipment to collect data. The narrator said that the mission marked a significant milestone in space exploration, demonstrating the ISS's potential as a platform for advanced space exploration. After the lesson, a leaner was asked to write an article about the space mission so that it can be published in the school magazine but she couldn't provide enough information.

Task:

As a learner of Physics, help the learner come up with a write up to be published in the school magazine about the explanation of the;

(a) Components of the solar system.

(b) Life cycle of stars

(c) Relevancy of the Hubble Telescope and the ISS in the mission.

Turn Over

SECTION B

PART I

Answer **one** *item from this part*

4. During the distribution of hydroelectric power, a certain trading center remained unconnected due to cases of electric cables and transformer oils theft. Community members became worried about relying on solar power during rainy season as majority complain of their phone batteries being spoilt by solar power. Upon demanding the authorities for the service, they were advised to purchase a transformer with 100 turns in the secondary coil and 4583 in the primary to supply the appropriate voltage to run their home equipments but they were concerned that the recommended transformer would produce insufficient voltage than the one required for house appliances.

Hint:

- All home appliances are rated 220 V~240 V
- Electricity at the substation is transmitted at 11 kV with a current of 0.05 A, using thick aluminum cables

Task:

Using your knowledge of Physics, help the locals understand:

(a) If the suggested transformer could run their home appliances.

(b) How the transformer recommended works.

(c) Why thick aluminum cables and high voltage are used during power transmission

(d) How a phone charger converts AC to DC to charge the phone batteries.

5. A fresh graduate has been employed to work at a printing company and given responsibility for maintaining and optimizing the photocopiers. She has recently encountered a malfunction with the machines but does not understand the principles of operation of the photocopier however while the technician was investigating the malfunction in the machine, she realized that motors are applied at the photocopier drum. While testing the machine, electricity unit was consumed and she wondered a bill of shs.10,000 was used up in just one week and wondered how much the machine can consume per month so that the bill is always paid once.

Hint:

- The photocopier is rated 220V, 1200W.
- The photocopier machine operates for 9 hours per day on average.
- The cost of electricity is 1,000/=

Task:

As a learner of Physics, help the fresh graduate;

(a) Understand how the principle of electrostatics is used in the operation of the photocopier machine.

(b) Understand how electrical motors in photocopier machine works.

(c) Know the weekly electricity cost of operating the photocopier machine.

PART II

Answer **one** *item from this part*

6. A plumber was designing a water pump system to transport water from a higher reservoir to a lower reservoir and vice versa. However, he encountered challenges due to the anomalous behavior of water at certain temperatures. The plumber realized that the pump will need to lift 1000 litres of water from a depth of 3000 cm to a height of 10000 cm at 27°C and discovered that the efficiency of the pump decreases at temperatures close to 4°C. He notified the community members about this situation which may affect the process of water supply they couldn't understand.

Hint:

- The densities of water at 4 °C and 27 °C are 1000 kgm^{-3} and 998.2 kgm^{-3} respectively.
- Acceleration due to gravity is 10 ms^{-2}

Task:

As a leaner of Physics, help the community members;

(a) Understand the behavior of water encountered during the design of the water supply system.

(b) Explain the mechanism of supplying water from the higher reservoir to a lower reservoir and from lower reservoir to a higher reservoir.

(c) Know the additional energy required to supply the water from 300 cm to 1000 cm at 4 °C compared to temperature of 27 °C

7. A driver parked the car under a hot day sunshine to have lunch at home and noticed that he was late to pick up his boss from a meeting in town. Worried as he was about being late, he drove as fast as possible for 120 minutes but as he approached the town, one of the car's tyre burst, prompting him to take the car to a garage. He noticed when the mechanic opened the car radiator that it was painted black and water was being used as a coolant but couldn't understand anything. He also questioned what caused the tyre to burst but couldn't get satisfactory explanation having been answered that he was over speeding.

Hint:

- The car traveled 300 km before the tyre burst.
- The speed limit on the road is 80 km/h.

Task:

As a physics student, help the driver;

(a) Understand why water is used in the car radiator.

(b) Explain what caused the tyre to burst.

(c) Know if he was over speeding.

END