THE MEGA PHYSICS SEMINAR HELD AT VISION FOR AFRICA HIGH SCHOOL NAKIFUMA ON 13TH JULY 2024

Uganda Certificate of Education

PHYSICS

Paper 1

Theory

SECTION A

THEME: LIGHT AND WAVES

Item 1

During the music gala in a hall, one of the adjudicators observed the following;

- the colour of cloth of one of the presenters changed from yellow dress with red dots to red dress with black dots on entering the stage.
- the sound from the nearest loud speaker reached him after 0.05s
- he kept on hearing the voices of two people singing yet he was seeing only one person on the stage.

Hint,

Speed of sound in air =320 ms^{-1}

Task

Using the knowledge of physic, help the adjudicator to understand,

(a) Why the colour of the cloth changed.
(b) Why the sound was reaching him after 0.05s
(c) The origin of the second voice and how it can be minimized.

Item 2

A certain tycoon is intending to construct a first-class hotel in your community. As he was consulting from the technical personnel, he was given the following guide lines on the some of the facilities he wanted to put in place;

- Swimming pull should be having label of its depths at different points to avoid relying on a deceptive look.
- The multipurpose hall must have a soft wall or use curtains along the wall.

- The entrance with security personnel should have strictly white lights as the inside of the hall may have any other LED lights for decoration.

Task

Using the knowledge of physics, help the business man understand;

(a) the cause of deceptive look.

(b) the reason behind multipurpose hall having a soft wall and curtains.

(c) why the entrance must have white lights and how decoration on individuals is attained from inside the hall.

THEME: MODERN PHYSICS

Item 3

During charity work in the hospital by Red Cross Society of a certain school, a certain liquid containing a radioactive material spilled on one student accidentally, having been placed on an open place by a medical intern. The hospital authorities immediately took the student for a mandatory self-isolation within the hospital premises. The parents accused the hospital of negligence and demanded to see their child in a weeks' time.

Hint

- The liquid had an activity of 250 counts per second when tested immediately, with a half-life of 2 days.
- The back ground count rate in the Laboratory was 50 counts per second.
- The student can be safe to re-join the public if the count rate falls below 10 counts per second.

Task

Use your knowledge of physics to:-

(a) Determine how long the student will be self-isolated.
(b) Enlighten the parents on the dangers of having their child at home without medical monitoring.
(c) Explain to the medical intern how such materials should be handled.

Item 4

In a certain family, a child got accident while playing with his friends and it was suspected to be broken leg. The family was referred by nearby health facility to go for

X-ray radiography. The family had already misconception about how X-rays on how they are produced and the related dangers to their child, therefor they were unwilling to go for it. X-ray machine requires a voltage of about 4kV to operate but the available main voltage supply is 10kV.

Hint: *Available resistors are 300 Ω and 200 Ω*

Task

As physics learner,

(a) Help the family
  (i) Clear the misconception about X-rays
  (ii) Understand how X-rays can be used to solve the problem of the family.
(b) Using the knowledge of digital electronics, help your friends understand how a 10kV voltage would be used to operate the machine.

THEME: EARTH AND SPACE PHYSICS

Item 5

In some southern part of south Africa, people were being ordered to vacate their areas and relocate to other parts of the country in anticipation of the heavy rains in the coming months, that are likely to cause flooding and landslides. The Local authorities have been requested by the Ministry of Disaster Preparedness to sensitize the people about the issues. However, they are finding difficulties in explaining to the people:-

- Why rains will be experienced in their area while other parts of the continent are experiencing dry season.

- How it is possible to predict accurately weather patterns before they occur.
- Why there are two seasons threatening them with high rainfall in a period of just a year.

Task

As a student of physics, help the Local authorities understand:-

(a) Variations In seasons as realized by the locals at the same time of the year.
(b) How the weather is always accurately predicted before it happens.
(c) Why the community is experiencing that challenge twice in the same year.

Item 6

An elder in a certain village was narrating his experience of a visit to London to his family members. Amidst the many narrations, the elder said that in London, day time was longer than night with 16 hours of day and 8 hours of night, this was unique to family. The elder also added that stars were rare organisms that died at day time and resurrected at night. Furthermore, the elder also stated that the shape of the moon kept changing over a month's cycle. Some of those experiences are equally found in their village but others were news to them. Unfortunately, they all did not understand the occurrences.

Task

As a student of physics, help the elder and his family to understand;

a) what the unique observed in London came about?
b) the observation of stars at day time and night time.
c) why the shape of the moon keeps on changing over the period of one month

SECTION B

PART I

THEME: HEAT AND MECHANICS AND PROPERTIES OF MATTER

Item 7

Your class intends to undertake a physics project to make a thermometer to be used in a physics laboratory. At the planning stage, the following questions have come up;

How to select the suitable liquid to be used

How to come up with the graduation on the thermometer.

Task

As a physics learner,

(a) Help your friends understand;
  (i) The factors you must consider to come up with a suitable liquid.
  (ii) How the thermometer is going to be given the graduations.
(b) If the volume of the liquid required is $5cm^3$, using the knowledge of principles of moments on how you would determine the density of the liquid to be used in the absence of a measuring cylinder or any other apparatus for measuring volume.

Item 8

The business man intends to install a storage gravity water tank in his home which should supply pressure at 10kPa. He also needs his tank to have a ladder with steps each of height 40cm for climbing up to clean his tank. To avoid bursting of the tank due to expansion and contraction of the pipes used due to extreme weather conditions, he has been advised to buy a pipes made of a material of specific heat capacity between $850Jkg^{-1}K^{-1}$ and $900Jkg^{-1}K^{-1}$.

Hint;

Density of water = $1gcm^{-3}$

Acceleration due to gravity = $10ms^{-2}$.

Task

Using the knowledge of physics;

(a) Help the business man understand,
  (i) the height the tank must be raised to.
  (ii) the number of steps to be put in the ladder.
(b) Help the business man understand by outlining the steps that would be taken to determine the suitability of the material of the pipes to be used.

Item 9

Your parents operating a diary business and buy on average five jerricans daily. Before buying any milk from any farmer, its purity is first tested using a hydrometer. One evening the hydrometer accidentally fell down and stopped working yet the milk

must be tested before buying. The milk put in a refrigerator which automatically switches off when the temperature of the milk has dropped from room temperature to a temperature of 10^0C .

Materials; beam balance, measuring cylinder and beaker.

Hint;

Volume of each jerrican of milk is 20 litres

Room temperature = 24^0C

Specific heat capacity of milk = $3.14Jkg^{-1}K^{-1}$

Density of pure milk = $1035kgm^{-3}$

Task

Using the knowledge of physics, help the parents;

(a) Determine the purity of the milk in absence of a hydrometer.
(b) Understand how much heat energy is withdrawn by the refrigerator from the milk.

Item 10

In a certain home, water is got from underground well for cooking and some boiled for drinking, using a rope and a bucket. This is the responsibility of children. One day children raised a complain to the father that pulling water using a rope and a bucket is tiresome. They suggested that the simple machine for pulling be designed for them. The water for drinking is then boiled from a temperature of 24 ^{0}C to 90 ^{0}C using aluminum saucepan of mass 2kg and the volume of water boiled per day is 10 litres.

TASK

Using the knowledge of physics, help the family;

(a) design the simple machine that can be used and understand how it works.
(b) understand how to improve on efficiency of the machine in (a) above.
(c) understand how much heat energy is used daily by the family to boil drinking water.

Use;

Specific heat capacity of aluminum $= 900Jkg^{-1}K^{-1}$

Specific heat capacity of water $= 4200 Jkg^{-1}K^{-1}$

Density of water $= 1000 kgm^{-3}$

PART II

THEME: ELECTRICITY AND MAGNETISM

Item 11

During a physics study tour to an electricity generation substation, learners were taken through the various processes of electricity generation to consumption. However, the learners observed the following, though they didn't understand due to limited time:-

- Electricity is transmitted at 13 KV in alternating current of 0.05 A.
- The voltage taken into houses for home consumption was 240 V with a little higher direct current in this case.
- The workers in the sub-station were wearing majorly rubber gloves and shoes.

Task

Using the knowledge of physics, help the learners understand:-

(a) Why the power is transmitted in a different form to the one consumed.
(b) And determine the exact current taken into the house for consumption.
(c) How the voltage changed from the transmission voltage to the consumed voltage.
(d) Why the workers chose the rubber shoes and gloves.

Item 12

A businessman constructed his house near a high-power line of 15 KV with 0.08 A. He intends to connect his house to the power and use some electrical appliances for a start. He consulted an electrician who assured him, that they can connect power line direct to reduce costs.

The businessman was warned by his colleagues that he risks burning down his house if he continues with the electricians' plan.

Hint

- The businessman wants to start up with the following in house.

Item	Number	Power rating	Time of use (hours)
Inside bulbs	4	60 W	8
Security bulbs	2	100 W	14
A television	1	120 W	20
A speaker	1	300 W	20
A fridge	1	600 W	4

Task

Using the knowledge of physics, help the business

(a) Understand
   i. Why his house can easily burn down and explain what he can do to get power safely.
   ii. How he may recommend for the connection of the bulbs in the house and why?

(b) Determine his weekly expenditure on electricity if the appliances are used daily, taking the unit cost of the electricity unit as Ushs. 550.

(c) Know the practices he needs to adapt which ensure his safety basing on the location of his house.

Item 13

On a rainy day, a certain house was struck by lightning, instantly destroying its fuse in the meter box. The family members were all safe but were advised always to take precautions while its raining.

Hint;

Power supplied to the house through the metre box is 240 V and the fuse made of a material of resistance 480 Ω.

Task

Using the knowledge of physics;

(a) Explain to the house owner how he can safe-guard his house from such occurrences in the future.

(b) Suggest precautions the family members should always take to be safe when such a situation arises.

(c) Determine the rating of the fuse and the current above which may have caused it to burn.

Item 14

6. A home owner was recently told electricity from a power substation is transmitted at 12 KV using thick aluminum cables to be used in a house at 240V. The home owner is however confused by how the electricity changes voltage from one value to another and says the thick cables are a waste of money. Inside the house are two sets of appliances of resistance 20Ω and 30Ω but the house owner is not sure of how they should be connected to ensure they work effectively.
   Use your knowledge of physics to;
   a) Help the home owner understand how the electricity changes from 12 KV to 240V.
   b) Why thick aluminum cables are used.
   c) How the appliances should be connected to ensure that they work effectively with a high amount of current.