**PHYSICS SCENARIO ITEMS 2024**

## A. SPACE PHYSICS

**Item 1.**

In a certain country, a Television (TV) reporter was reporting live near the ocean about the high tides during night time. Viewers in another country were watching the live broadcast of the news bulletin during day time. The viewers wondered how it could be day and night at the same time, and how the event in one country could be watched live on TV in another country.

**Task**

Using your knowledge of physics, help the viewers to understand;

(a) the possibility of it being day in one place and night in another place.

(b) the occurrence of high ocean tides.

(c) how an event in one place can be broadcast live in another country.

**Item 2**

One of the most important components of our solar system is the sun. Another important component of our solar systems are the big masses called planets.

(a) Name all the planets found in our solar system.

(b) (i) Identify the planet that sustains life in our solar system.

(ii) How are the times and seasons of the year explained on the planet mentioned in (ii) above?

(c) Explain the statement “the sun has a life cycle”.

**Item 3**

On November 7th 2022, Uganda launched its first satellite named PearlAfricaSat-I into space with the help of National Aeronautics and Space Administration (NASA). The purpose of the mission was to study weather patterns. Students of physics were availed with data collected over a certain of time and they noticed the following while some places were having day time. Other places were having night time. Various places were having different seasons.

**Task:**

As a learner of physics

(a) Explain why some places had daytime while it was night time at other places.

(b) Explain why different places had weather patterns and how world- wide communication is made possible through satellites.

## B. LIGHT AND WAVES

**Item 1.**

During a science project, learners are given two mirrors; a concave mirror of focal length 20cm and a convex mirror of focal length 20cm.

**Task:**

As a learner of physics;

(a) help the students to determine which mirror forms a bigger image of a man of height 4cm standing 25 cm a way from each of the mirror.

(b) write a brief report about the nature of image formed by each mirror

(c) advise which mirror is suitable for use as driving mirror

**Item 2.**

A brass band was invited to play during a celebration near a tall building, a distance slightly more than 17 m away. Two friends standing in the same direction and in line with the playing band, heard the sound from the band at different intervals of time which attracted them to go and attend the celebration.

On arrival, the sound they heard was unclear, confused and indistinct. Later in the night during the cerebration, coloured lights flashing red, blue and green made the colours of their clothes look different from the original colours which puzzled them. The two friends heard sound after 4 s and 5 s, respectively and were originally wearing yellow clothes.

**Task:**

As a physics student, help the two friends to understand why;

(a) they heard the sound at different intervals.

(b) the sound they heard was unclear, confused and indistinct.

(c) the colour of their clothes kept changing when coloured lights flashed on them.

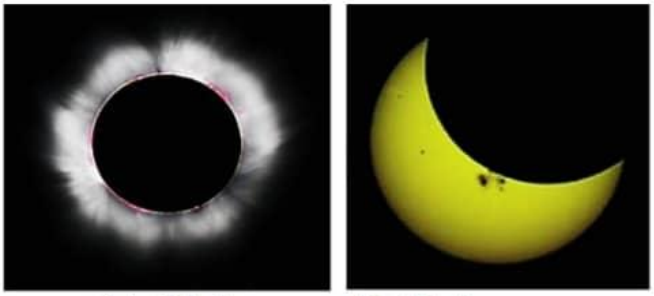
Speed of sound in air = 330 $ms^{-1}$

**Item 3**

Long time ago eclipses were considered as a message from the gods sine the people in that age dwelt so much in the spiritual realm than the scientific word. But with the development of science and technology, eclipses can now easily be explained scientifically instead of spiritually. Whenever eclipses occur many people gather out in open places to watch the beautiful view of the heavenly bodies as they align themselves in a beautiful display.

However, in most remote areas of Uganda some people still observe the eclipse directly using naked eyes not aware of the risk they are exposing their eyes to in the long run.

SUPPORT MATERIAL



(a) Total eclipse (b)Partial eclipse

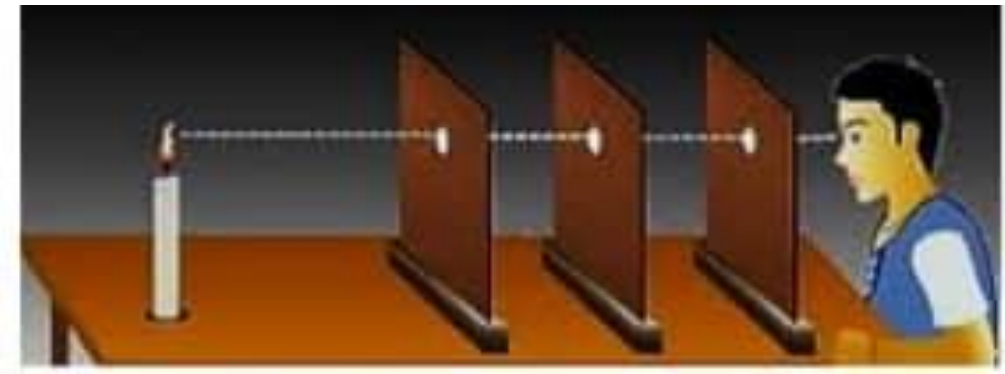
**Task:**

As a learner of physics;

(a) Explain the difference between total and partial eclipse.

(b) Using illustrations, explain the differences between solar eclipse and lunar eclipse.

(c) In a certain experiment to investigate nature of light, the set up below was arranged.

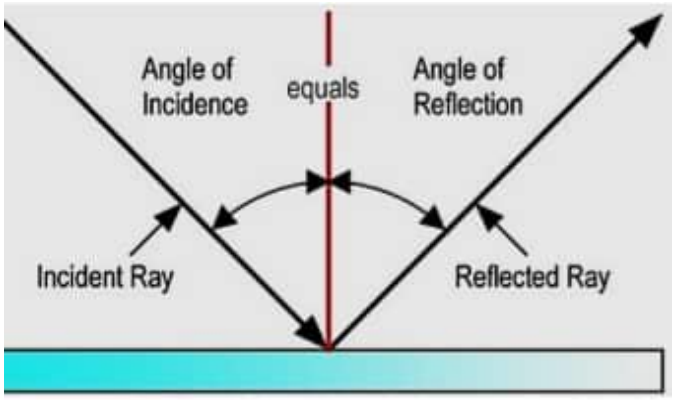


(i) State the property of light being investigated and explain its implications in daily life.

(ii) Explain what would happen when one of the cardboards is displaced slightly.

**Item 4**

We normally see the images of our faces when we look into the mirror. This is due to reflection of light.




**Task:**

As the learner of physics;

(a) State the laws of reflection of light and use them to find the glancing angle if the angle of reflection is $35^0$.

(b)

(i) Describe the nature of the images formed by plane mirrors.

(ii) State the real-life applications of plane mirrors.

(c) With the aid ray diagrams, describe the differences between images formed by plane mirrors and a pin hole camera.

**Item 5**

While in your literature lesson, your teacher asks your friend to stand up and read for the class a book of Oliver Twist, however your friend always tells your literature teacher that she is unable to see the letters in the books and even when she sits near the board, she's unable to see but your teacher and other fellow literature students think she's bewitched. On the s.4 leavers party, a boy of height 120cm stands in front of a lens camera with a lens of focal length 40cm at a distance 160cm from camera.

**Task**

As a learner of physics,

(a) By scale drawing find the; nature size and position of the image of the boy on the camera

(b) explain to your fellow students and the literature teacher the cause of the problem and the would-be possible solution to the above problem

**Item 6**

A certain student was puzzled that the shallow end of the swimming pool at his school appeared to be about 1.5m deep when in the actual sense it was 2.0 m.

(a)

(i) Use a ray diagram to illustrate student's puzzle and explain why the swimming pool appeared shallower than it is actually is.

(ii) Determine the refractive index of the water in the swimming pool at school

(b) A barber was given a curved mirror of focal length 30 cm so that he could use it as a shaving mirror in his salon.

(i) Identify the type of curved mirror given to the barber and using a ray diagram explain how the selected curved mirror is used as a shaving mirror.

(ii) State the properties of the image formed above?

(c) Which type of curved mirror is suitable to be used as a side mirror and why?

**Item 7**

During a science project, learners are given two devices; a pin hole camera of length 50cm and a concave mirror of focal length 50cm.

As a learner of physics;

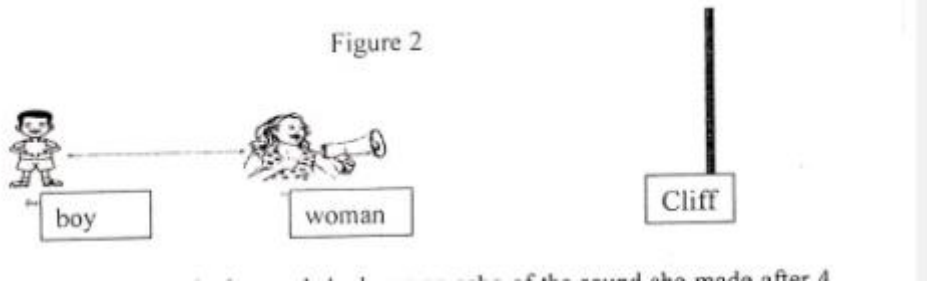
(a) Help the students to determine which instrument forms a bigger image of a man of height 1.8m standing 2m away from each of the instruments.

(b) Explain the difference in the properties of the images formed by the two instruments and identify the practical applications of the instruments.

**Item 8**

Two people stand in front of a cliff at an unknown distance between them as shown below.

Figure 2




The woman calls out the boy, she hears an echo of the sound she made after 4 seconds while the boy hears the same echo 3.5 seconds later.

**Task:**

As a learner of physics;

(a) Help these people to determine the distance between them.

(b)

(i) Write a report about the factors that increase the rate of movement of sound.

(ii) Explain why it would be easier for the sound to travel from the girl to the cliff at night than during the day.

## C. ATOMIC AND NUCLEAR PHYSICS

**Item 1**

In a certain town, people are concerned about the waste disposal from the factory into nearby lake which is their source of water for home use. They raised this issue to the chairperson Local Council 1 (LC1) who directed the management of the factory to stop disposing waste into the lake. A scientist was contacted to investigate the presence of radioactive material in the water. The scientist found out that the water was indeed radioactive as shown in table 1.

| Time/days | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| Activity/counts per minute | 1200 | 740 | 440 | 260 | 160 | 90 | 60 |

Although the water from the lake remains radioactive for a long time, the scientist recommended that water will be safe for use again when the activity is less than 38 counts per minute.

**Task:**

As a student of physics;

(a) Advise the chairperson LC1 about the time the community will wait for the water to be safe for use again.

(b) Sensitise the members of the community about the risks associated with radioactive materials and how such materials should be handled.

## D. MECHANICS AND HEAT

**Item 1.**

In certain town it's a must for drivers to be tested together with their vehicles for road worthiness. On certain day, a car started from rest and accelerated to 50m/s in ten seconds. The driver maintained that velocity for 20s and suddenly decelerated to rest in 2s making him to crash into the wind screen.

**Task:**

As a learner of physics,

(a) Draw a graph to show the relationship between velocity and time for the car.

(b) State whether the driver's average velocity does not exceed the town's speed limit of 8m/s.

(c) Find the rate at which the car's velocity reduces

(d) Explain why the driver crashed into the wind screen and how this can be prevented

**Item 2**

Zacharias is puzzled because his metallic doors are always very hard to close during day time when it is shining too much, and he says that the same doors are very easy to close in the evenings when the temperatures have lowered by considerable amounts.

**Task:**

As a Physics learner who understands better, the effect of temperature change on matter:

(a) Explain the cause and applications of Zacharias' puzzle in our daily life

(b) Basing on the kinetic theory, explain why liquids expand much more than solids for the same temperature change?

(c). Explain the Biological importance of the anomalous expansion of water in preserving aquatic life in countries like Switzerland where temperatures go below $0^{o}$ C, relating to the diagram shown below.

**Item 3**

Some bottles of colourless liquids were being labelled when the technicians accidentally mixed them up and lost track of their contents. $\mathbf{15.0}\ \boldsymbol{ml}$ sample withdrawn from one bottle weighed 22.3 g. The technicians knew that the liquid was either acetone, benzene, chloroform, or carbon tetrachloride. He however has challenges identifying the right chemical to label.

**SUPPORT MATERIAL (hint 1ml =1cm$^3$)**

| LIQUID | Acetone | Benzene | Chloroform | Water | Carbon tetrachloride |
|---|---|---|---|---|---|
| DENSITY ($\boldsymbol{g/cm3}$) | 0.792 | 0.899 | 1.487 | 1.000 | 1.595 |

a) What was the identity of the liquid? (Clearly show each step of your work out)

b) Using the table above Name those liquids which can float on water and explain why they float on water

c) Using the table Name those liquids on which water floats on top and explain why water floats on those liquids named.

**Item 4**

In your trading Centre, empty mineral water bottles are scattered everywhere, thus causing blockage of trenches. A business man came to your trading Centre to buy empty mineral water bottles and pays according to the mass of each bottle. The businessman only buys bottles whose mass exceeds 30g. Your brother wants to sell his mineral water bottle but wants to know its mass before selling to the businessman and has no access to any instrument measuring mass.

**Task:**

You are given a metre rule, a knife edge, a 100g mass and two pieces of thread. As a student of physics describe how you will assist your brother to determine the mass of the bottle so that he is able to sell it. In your investigation you find that when a mass of 100g is placed 15.0cm from the knife edge placed at the Centre of gravity of the metre rule, the bottle should be placed 37.5cm for the metre rule to balance. Assist your brother to find out whether the bottle can be sold to the businessman.

**Item 5**

A certain home owner intends to put up a metallic tank of height 4 m with a maximum volume of 5000 l fitted with an electrical heater which supplies 20,000 kJ of heat energy as shown in figure 1.

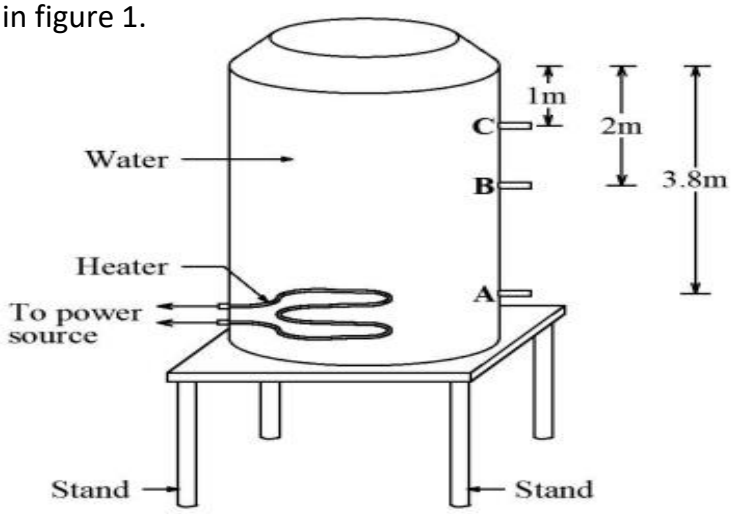



**Fig. 1**

The home owner found out that the heater was fitted at the lower part of the tank but he did not understand why it was done like that. Just before the hole for the outlet pipe was drilled at point A, the home owner told the person with the drill that the correct position was either B or C. Task: As a learner of Physics;

(a) Explain to the home owner why;

(i) the electrical heater was fitted at the lower part of the tank and how eventually all the water gets hot.

(ii) the outlet pipe was drilled at point A.

(b) If the initial temperature of the water in the tank is 20 $^{o}$C, help the home owner to find out if the heater is working.

(c) Advise the home owner on measures that can be taken to ensure that the tank stand can withstand the weight of the tank and water for a long time.

Use: Density of water = 1000 kgm$^{-3}$. Specific heat capacity of water = 4200 J kg$^{-1}$ K$^{-1}$. Acceleration due to gravity = 10 ms$^{-2}$

**Item 6**

A certain hotel has its bathrooms situated on the 3rd floor of a building. A customer of the hotel expects to bathe water at 32 $^{o}$C. The hotel provides 10 litres of water at 20 $^{o}$C to each customer. A boiler on ground floor heats water to 80 $^{o}$C for the customers to use. The hotel management does not allow its workers to carry the hot water via the staircase.

**Task:**

Having studied physics;

(a) help the hotel management to determine the quantity of hot water to be given to a customer for bathing.

(b) advise the hotel management on how to keep the boiled water hot for a long period of time without keeping the boiler on.

(c) explain to the management how the water from the boiler can reach the third floor safely.

Use: Density of water = 1000 kgm$^{-3}$. Specific heat capacity of water = 4200 J kg$^{-1}$ K$^{-1}$. Acceleration due to gravity = 10 ms$^{-2}$

**Item 7**

A jackfruit of mass 2500g is plucked off fruit the jackfruit tree from a height 4m above the ground and falls freely. The jackfruit accelerated to the ground and hit the ground.

**Task.**

As a learner of physics;

(a) State and calculate the form of mechanical energy stored in the jackfruit before falling.

(b) Determine the kinetic energy of the fruit as it hits the ground stating clearly the assumption and hence calculate the velocity with which it hits the ground.

(c) Explain why the jackfruit comes to rest after hitting the ground and does not bounce back to the original height hence state the law shown by the behaviour of the fruit.

(d) Determine the kinetic energy possessed by the fruit as it passes a point 1.5m above the ground.

**Item 8**

For man to earn a living, he has to do some work. A certain business man has to climb 20 stairs each of height 20cm to reach out his business store on the first floor of their business Arcade in Kampala city.

Stairs

**Task:**

As a physics scholar;

(a) Help a lay man to understand the meaning of the term "work" and state its appropriate S.I units.

(b) If the businessman has a mass of 73.5kg and is holding a bag of mass 1.5kg, determine the work done by the man when climbing the stairs and the power dissipated in 5minutes.

(c) Explain why it is easier for the man to move down stairs than climbing them.

**Item 9**

At a certain construction site in a given town casual labourers were required to raise construction materials to the 3$^{rd}$ level which was 2400m from the ground, they requested for a crane consisting of a pulley system of velocity ratio 7. The operator raised a total load of 40,000N using an effort of 8,000N.

**Task:**

As a learner of physics;

(a) Draw a diagram to illustrate the pulley system contained in the crane.

(b) Determine the efficiency of the pulley system.

(c) (i) Explain why the efficiency of the machines is always less than 100% and state how it can be improved.

(ii)State the applications of pulleys in our daily life.

**Item 10**

A heap of weed of mass 3 tonnes is moving towards the turbines at the Jinja power station. A group of engineers needs to use a machine operating at 20 kW for five minutes, to remove the weed from the river as shown in Figure and place it at the bank, which is 15 m above the river.

Figure 1

(a) Determine the efficiency of the machine and explain its value.

(b) Explain how the machine is capable of floating in the water yet it is denser than water.

**Item 11**

The figure below shows a uniform metallic rod of length 4.0m pivoted at its centre that is used at a certain children's play resort.

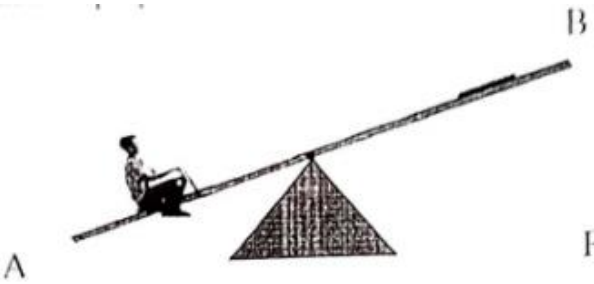



Figure 1

**Task:**

As a physics scholar;

(a) Given that a boy of mass 48kg sits 1.5m from end A. Help the guide at play resort to determine if another boy of mass 40kg will restore equilibrium in the beam if he sits at a distance of 0.6m from the centre.

(b) Identify two other instances in which the knowledge in this scenario would be applicable in real life.

(c) With the boys off the rod, explain what would happen to the beam if the end B was heated by a considered hot flame.

## E. ELECTRICITY AND MAGNETISM

**Item 1**

Small pieces of metal which are unsafe to be eaten by chicken were found in feeds that had just been bought from a milling company by a poultry farmer. The small pieces of metal were later identified as iron. The farmer thought of disposing off the feeds but remembered that the pieces of metals could be sorted with a magnet which he did not have.

**Hint:**

A nail connecting wires of resistance 0.5Ω, two dry cells each of 1.5V were available to the farmer.

**Task:**

As a student of physics;

(a) Help the farmer to remove the pieces of iron from the feeds.

(b) Comment on the effectiveness of what you have designed, given that current of 4A is enough to create a strong magnet.

**Item 2**

In a certain place, electricity is transmitted at 120V. A business person intends to connect 4 bulbs in a house rated 240V, 60w each and other domestic electrical appliances such that there is minimum power wastage. The business person has been advised to purchase a transformer of suitable specifications to achieve the objectives. The business person does not know what a transformer is, how and is bothered by the type of transformer that should be purchased.

**Task:**

As a student of physics, help the business person to solve the problems he/she is faced with.