

LIGHT COLLEGE KATIKAMU

PHYSICS DEPARTMENT

S4 END OF TERM I

PHYSICS P1

2 hours

Instruction: attempt *all* items in section *A* and *two* items in section *B*. Item 5 is compulsory. Answer *four* items in all.

SECTION A

1. A science exhibition organized by a university drew the attention of government officials, secondary schools and universities. Among the showcased instruments were:
 - A device developed by university's physics department students capable of converting low frequency vibrations ($< 60\text{HZ}$) into electrical signals. It could measure the speed of the vibrations and visualize their characteristics on an attached screen.
 - Secondary school students presented a black box measuring 40cm in length, featuring a small hole at one end and a translucent screen at the other end.

When an official looked through the box, he observed a large tree appearing diminished and inverted, sparking curiosity. The official questioned why there was only one small hole in the box. Additionally, he wondered if the machine could effectively transmit vibrations to electrical signals, particularly in comparison to a nearby road roller.

Hint:

The screen attached to the machine displayed a sine curve and the distance between three successive tops of the curve was 12cm. It also registered the speed of the vibrations as 129.6kmhr^{-1}

The tree was of height 8m and positioned 16m from the hole of the box.

Task:

As a physics student help the official understand;

- a) How the inverted image is formed.
- b) The reason as to why the tree appeared diminished and also help him to know its size as observed on the screen.

- c) Why there's one small hole in the box.
 - d) Whether the machine could effectively convert the vibrations into electrical signals, addressing the official's concerns regarding its functionality compared to a nearby road roller.
2. In the space section of a certain newspaper, various articles were published, including statements about changes in the motion of the earth, moon and sun over time, the challenges facing the solar system and ongoing exploration for habitable places in the universe. However, the locals found it difficult to understand the significance of these news items.
- Utilizing your knowledge of physics, clarify the following points for them:
- a) The motion of the earth, moon and the sun.
 - b) The components of the solar system.
 - c) Why earth remains the only known habitat for humans.

SECTION B

PART 1

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

3. During the midday heat of an extremely hot day, district engineers made a visit to a construction site situated near a primary school. However, one of the engineers expressed concern about a foul odor coming from the primary school latrines. This prompted him to approach the school administrators, who admitted their lack of knowledge regarding the cause of the odor spread, attributing it to hot weather conditions beyond their control. A week later the engineers presented their findings:
- Some construction materials lacked sufficient mechanical properties.
 - Carrying concrete on their heads posed a risk to the builder's safety. They urged them to continue using concrete however recommended reinforcing concrete for increased strength.
 - A small material of the same type as the iron bars used at the site measuring 14cm in length, exhibited an extension of 0.3cm when subjected to a load of 20kg.

This information caused confusion among the builders.

Hint: *the diameter of the iron sample material (having the same properties as the iron bars used at the site) was $7 \times 10^{-2} \text{mm}$, the recommended iron bars should have a Young's modulus of at least $4.0 \times 10^9 \text{Nm}^{-1}$, acceleration due to gravity, $g = 10 \text{ms}^{-2}$*

Task:

Having acquired some physics knowledge, help

- a) The builders understand
 - i) The emphasized mechanical properties highlighted in the report.
 - ii) Why they urged them to continue using concrete, what it means by reinforcing concrete and suggest alternative methods for transporting concrete to higher floors.
 - b) The builders evaluate whether the iron bars used were suitable for construction of such structures.
 - c) The school administrators understand why the odor could spread much during hot days and provide strategies to minimize the odor spread.
4. A group of scouts on a camping trip noticed something unusual about their flag at the lake shore. During hot days, the flag flew towards land and at night, it flew toward the sea, even though there was no wind. They were puzzled by this observation. Later, they met a local farmer who had recently built a dam on his farm. He was unsure about whether it was safe to fill the dam to its full capacity and why the walls of the dam were so thick at the bottom of the dam. Additionally, the farmer was concerned about the quality of milk produced on his farm and suspected that his employees might be diluting it.

Hint: *the dam is 8m deep and can support a maximum pressure of 70000Pa .*

Task:

As a student of physics;

- a) Explain to the scouts why the flag behaved that way.
- b) Help the farmer understand the purpose of thick walls at the bottom of the dam and advise him on whether to fill the dam to capacity.
- c) Suggest a way for the farmer to determine if his milk was being diluted or if there were other factors affecting it.

Use: *density of water = 1000kgm^{-3} , acceleration due to gravity, $g = 10\text{ms}^{-2}$*

PART 2

This item is ***compulsory***

5. In a certain district struck by lightning, schools suffered significant loss of life and property damage. When government officials visited one of the affected schools, they engaged with the students. Among the conversations, a student recounted an incident where he and his friend were caught in heavy rainfall as they moving in school. His friend who was holding a broken metal-handled umbrella was struck by lightning and perished while for him had an umbrella with a plastic handle and survived.

Despite this, the school owner attributed the incident to bad luck and dismissed the need for lightning conductors on the buildings as the government officials had advised him. Due to internet failure, the government team resorted to using a campus needle (magnetic campus) for navigation despite it being their first encounter with the device.

Task:

As a physics student;

- a) Explain to the friend of the deceased why luck wasn't the determining factor in the lightning strike and why he wasn't struck by lightning.
- b) Help the school administration understand the science behind the incident that happened and as to why he should take the officials' advice.
- c) Help the government team understand the functionality of a campus needle for determining direction.